Punjab MASSTRANSIT AUTHORITY (PMA)



TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

December - 2025

BIDDING DOCUMENTS – VOLUME I

- Instructions to Bidders (ITB)
- Bidding Data
- Forms of Bid and Schedules to Bid
- General Conditions of Contract
- Particular Conditions
  - Part A – Contract Data
  - Part B – Special Provisions

National Engineering Services Pakistan (Pvt.) Limited
Construction Manamgement Division, NESPAK House,
1-C, Block N, Model Town Extension, Lahore

Clearance Code	4768/13/BD/1225	Doc. No.	4768 – 01	Rev No.	00

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INSTRUCTIONS TO BIDDERS

A. GENERAL

IB.1 Scope of Bid

1.1 The "Employer" as defined in the Bidding Data, hereinafter called the "Employer" wishes to receive Bids from eligible Bidder or JVs Partner/Consortium on EPC (Engineering, Procurement and Construction) mode and Remedying any defects therein) of works as described in these Bidding Documents, and summarized in the ***Bidding Data*** hereinafter referred to as the "Works".

1.2 The successful Bidder will be expected to complete the Works within the time specified in ***Bidding Data***.

IB.2 Source of Funds

2.1 The Employer has applied for/received a funding from the source(s) in various currencies towards the cost of the project specified in the Bidding Data and it is intended that part of the proceeds of this funding will be applied to eligible payments under the Contract for which these Bidding Documents are issued.

IB.3 Eligible Bidders

3.1 This Invitation for Bids is open to all Bidders meeting the following requirements at the time of submission of Bids and thereafter:

a) Duly eligible for this bidding process;

b) Duly licensed by the Pakistan Engineering Council (PEC) in the category relevant to the value of the Works in the relevant field of specialization.

However, a Foreign Constructor can submit provisional license with its Bid but the Foreign Constructor will be required to submit standard license after award of Contract and before start of work.

Foreign Constructor shall not be eligible to participate in bidding individually. Foreign Constructor shall enter into joint venture with Pakistani Constructor registered with the Pakistan Engineering Council in equivalent/compatible category and submit the joint venture agreement to the Employer before participating in bidding in accordance with PEC Construction and Operation of Engineering Works Bye-laws, 1987;

c) Pakistani Constructor must be on Active Taxpayer List of the Federal Board of Revenue and provincial revenue authority/ board where applicable; and

d) All partners constituting the Bidder including proposed subcontractors do not appear in the list of debarred/ blacklisted firms and individuals on the websites of

PEC and Federal & Provincial Procurement Regulatory Authorities and have not been declared debarred/ blacklisted by foreign country, international organizations or other foreign institutions.

IB.4 Eligible Materials, Equipment and Services

4.1 All materials, equipment and services to be supplied under this Contract shall have their origin in eligible countries described under paragraph 4.4 hereunder.

4.2 For purpose of this Clause, "origin" means the place where the Goods are mined, grown or produced or from where the ancillary services are supplied. Goods are produced when, through manufacturing, processing or substantial and major assembling of components, a commercially recognized product results that is substantially different in basiccharacteristics or in purpose or utility from its components.

4.3 The origin of Goods and Services is distinct from the nationality of the Bidder.

4.4 Eligible countries to participate in this bidding process are those which have been notified by Ministry of Interior, Government of Pakistan as Business Friendly Countries (BVL); information can be accessed through following link: http://www.dgip.gov.pk/Files/Visa%20Categories.aspx#L

IB.5 One Bid per Bidder

5.1 Each Bidder shall submit only one bid either by himself, or as a partner in a joint venture. A Bidder who submits or participates in more than one Bid (other than alternatives pursuant to Clause IB.17) will be disqualified.

IB.6 Site Visit

6.1 The Bidders are advised to visit and examine the Site of Works and its surroundings and obtain for themselves on their own responsibility, all information that may be necessary for preparing the Bid and entering into a contract for Construction of the Works. All cost in this respect shall be at the Bidder's own expense.

6.2 The Bidders and any of their personnel or agents will be granted permission by the Employer to enter upon his premises and lands for the purpose of such inspection, but only upon the express condition that the Bidders, their personnel and agents, will release and indemnify the Employer, his personnel and agents from and against all liability in respect thereof and will be responsible for death or personal injury, loss of or damage to property and any other loss, damage, costs and expenses incurred as a result of such

inspection.

B. BIDDING DOCUMENTS

IB.7 Contents of Bidding Documents

7.1 The Bidding Documents, in addition to invitation for Bids, are those stated below and should be read in conjunction with any Addenda issued in accordance with Clause IB.9.

1. Instructions to Bidders;
2. Bidding Data;
3. Schedules and Forms to Bid;
4. Letter of Technical and Price Bid;
5. General Conditions of Contract, (GCC);
6. Particular Conditions of Contract, (PCC);
   - Part A- Contract Data;
   - Part B – Special Provisions;
7. Employer's Requirements
   - Design Requirements
   - Operation Requirements
8. Specifications
   - Technical Specifications
   - Specific Specifications
9. Referenced Bill of Quantities
10. Referenced Drawings

7.2 The Bidders are expected to examine carefully the contents of all the above documents. Failure to comply with the requirements of Bid submission will be at the Bidder's own risk. Pursuant to Clause IB.26, Bids which are not substantially responsive to the requirements of the Bidding Documents will be rejected.

IB.8 Clarification of Bidding Documents & Pre-Bid Meeting

8.1 Any prospective Bidder requiring any clarification(s) in respect of the Bidding Documents may notify the Employer in writing at the Employer's address indicated in the Invitation for Bids. The Employer will respond to any request for clarification which he receives earlier than the period specified in the ***Bidding Data***, prior to the deadline for submission of bids.

8.2 Copies of the Employer's response will be forwarded to all purchasers of the Bidding Documents, including a description of the enquiry but without identifying its source.

8.3 The Employer may on his own or at the request of any prospective Bidder(s), hold a pre-bid meeting to clarify issues and to answer any questions on matters related to the Bidding Documents. The date, time and venue of pre-bid meeting, if convened, are as stipulated in the ***Bidding Data***. All prospective Bidders or their authorized representatives shall be invited to attend such a pre-bid meeting.

8.4 The Bidders are requested to submit questions, if any, in writing so as to reach the Employer not later than seven (07) days before the proposed pre-bid meeting.

8.5 Minutes of the pre-bid meeting, including the text of the questions raised and the replies given, will be transmitted without delay to all purchasers of the Bidding Documents. Any modification of the Bidding Documents listed in Sub- Clause IB.7.1 hereof which may become necessary as a result of the pre-bid meeting shall be made by the Employer exclusively through the issue of an Addendum pursuant to Clause IB.9 and not through the minutes of the pre-bid meeting.

8.6 Absence at the pre-bid meeting will not be a cause for disqualification of a Bidder.

IB.9 Amendment of Bidding Documents

9.1 At any time prior to the deadline for submission of Bids, the Employer may, for any reason, whether at his own initiative or in response to a clarification requested by a prospective Bidder, modify the Bidding Documents by issuing addendum.

9.2 Any addendum thus issued shall be part of the Bidding Documents pursuant to Sub-Clause IB 7.1 hereof and shall be communicated in writing to all purchasers of the Bidding Documents. Prospective Bidders shall acknowledge receipt of each addendum in writing to the Employer.

9.3 Such addendum shall be issued not later than number of days prior to the deadline for submission of bids, specified in the Bidding Data. To afford prospective Bidders reasonable time in which to take an addendum into account in preparing their Bids, the Employer may extend the deadline for submission of Bids in accordance with Clause IB.20.

C. PREPARATION OF BIDS

IB.10 Cost of Bidding

10.1 The Bidders shall bear all costs associated with the preparation and submission of their respective bids and the Employer will in no case be responsible or liable for those costs, regardless of the conduct or outcome of the bidding process.

IB.11 Language of Bid

11.1 The Bid and all correspondence and documents related to the Bid exchanged by a

Bidder and the Employer shall be in the Bid language stipulated in the ***Bidding Data*** and Particular Conditions of Contract. Supporting documents and printed literature furnished by the Bidders may be in any other language provided the same are accompanied by duly certified translation of the relevant parts in the Bid language, in which case, for purposes of evaluation of the bid, the translation in Bid language shall prevail.

IB.12 Documents Comprising the Bid

12.1 Each Bidder shall:

(a) submit duly filled in, signed and stamped Letter of Bid and completed Schedules to Bid as required, including Bill of Quantities, in accordance with Clause IB.18 hereof;

(b) submit Bid Security in accordance with Clause IB.16 hereof;

(c) submit alternative proposal, if permissible in accordance with Clause IB.17;

(d) submit a written power of attorney authorizing the signatory of the Bid to act for and on behalf of the Bidder. The name and position held by each person signing the authorization must be typed or printed below the signature;

(e) submit the Qualification Updating Forms duly filled in, signed and stamped along with requisite attachments, to establish that the Bidder continues to meet the Eligibility and Qualification Criteria set out in bidding document and as provided in the Section "Evaluation Criteria and Qualification Updating Forms";

(f) furnish a technical proposal taking into account the various Schedules to Bid, specially the following:

Schedule-C to Bid	Proposed Construction Schedule
Schedule-D to Bid	Method of Performing the Work
Schedule-E to Bid	List of Major Equipment
Schedule-F to Bid	Organization Chart for Supervisory Staff and other pertinent information such as mobilization program etc.

12.2 Bids submitted by a Joint Venture of two (02) or more firms specified in ***Bidding Data***, shall comply with the following requirements:

(a) the bid, and in case of a successful bid, the Form of Contract Agreement shall be signed by all members so as to be legally binding on all partners;

(b) one of the joint venture partners shall be nominated as being in-charge; and this authorization shall be evidenced by submitting a power of attorney signed by

legally authorized signatories of all the joint venture partners;

(c) the partner-in-charge shall always be duly authorized to deal with the Employer regarding all matters related with and/or incidental to the execution of Works as per the terms and Conditions of Contract and in this regard to incur any and all liabilities, receive instructions, give binding undertakings and receive payments on behalf of the joint venture;

(d) all partners of the joint venture shall at all times and under all circumstances be liable jointly and severally for the execution of the Contract in accordance with the Contract terms and a statement to this effect shall be included in the authorization mentioned under Sub- Para(b) above as well as in the Letter of Bid and in the Form of Contract Agreement (in case of a successful bid); and

(e) a copy of the agreement entered into by the joint venture partners shall be submitted with the bid stating the conditions under which it will function, its period of duration, the persons authorized to represent and obligate it and which persons will be directly responsible for due performance of the Contract and can give valid receipts on behalf of the joint venture, the proportionate participation and corresponding duties & responsibilities of the several firms forming the joint venture, and any other information necessary to permit a full appraisal of its functioning. No amendments/ modifications whatsoever in the joint venture agreement shall be agreed to between the joint venture partners without prior written consent of the Employer.

12.3 The Bidder shall also submit proposals of work methods and schedules in sufficient detail to demonstrate the adequacy of the Bidders" proposal to meet the technical specifications and the completion time referred to in Sub-Clause IB 1.2 hereof.

IB.13 Bid Prices

13.1 The price and discount if any quoted by the Bidders in the Letter of Bid and in the Bill of Quantity shall conform to the requirement specified below:

13.2 The Bidder shall quote any discounts and the methodology for their application.

13.3 If bids are being invited for individual lots (contracts) or for any combination of lots, the Bidders can offer discounts for the individual lots (contracts) as well as for award of more than one Contract and shall specify in their bid.

13.4 Unless stated otherwise in the Bidding Documents, the Contract shall be for the whole of the Works as described in Sub-Clause IB.1.1 hereof, based on the unit rates and/or prices.

13.5 The Bidders shall fill in rates and prices for all items of the Works described in the Bill of Quantities. Items against which no rate or price is entered by a Bidder will not be paid for by the Employer when executed and shall be deemed covered by rates and prices for other items in the Bill of Quantities.

13.6 All duties, taxes and other levies payable by the Contractor under the Contract, or for any other cause, as on the date 28 days prior to the deadline for submission of bids shall be included in the rates and prices and the total Bid Price submitted by a Bidder.

Additional/reduced duties, taxes and levies due to subsequent additions or changes in legislation shall be reimbursed/ deducted as per Sub Clause 13.6 [Adjustment for Changes in Laws] of the Conditions of Contract.

13.7 The rates and prices quoted by the Bidders are subject to adjustment during the performance of the Contract in accordance with the provisions of Sub-Clause 13.7 [Adjustments for Changes in Cost] of the General Conditions of Contract. The Bidders shall furnish the prescribed information for the price adjustment formulae in Schedule-A to Bid, and shall submit with their bids such other requisite supporting information if required under the said Schedule.

IB.14 Currencies of Bid and Payment

14.1 The unit rates and the prices shall be quoted by the Bidder entirely PKR.

A Bidder expecting to incur expenditures in other currencies for inputs to the Works supplied from outside the Employer's country (referred to as the "Foreign Currency Requirements") shall indicate in Table III of Schedule-A to Bid the proportion of the Bid Price (excluding Provisional Sums) needed by him for the payment of such Foreign Currency Requirements; in such case the unit rates and the prices shall be quoted by the Bidder in Equivalent PKR.

14.2 The rates of exchange to be used by the Bidder for currency conversion shall be the TT Selling Rates published or authorized by the State Bank of Pakistan prevailing on the date twenty eight (28) days prior to the deadline for submission of bids. Such rates shall be notified by the Employer not later than fourteen (14) days prior to the deadline for submission of Bids.

For the purpose of payments, the exchange rates used in Bid preparation shall apply for the duration of the Contract.

IB.15 Bid Validity

15.1 Bids shall remain valid for the period stipulated in the ***Bidding Data*** after the Date of Bid Opening specified in Clause IB.23.

15.2 In exceptional circumstances, prior to expiry of the original Bid validity period, the Employer may request that the Bidders extend the period of validity for a specified additional period which shall in no case be more than the original Bid validity period. The request and the responses thereto shall be made in writing. A Bidder may refuse the request without forfeiting his Bid Security. A Bidder agreeing to the request will not be required or permitted to modify his Bid, but will be required to extend the validity of his Bid Security for the period of the extension, and in compliance with Clause IB.16 in all respects.

IB.16 Bid Security

16.1 Each Bidder shall furnish, as part of his Bid, a Bid Security in the amount stipulated in the ***Bidding Data*** in Pak Rupees or an equivalent amount in a freely convertible currency.

16.2 The Bid Security shall be, at the option of the Bidder, in the form of Call Deposit Receipt (CDR)/ Pay Order or a Security issued in the prescribed form included in the Bidding Documents, by (a) a Scheduled Bank in Pakistan or (b) a foreign bank duly counter-guaranteed by a Scheduled Bank in Pakistan or (c) an Insurance Company listed in the **Bidding Data** and rated by PACRA/VIS of rating as provided in Table below in favour of the Employer valid for a period 14 days beyond the Bid Validity date. The Bid Security of Joint Venture shall be in the name of Joint Venture or Lead/either Firm of the JV or in ratio of shares of the individual JV partners, submitting the bid.

Bid Price (In Eq. million PKR)	Minimum Rating of Insurance Companies
Up to 1000	A (+)
1001 to no limit	AA
[Note: Insurance Company includes Joint Ventures of Insurance Companies also]	

16.3 Any Bid not accompanied by an acceptable Bid Security shall be rejected by the Employer as non-responsive.

16.4 The Bid Securities of the Bidders except the lowest three will be returned by the Employer within twenty-eight (28) days from the opening of Bids, provided a Bidder requests for the return of its Bid Security, or upon the expiry of original validity of Bid Security or as extended, whichever is earlier.

16.5 The Bid Security of the lowest three Bidders including the successful Bidder will be returned when the successful Bidder has furnished the required Performance Security.

16.6 The Bid Security may be forfeited:

(a) If the Bidder withdraws his Bid except as provided in Sub Clause IB 22.1;

(b) If the Bidder does not accept the correction of his Bid Price pursuant to Sub Clause IB 28.2 hereof; or

(c) In the case of successful Bidder, fails to furnish the required Performance Security.

16.7 In case of annulment, all Bids submitted and specially, bid securities, shall be returned to the Bidders within 14 days of annulment.

IB.17 Alternate Proposals by Bidder

17.1 Unless otherwise specified in the Bidding Data, alternative proposal(s) shall not be

considered.

17.2 Should any Bidder consider that he can offer any advantages to the Employer by a modification to the designs, specifications or other conditions, he may, in addition to his Bid to be submitted in strict compliance with the Bidding Documents, submit any alternative proposal(s) containing
(a) relevant design calculations; (b) technical specifications;
(c) proposed construction methodology; and (d) any other relevant details/conditions, provided always that the total sum entered on the Letter of Bid shall be that which represents complete compliance with the Bidding Documents.

17.3 Alternative proposal(s), if any, of the Bidder having submitted most advantageous Bid only may be considered by the Employer as the basis for the award of Contract to such Bidder.

IB.18 Format and Signing of Bid

18.1 Bidders are particularly directed that the amount entered on the Letter of Bid shall be for performing the Contract strictly in accordance with the Bidding Documents.

18.2 All Schedules to Bid are to be properly completed and signed.

18.3 No alteration is to be made in the Letter of Bid nor in the Schedules thereto except in filling up the blanks as directed. If any such alterations be made or if these instructions be not fully complied with, the Bid may be rejected.

18.4 Each Bidder shall prepare by filling in the forms completely and without alterations one (1) original and number of copies, specified in the Bidding Data, of the documents comprising the Bid as described in Clause IB.12 and clearly mark them “ORIGINAL” and ‘COPY” as appropriate. In the event of discrepancy between them, the original shall prevail.

The Bidder shall also provide complete searchable PDF versions as well as Word, Excel, etc. versions of the Bid if so required by the Employer.

18.5 The original and all copies of the Bid shall be typed or written in indelible ink and shall be signed by a person duly authorized to sign on behalf of the Bidder pursuant to Sub-Clause IB.12.1(d) hereof. All pages of the Bid shall be initialed and stamped by the person or persons signing the bid.

18.6 The Bid shall contain no alterations, omissions or additions, except to comply with instructions issued by the Employer, or as are necessary to correct errors made by the Bidder, in which case such corrections shall be initialled by the person or persons signing the Bid.

18.7 Bidders shall indicate in the space provided in the Letter of Bid, their full and proper addresses at which notices may be legally served on them and to which all correspondence in connection with their Bids and the Contract is to be sent.

18.8 Bidders should retain a copy of the Bidding Documents as their file copy.

18.9 All documents executed outside Pakistan required to be submitted with the Bid must be certified by Pakistani Embassy in the respective country(ies).

D. SUBMISSION OF BIDS

IB.19 Sealing and Marking of Bids

19.1 Each Bidder shall submit his Bid as under:

(a) ORIGINAL and each copy of the Bid shall be separately sealed and put in separate envelopes and marked as such.

(b) The envelopes containing the ORIGINAL and copies will be put in one sealed envelope and addressed / identified as given in Sub Clause IB.19.2 hereof.

19.2 The inner and outer envelopes shall:

(a) Be addressed to the Employer at the address provided in the ***Bidding Data***;

(b) bear the specific identification of this bidding process as specified in the ***Bidding Data***; and

(c) Provide a warning not to open before the time and date for Bid Opening, as specified in the ***Bidding Data***.

19.3 In addition to the identification required in IB 19.2 hereof, the inner envelope shall indicate the name and address of the Bidder to enable the Bid to be returned unopened in case it is declared "late" pursuant to Clause IB.21

19.4 If the outer envelope is not sealed and marked as above, the Employer will assume no responsibility for the misplacement or premature opening of the Bid.

IB.20 Deadline for Submission of Bids

20.1 (a) Bids must be received by the Employer at the address specified no later than the time and date stipulated in the ***Bidding Data***.

(b) Bids with charges payable will not be accepted, nor will arrangements be undertaken to collect the Bids from any delivery point other than that specified above. Bidders shall bear all expenses incurred in the preparation and delivery of Bids. No claims will be entertained for refund of such expenses.

(c) Where delivery of a Bid is by mail and the Bidder wishes to receive an acknowledgment of receipt of such Bid, he shall make a request for such acknowledgment in a separate letter attached to but not included in the sealed Bid envelope.

(d) Upon request, acknowledgment of receipt of Bids will be provided to those making delivery in person or by messenger.

20.2 The Employer may, at his discretion, extend the deadline for submission of Bids by

issuing an amendment in accordance with Clause IB.9, in which case all rights and obligations of the Employer and the Bidders previously subject to the original deadline will thereafter be subject to the deadline as extended.

IB.21 Late Bids

21.1 (a) Any Bid received by the Employer after the deadline for submission of Bids prescribed in Clause IB.20 shall be declared late, rejected and returned unopened to such Bidder.

(b) Delays in the mail, delays of person in transit, or delivery of a Bid to the wrong office shall not be accepted as an excuse for failure to deliver a Bid at the proper place and time. It shall be the Bidder's responsibility to determine the manner in which timely delivery of his Bid will be accomplished either in person, by messenger or by mail.

IB.22 Modification, Substitution and Withdrawal of Bids

22.1 Any Bidder may modify**,** substitute or withdraw his Bid after Bid submission provided that the modification, substitution or written notice of withdrawal is received by the Employer prior to the deadline for submission of Bids.

22.2 The modification, substitution, or notice for withdrawal of any Bid shall be prepared, sealed, marked and delivered in accordance with the provisions of Clause IB.19 with the outer and inner envelopes additionally marked "MODIFICATION", "SUBSTITUTION" or "WITHDRAWAL" as appropriate.

22.3 No Bid may be modified by a Bidder after the deadline for submission of Bids except in accordance with IB 22.1 and 28.2.

22.4 Withdrawal of a Bid during the interval between the deadline for submission of Bids and the expiration of the period of Bid validity specified in the Form of Bid may result in forfeiture of the Bid Security in pursuance to Clause IB.16.

E. BID OPENING AND EVALUATION

IB. 23 Bid Opening

23.1 The Employer will open the Bids including withdrawals, substitution and modifications made pursuant to Clause IB.22, in the presence of Bidders' representatives who choose to attend, at the time, date and location stipulated in the Bidding Data. The Bidders' representatives who are present shall sign a register evidencing their attendance.

23.2 Envelopes marked "MODIFICATION", "SUBSTITUTION" or "WITHDRAWAL" shall be opened and read out first. Bids for which an acceptable notice of withdrawal has been submitted pursuant to Clause IB.22 shall not be opened. Only bids that are opened and read out at Bid opening shall be considered further.

23.3 The Bidder's name, total Bid Price and price of any alternative proposal(s), any discounts, Bid modifications, substitution and withdrawals, the presence or absence of Bid security, and such other details as the Employer may consider appropriate, will be announced by the Employer at the opening of Bids. Only discounts and alternative proposals read out at Bid opening shall be considered for evaluation. The Letter of Bid and the Summary Bill of Quantities are to be initialled by representative(s) of the Employer attending Bid opening. The Employer shall neither discuss the merits of any Bid nor reject any Bid (except for late Bids, in accordance with Sub-Clause IB 21.1).

23.4 The Employer shall prepare minutes of the Bid opening, including the information disclosed to those present in accordance with the Sub-Clause IB.23.3.

IB.24 Process to be Confidential

24.1 Information relating to the examination, clarification, evaluation and comparison of Bids and recommendations for the award of Contract shall not be disclosed to Bidders or any other person not officially concerned with such process before the announcement of the result of Bid evaluation in the form of final evaluation report giving justification for acceptance or rejection of Bids which shall be done at least fifteen (15) days prior to Award of Contract. The announcement to all Bidders will include table(s) comprising read out prices, discounted prices, price adjustments made, final evaluated prices and recommendations against all the Bids evaluated. Any effort by a Bidder to influence the Employer's processing of Bids or Contract award decisions may result in the rejection of such Bidder's Bid. Whereas any Bidder feeling aggrieved may lodge a written complaint not later than five (5) days after the announcement of the final evaluation report.

IB.25 Clarification of Bids

25.1 To assist in the examination, evaluation and comparison of Bids, the Employer may, at his discretion, ask any Bidder for clarification of his Bid, including breakdowns of unit rates and lump sum prices. Any clarification submitted by a Bidder that is not in response to a request by the Employer shall not be considered. The request for clarification and the response shall be in writing. No change in the price or substance of the Bid shall be sought, offered or permitted except as required to confirm the correction of arithmetic errors discovered by the Employer in the evaluation of the Bids in accordance with Clause IB.28.

25.2 The Employer may, at his discretion, ask any Bidder for confirmation/submission of missing information to clarify its Bid. However, the Employer does not have an obligation to request any additional information or clarification with respect to missing or deficient information in a Bid. The Employer may reject any Bid as non-responsive if found materially incomplete, obscure, irregular or omitting any material information required to be submitted in accordance with the Bidding Documents.

25.3 If a Bidder does not provide clarifications of its Bid by the date and time set reasonably

(not less than seven (7) days) in the Employer's request for clarification, the Employer may proceed with the evaluation based on the information submitted in the Bid without waiting for the Bidder's response.

IB.26 Examination of Bids and Determination of Responsiveness

26.1 Prior to the comparison of Bids, the Employer will determine whether each Bid is substantially responsive to the requirements of the Bidding Documents.

26.2 The Employer's determination of a Bid's responsiveness is to be based on the contents of the Bid itself, as defined in Sub- Clause IB.12.

26.3 A substantially responsive Bid is one which meets the requirements of the Bidding Documents, without material deviation, reservation or omission. A material deviation, reservation or omission is one that,

(a) if accepted, would:

(i) affect in any substantial way the scope, quality orperformance of the Works; or

(ii) limit in any substantial way, inconsistent with the Bidding Documents, the Employer's rights or the Bidder's obligations under the proposed Contract; or

(b) if rectified, would unfairly affect the competitive position of other Bidders presenting substantially responsive Bids.

26.4 During the evaluation of Bids, the following definitions apply:

(a) "Deviation" is a departure from the requirements specified in the Bidding Documents;

(b) "Reservation" is the setting of limiting conditions or withholding from complete acceptance of therequirements specified in the Bidding Documents; and

(c) "Omission" is the failure to submit part or all of theinformation or documentation required in the BiddingDocuments.

26.5 The Employer shall examine the technical aspects of the Bid submitted in accordance with Sub-Clause IB.12.1(f), in particular, to confirm that all requirements stated in Specifications have been met without any material deviation, reservation or omission.

26.6 If a Bid is not substantially responsive to the requirements of the Bidding Documents, it will be rejected by the Employer, and may not subsequently be made responsive by correction or withdrawal of the non-conforming deviation, reservation or omission.

IB.27 Nonmaterial, Nonconformities

27.1 Provided that a Bid is substantially responsive, the Employer may waive any nonconformities in the Bid.

27.2 Provided that a Bid is substantially responsive, the Employer may request that the Bidder submit the necessary information or documentation, within a reasonable period

of time, to rectify nonmaterial, nonconformities in the Bid related to documentation requirements. Requesting information or documentation on such nonconformities shall not be related to any aspect of the price of the Bid. Failure of the Bidder to comply with the request may result in the rejection of its Bid.

27.3 Provided that a Bid is substantially responsive, the Employer shall rectify quantifiable non-material nonconformities related to the Bid Price. To this effect, the Bid Price shall be adjusted, for comparison purposes only, to reflect the price of a missing or non-conforming item or component, by adding the average price of the item or component quoted by other lowest two evaluated substantially responsive Bidders. If the price of the item or component cannot be derived from the price of other substantially responsive Bids, the Employer shall use a suitable CSR, adjusted to the date 28 days earlier to the Bid submission date or its best assessment.

IB.28 Correction of Arithmetic Errors

28.1 Bids determined to be substantially responsive will be checked by the Employer for any arithmetic errors. Errors will be corrected by the Employer as follows:

(a) Where there is a discrepancy between the amounts in figures and in words, the amount in words will govern; and

(b) Where there is a discrepancy between the unit rate and the line item total resulting from multiplying the unit rate by the quantity, the unit rate as quoted will govern, unless in the opinion of the Employer there is an obviously gross misplacement of the decimal point in the unit rate, in which case the line item total as quoted will govern and the unit rate will be corrected.

(c) if there is an error in a total corresponding to the addition or subtraction of subtotals, the subtotals shall prevail and the total shall be corrected.

28.2 The amount stated in the Letter of Price Bid will be adjusted by the Employer in accordance with the above procedure for the correction of errors and with the concurrence of the bidder, shall be considered as Binding upon the Bidder. If the Bidder does not accept the corrected Bid Price, his Bid will be rejected, and the Bid Security shall be forfeited in accordance with IB.16.6 (b) hereof.

IB.29 Evaluation and Comparison of Bids

29.1 The Employer will evaluate and compare only the Bids determined to be substantially responsive in accordance with Clause IB.26. The Employer shall use the criteria and methodologies listed in this Clause. No other evaluation criteria or methodologies shall be permitted.

29.2 In evaluating and comparing the Bids, the Employer will determine for each Bid the evaluated Bid Price by adjusting the Bid Price as follows:

(a) Making any correction for arithmetic errors pursuant to Clause IB.28;

(b) price adjustment due to discounts offered in accordance with Sub-Clause

IB.23.3;

(c) excluding Provisional Sums and the provision, if any, for contingencies in the Summary Bill of Quantities, but including competitively priced daywork;

(d) making an appropriate price adjustment for any quantifiable nonmaterial nonconformities in accordance with Sub-Clause IB.27.3;

(e) the additional evaluation factors are specified in Section Evaluation Criteria and Qualification Updating Forms.

29.3 The estimated effect of the price adjustment provisions of the Conditions of Contract, applied over the period of execution of the Contract, shall not be taken into account in Bid evaluation.

IB.30 Abnormally Low Bids

30.1 If the Bid Price of the successful Bidder is more than 15% below the lower of the Employer's estimate of the cost of work to be performed under the Contract or average of other lowest two evaluated substantially responsive Bids, the Employer may require the Bidder to produce detailed price analyses for any or all items of the Bill of Quantities to demonstrate the internal consistency of those prices with the construction methods and schedule proposed. After evaluation of the price analyses, the Employer may require an additional Performance Security by 10% of the difference of the Bid Price as determined hereinabove upto issuance of Taking Over Certificate at the expense of the successful Bidder to a level sufficient to protect the Employer against financial loss in the event of default of the successful Bidder under the Contract. The Bids having Bid Price lower than 25% shall be liable to be rejected.

IB.31 Unbalanced or Front-Loaded Bids

31.1 If the Bid of the successful Bidder is seriously unbalanced (Front Loaded) in relation to the average of other evaluated substantially responsive Bids, the Employer during execution of contract may pay against measured quantities of significantly higher quoted line item(s) rate(s) with respect to same line item(s) rate(s) determined from the average of other lowest two evaluated substantially responsive Bids as instructed by the Engineer. The balance line item(s) rate(s) may be paid against the same measured quantities at the time of issuance of Taking Over Certificate or as instructed by the Engineer.

F. AWARD OF CONTRACT

IB.32 Award Criteria

32.1 Subject to Clauses IB.33 and IB.39, the Employer will award the Contract to the Bidder whose Bid has been determined as most advantageous Bid (substantially responsive to requirements of the Bidding Documents with the lowest evaluated Bid Price).

IB.33 Employer's Right to Annul the Bidding Process Bids

33.1 Notwithstanding Clause IB.32, the Employer reserves the right to annul the bidding process and reject all Bids, at any time prior to award of Contract, without thereby incurring any liability to the affected Bidders or any obligations.

The Employer shall upon request communicate to any Bidder who submitted a Bid, the grounds for its rejection of all Bids but is not required to justify those grounds. Rejection of all Bids shall be notified to all Bidders promptly.

IB.34 Notification of Award

34.1 Prior to expiration of the period of Bid validity prescribed by the Employer, the Employer will notify the successful Bidder in writing ("Letter of Acceptance") that his Bid has been accepted. This letter shall name the sum which the Employer will pay the Contractor in consideration of the execution and completion of the Works by the Contractor as prescribed by the Contract (hereinafter and in the Conditions of Contract called the "Accepted Contract Amount").

The Letter of Acceptance will also state the remedies withrespect to Sub-Clauses IB.30 & IB.31 if applicable.

34.2 No negotiation with the Bidder having submitted most advantageous Bid or any other Bidder shall be permitted, however, Employer may have clarification meetings before issuing Letter of Acceptance to get clarified any item in the Bid evaluation report.

34.3 The Letter of Acceptance/ notification of award and its acknowledgement/acceptance by the Bidder will constitute the formation of the Contract, binding the Employer and the Bidder till signing of the formal Contract Agreement.

34.4 Upon furnishing by the successful Bidder of a Performance Security, the Employer will promptly notify the other Bidders that their Bids have been unsuccessful and return their Bid securities in accordance with Sub-Clause IB.16.5.

IB.35 Performance Security

35.1 The successful Bidder shall furnish to the Employer a Performance Security in the form and the amount stipulated in the Conditions of Contract and additional Performance Security if applicable under IB.30 as stated in the Letter of Acceptance, within a period of 28 days after the receipt of Letter of Acceptance.

35.2 Failure of the successful Bidder to comply with the requirements of Sub Clause IB.35.1 or Clauses IB.36 or IB.38 shall constitute sufficient grounds for the annulment of the award, forfeiture of the Bid security and to award the Contract to the Bidder having submitted next advantageous Bid.

IB.36 Signing of Contract Agreement

36.1 Within 14 days from the date of furnishing of acceptable Performance Security under the Conditions of Contract, the Employer will notify the successful Bidder to depute its

representative with appropriate Power of Attorney to sign the Contract Agreement in the form provided in the Bidding Documents, incorporating all agreements between the parties.

36.2 The formal Agreement between the Employer and the successful Bidder shall be executed within 14 days of the receipt of the above stated notification by the successful Bidder from the Employer.

IB.37 Integrity Pact

37.1 The Bidder shall sign and stamp the Integrity Pact provided at Schedule-J to Bid in the Bidding Documents for all Punjab Government procurement contracts exceeding PKR ten million. Failure to provide such Integrity Pact shall make the Bidder non-responsive.

IB.38 Instructions not Part of Contract

38.1 Bids shall be prepared and submitted in accordance with the Instructions to Bidders which are provided to assist the Bidders in preparing Bids but do not constitute part of the Contract.

IB.39 Corrupt and Fraudulent Practices

39.1 The Employer will reject a Bid if it determines that the Bidder recommended for award, or any of its personnel, or its agents, or its sub-contractors, service providers, suppliers and/or their employees, has, directly or indirectly, engaged in corrupt, fraudulent, collusive, coercive, or obstructive practices in competing for the contract under this bidding.

39.2 The Employer will blacklist and hence forthwith debar a Constructor or individual, at any time, in accordance with the prevailing Public Procurement Rules 2004.

Bidding Data

The following specific data for the Works to be bid shall complement, amend, or supplement the provisions in the Instructions to Bidders. Wherever there is a conflict, the provisions herein shall prevail over those in the Instructions to Bidders.

In the Instructions to Bidders (ITB), "Invitation for Bids (IFB)" means the "Advertisement / Public Notice" issued by the Employer for inviting bids, and all references to 'Invitation for Bids', wherever appearing in the ITB shall be read accordingly.

The word "Pre-Bid" is synonymous to the word "Clarification" where ever it appears in the ITB / Bidding Document.

IB Clause Reference	Bidding Data
1.1	Add "through EPADS" after to receive in 2nd line of sub clause 1.1. and the word "Consortium" is deleted after "Partner" in 2nd line of this sub-clause. Name and address of the Employer: **Name:** *Punjab Mass Transit Authority (PMA)* **Address:** *Punjab Masstransit Authority, 5th Floor, Arfa Software Technology Park (ASTP), 346-B, Main Ferozepure Road, Lahore, Pakistan.*
1.1	Name of the Project & Summary of the Works: ***Project:*** *EPC Document for Tourist Glass Train from Islamabad to Murree.* *Brief summary of work under this contract shall be:* • *Straddle Monorail infrastructure from Islamabad to Murree (40 km Approx.).* • *Rolling Stock* • *Electric Traction System.* • *Station buildings and Platforms.* • *Electric Power* • *Signalling and Telecommunication System.* • *Depot and allied structures.* • *Earthwork.*
1.2	Time for Completion for the Works: 840 days
1.3	New Sub-Clause 1.3 is added: "Bids shall be invited on Single Stage Two Envelope Bidding Process".
2.1	Source of Funding: The Project shall be financed by the Employer, through Punjab Government Annual Development Plan.
3.1	Sub-paras (a) to (d) are deleted in their entirety and substituted with the following: • Bids are invited according to Rule 38 of Punjab PPRA Regulations 2014

	(amended upto date); **1. <u>For Local Entity:</u>** a) For Constructors having valid registration with the Pakistan Engineering Council (PEC) in Category CA' (No Limit) and having Specialized Codes of Constructors CE-01, CE02, CE-07, CE09, CE-10, ME-01, ME-02, ME-03, EE-02, EE-04, EE-05, EE-11 (General Electrical works only), BC-01. b) For Consultants having valid registration with the Pakistan Engineering Council (PEC) with relevant Project Profile Codes: 1214 and 1215. **2. <u>Single Bidder</u>** In case of single bidder, the firm must comply with requirements mentioned at para 1 (a) and 4. **3. <u>For Joint Venture:</u>** Foreign Entity shall not be eligible to participate in the bidding individually. Any Foreign Entity wishing to participate shall form a Joint Venture with a Pakistani Entity duly registered with the Pakistan Engineering Council (PEC) in the category specified above at para 1(a) or 1 (b), and such Joint Venture shall be the Bidder. The Joint Venture must meet the requirements mentioned at para – 4. **4. <u>Other Requirements</u>** a) Valid Company / Firm Registration in the Country of Origin. b) Has valid Registration certificate for Income Tax, Sales Tax (on Goods and Services where applicable). In case of Foreign Entity(ies), possess corresponding equivalent certificate from the country of origin in accordance with Clause IB-41 of the Bidding Documents; c) The Local / Foreign Entity(ies) shall not be eligible to participate if debarred / blacklisted by any Government / Semi Government / Public Department / International Body(ies); Eligible Single Bidder or JV must meet qualification requirements given in Schedules K & L to Bid. A minimum 65% marks are necessary in each category and a minimum 70% overall marks in Schedule-K and Schedule-L to Bid are required for qualification.
7.1	Add "are available on EPADS" after Bidding Document" in the First Line. The list provided in this instruction from item no. "1" to item no. "10" are substituted with the following:

	1. Instructions to Bidders; 2. Bidding Data; 3. Schedules and Forms to Bid; 4. Letter of Technical and Price Bid; 5. General Conditions of Contract, (GCC); 6. Particular Conditions of Contract, (PCC); • Part A- Contract Data; • Part B – Special Provisions; 7. Employer's Requirements; • Design Requirements • Construction Requirements • Technical Specifications • Specific Specifications • Environmental Management Plan 8. Referenced Bill of Quantities 9. Referenced Drawings. 10. Any addendum issued as per IB 9.2. 11. or any other document issued by the Client.
8.1	The Text of this sub-clause is amended as following: A prospective Bidder requiring any clarification(s) in respect of the Bidding Documents may notify the Employer in writing through EPADS and at the following address: Punjab Masstransit Authority, 5th Floor, Arfa Software Technology Park (ASTP), 346-B, Main Ferozepure Road, Lahore, Pakistan. Telephone: (042)99028000. Fax: +92(42)99232541 Email: rizwan.aziz@pma.punjab.gov.pk Employer's representative will examine the request for clarification of the Bidding Documents which it receives not later than **seven (07)** days prior to the deadline for the submission of bids and if needed will issue the clarification at least **three (03)** days before the date of submission of Bids (without identifying the source of enquiry) to all prospective Bidders who have purchased the Bidding Documents.
8.2	Copies of the Employer's response will be forwarded to all identified Prospective Bidders through EPADS or email, including a description of the inquiry, but without identifying its source.
8.3	In the first line after the Employer "may" is replaced with "shall" Venue, time, and date of the Pre-Bid meeting: *Pre-Bid Meeting shall be held on **January 8th, 2026 at 1500 Hours PST** at Office of Punjab Masstransit Authority, 5th Floor, Arfa Software Technology Park (ASTP), 346-B, Main Ferozepure Road, Lahore, Pakistan.*

	Telephone: (042)99028000. Fax: +92(42)99232541 Email: rizwan.aziz@pma.punjab.gov.pk
8.4	Add "through EPADS and through email provided above," after " to submit questions" in the 1st line of this sub-clause.
9.1	Add "through EPADS" at the end of this sub-clause after "addendum".
9.2	Add "through EPADS" after "communicated in writing" in the 2nd line of this sub-clause.
9.3	The Text of this sub-clause is amended as: "Any addendum issued under Clause IB.9 shall form part of the Bidding Documents. Addenda may be issued by the Employer at any time prior to the deadline for submission of Bids through respective websites of Employer (http://www.pma.punjab.gov.pk/) , Punjab PPRA (http://www.ppra.punjab.gov.pk/) and on EPADS (https://punjab.eprocure.gov.pk). To afford prospective Bidders reasonable time in which to take an addendum into account in preparing their Bids, the Employer may, where it considers appropriate, extend the deadline for submission of Bids in accordance with Clause IB.20."
11.1	The language of the Bidding Documents is English.
12.1	Existing text is deleted and substituted with the following: Each Bidder shall, through EPADS, submit the Bid which shall comprise of two volumes submitted simultaneously, one called the Technical Bid containing the document as listed under para (A) and the other called the Price Bid containing the documents listed in para (B) hereunder. **A. Technical Bid shall be submitted through EPADS and shall comprise the following documents, each duly completed, signed and stamped by the Bidder.** - *Bidding Documents (duly signed and stamped)* -

	- *Letter of Technical Bid duly filled, signed in accordance with Clause IB.18*	
	- *Bid Security*	***IB.16***
	- *Valid registration in the Country of Origin*	
	- *Income Tax and Sales Tax Certificates (on Goods and Services where applicable) or Equivalent in case of Foreign Entity(ies)*	
	- *In Case of Local Constructors or Consultant, Pakistan Engineering Council registration certificate as per para 3.1(1)*	
	- *Bidder Information form*	***Form – 2A***
	- *Bidder's JV Information Form*	***Form - 2B***
	- *Pending litigation information (on Rs 300 stamp paper as per stamp paper act 1899)*	***Form – 2C***
	- ***Financial Situation and Performance Form*** *<u>Evidences Required</u>.* *Credit Line Facility Certificate;* *Financial Statement of Past three (03) years audited by Chartered Accountant Firm(s).* *Average Working Capital of Past three (03) years.* *Average Annual Turn – over of Past three (03) years.*	***Form – 2D***
	All Documents shall be as per the Schedule K -1 to Bid	
	- ***Project Information Format*** *<u>Evidence Required.</u>*	***Form - 2 E-1 & 2 E-2***
	- *In case of <u>Straddle Monorail System and Rail Based Projects</u> Completion Certificate / Performance Certificate / Taking Over Certificate / Substantial Completion Certificate / BOQ or any other valid evidence of information to substantiate the work done is not attached.*	
	- *In case of <u>Technical / Design Capability</u>*	

	If complete In-House Design Team provide CVs of Key Staff in Form – 2F or in case of partial In-House / Fully outsourced Design Team, please provide MoU / JV agreements or any other formal arrangements ***All Documents shall be as per the Schedule L -1 to Bid*** - ***Proposed HR Team*** ***Form – 2F*** *Evidence Required* *Information for the Proposed Project Team shall be provided as per Form – 2 F.* ***Detail list of Proposed Project Team is provided in the Schedule L -3*** - ***Major Equipment Details*** ***Form – 2G*** *Evidence Required.* *Bidder to provide the information of Owned / Rented / Leased evidence of all the equipment(s).* ***Detail list of Major Equipment is provided in the Schedule L-2 to Bid.*** - *Written Power of Attorney authorizing the signatory of the Bid (on Rs 300 stamp paper as per stamp paper act 1899).* ***IB.18 Schedule – A to Bid*** - *Bidder's Proposal* ***Form - 3A to Bid*** - *Proposed Organization Chart of the Bidder* ***Form - 3B to Bid*** - *Proposed Programme of Works* ***Form - 3C to Bid*** - *Proposed Programme for Procurement of Imported Items* ***Form - 3D to Bid*** - *Method of Performing the Works* ***Form - 3E to Bid*** - *Construction Camps and Housing Facilities* ***Form - 3F to Bid*** - *Specific Works Data* ***Form - 3G to Bid*** - *Works to be Performed by subcontractor* ***Form - 3H to Bid*** - *Deviations from Technical Provisions* ***Form - 3I to Bid*** - *Joint Venture agreement (if applicable)* ***Form - 3J to Bid*** - *Financial Competence and Access to Financial Resources.* ***Schedule K to Bid*** ***Schedule-L to Bid***

	- *Past Performance, Commitment, Equipment and Personnel Qualification and Experience* - *Integrity Pact* — ***Schedule-B to Bid*** - *Affidavit of Correctness of Information / No Falsification of Information (on Rs. 300/- e-stamp paper)* — ***Schedule – C to Bid*** - *General Conditions of Contracts (GCC)* — ***Refer Volume-I*** - *Particular Conditions of Contracts (PCC)* *Part A – Contract Data* — ***Refer Volume-I*** - *Particular Conditions of Contracts (PCC)* *Part B – Special Provisions* — ***Refer Volume-I*** - *Employer's Requirements* — ***Refer Volume-III*** - *Reference Drawings* — ***Refer Volume - IV*** **B. Price Bid shall be submitted through EPADS and shall comprise the following documents, each duly completed, signed and stamped by the Bidder.** - *Letter of Priced Bid* - *Milestone Payments* — ***Refer Volume – II*** - *Reference Bill of Quantities* — ***Refer Volume – II*** - *Estimated Progress Payments* - ***Form – 3M to Bid*** - *Lumpsum Cost Breakup for major cost items* - ***Form – 3N to Bid***
12.2	Maximum number of JV Members shall be 04 (Four Nos.)
12.3	Sub-clause is deleted in its entirety and replaced with the following: "The Bidder shall furnish, as part of the Technical Bid, a Bidder's Proposal including a statement of work methods, equipment, personnel, schedule and any other information as stipulated in Bidding Forms, in sufficient detail to demonstrate the adequacy of the Bidder's proposal to meet the work requirements and the completion time referred to in Sub-Clause 1.2 hereof."

13.1	Words 'Letter of Bid and the Bill of Quantity' appearing in 1st line are amended to read as "Letter of Price Bid and Referenced Bill of Quantities ".
13.3	Deleted
13.5	The Bidders shall quote a Lumpsum Contract Price covering the entire scope of the Works for "Engineering, Procurement and Construction" (EPC), as described in the Employer's Requirements. A Bill of Quantities is provided for reference purpose only.
13.7	Deleted.
14.1	Existing text of this sub-clause is deleted and replaced with the following: "Bidders to quote entirely in PKR Rupees. Foreign Currency Requirements are not applicable."
14.2	Existing text of this sub-clause is deleted and replaced with the following: "Payment under this contract shall be made entirely in PKR Rupees."
15.1	The Bids shall remain valid for 90 days after the date of opening of Bid.
15.2	At the end of this sub-clause Add "Rule 28 of PPR-14 shall be applicable for Bid Validity period".
16.1	Amount of Bid Security: ***PKR 2,200,000,000 /- (Pak Rupees Two Billion Two Hundred Million Only).*** *The Bid Security shall be furnished by the Bidder of the aforesaid amount in favour of:* ***Account Title**: MASSTRANSIT AUTHORITY NON FARE REVENUE (NFR) FUND ACCOUNT.* *Account Number: 6580045522200045* ***IBAN**: PK50BPUN6580045522200045* ***Bank Name:** The Bank of Punjab* ***Branch Name:** Afra Software Technology Park Branch, Lahore.* ***Branch Code:** 0320* *Scanned Copy of Bid Security to be attached on EPADS as part of the Technical Bid and Original should be submitted to the Officer as specified in the bidding document / advertisement before the Bid submission deadline, failing to which shall lead to rejection.*
16.2	Sub-clause is deleted in its entirety and replaced with the following: "The Bid Security shall be in the form of Bank Guarantee / CDR by (a) a Scheduled Bank in Pakistan or (b) a foreign bank duly counter-guaranteed by a Scheduled Bank in Pakistan in favour of the Employer valid for a period 28 days beyond the Bid Validity date. The Bid Security of Joint Venture shall be in the name of Joint Venture or Lead on behalf of JV, submitting the bid."
16.4	Sub-clause is deleted in its entirety and replaced with the following:

	"The Bid securities of unsuccessful Bidders will be returned as promptly as possible, but not later than 28 days after the expiration of the period of Bid Validity."
16.5	Sub-clause is deleted in its entirety and replaced with the following: "The Bid Security of the successful Bidder will be returned when the Bidder has furnished the required Performance Security and signed the Contract Agreement."
16.6	Sub-clause (c) is deleted in its entirety and replaced with the following: In the case of successful Bidder, fails within the specified time limit to: (i) Furnish the required Performance Security; (ii) Sign the Contract Agreement.
17	***Alternative Proposal(s) by the Bidder shall not be considered.***
18.1	Words "Letter of Bid" are amended to read as "Letter of Price Bid".
18.2	The text is amended as "All schedules and forms are to be properly filled, signed, stamped and uploaded on EPADS".
18.3	Words "Letter of Bid" are amended to read as "Letter of Technical Bid and Letter of Price Bid".
18.4 & 18.5	Sub-clause is deleted in its entirety and replaced with the following: Each Bidder shall prepare its Bid in accordance with sub-para(s) 12.1(A) and 12.1(B) & Clause IB-41 [Language & Documents Submitted with Bid], and shall upload its Bid through EPADS (E-Pak Acquisition & Disposal System) in accordance with the instructions given in the EPADS training manuals available on the Punjab Public Procurement website (https://punjab.eprocure.gov.pk).
18.7	Words 'Letter of Bid' are replaced with "Letter of Technical Bid and Letter of Price Bid".
18.9	The text of this sub-clause is deleted and replaced with the following: "All documents originating outside Pakistan and submitted by the Bidder shall comply with the requirements of Clause IB-41 [Language & Documents Submitted with Bid]."
19.1	Deleted
19.2(a)	Each Bidder shall prepare its Bid in accordance with sub-clauses 12.1(A) and 12.1(B) & Clause IB-41 [Language & Documents Submitted with Bid], and shall upload its Bid through EPADS (E-Pak Acquisition & Disposal System) in accordance with the instructions given in the EPADS training manuals available on the Punjab Public Procurement website (https://punjab.eprocure.gov.pk)..

19.2(b)	Name and Number of the Contract: ***Name:*** *Engineering, Procurement and Construction (EPC) of Tourist Glass Train from Islamabad to Murree (Lake View to Murree)*
19.2(c), 19.3, & 19.4	Deleted.
20.1(a)	Deadline for submission of Bids: The Bids must be submitted through EPADS on or before at **1500 HOURS PST January 30th, 2026.** .
20.1(d)	The text of this sub para is amended as follows: "Upon submission of the Bid Security in the prescribed manner, and upon request of the Bidder, the Employer may issue a written acknowledgement evidencing receipt of the Bid Security."
21.1 (a)	The text of this sub-clause if deleted and replaced with the following: "Any Bid submitted online after the deadline for submission of Bids prescribed by the Employer in Clause IB-20 shall not be entertained."
21.2(b)	The text of this sub-clause is deleted and replaced with the following: "It shall be the Bidder's sole responsibility to ensure timely preparation and electronic submission of its Bid through EPADS. Any delay arising from the Bidder's internal approvals, internet connectivity, hardware/software issues, power supply, or any other cause on the Bidder's side shall not be accepted as an excuse for failure to submit the Bid on time. No alternative (manual or email) submission shall be permitted in lieu of EPADS submission."
22	Whole clause IB 22 is deleted in its entirety and substituted with the following: 22.1 A Bidder may Modify or Substitute his Bid on EPADS after the Bid submission, prior to the deadline for submission of Bids. 22.2 The modification, substitution or notice of withdrawal of any Bid shall be submitted on EPADS. 22.3 Withdrawal of a Bid during the interval between the deadline for submission of Bids and the expiration of the period of Bid validity specified in the Form of Technical Bid may result in forfeiture of the Bid Security pursuant to Clause IB-15.
23	The text of this sub-clause is deleted in its entirety and replaced with the following: 23.1 The Employer will open the Technical Bids on EPADS, including withdrawals, in the presence of Bidder at the Employer's Office at **1530 HOURS PST on January 30th, 2026:**". The Priced Bid(s) shall remain unopened / locked / encrypted on EPADS and

	shall not be opened at this stage. 23.2 The Technical Bids shall be opened through EPADs and the following read out and recorded: • The name of the Bidder; and • Presence or absence of Bid Security The Employer will, if applicable, record the minutes of the opening Technical Bid(s). The Employer shall neither reject or discuss the merits of any Bid. 23.3 At the end of the evaluation of the Technical Bids, the Employer will invite Bidders whose Technical Bids have been declared substantially responsive, to attend the opening of the Price Bids. The date, time, and location of the opening of Price Bids will be advised in writing/ through email by the Employer through EPADs. Bidders shall be given reasonable notice of the opening of Price Bids. 23.4 The Employer will notify those Bidders in writing through EPADs who have been rejected on the grounds of their Technical Bids being substantially non-responsive to the requirements of the Bidding Documents. 23.5 Priced Bid(s) shall be opened through EPADs and the followings are read out and recorded: • the name of the Bidder; • the Bid Prices, including any discounts/premium; and • any other details as the Employer may consider appropriate. Only Priced Bid(s)s and discounts/premium read out and recorded during the opening of Priced Bid(s), shall be considered for evaluation. No Bid shall be rejected at the opening of Priced Bids.
25.1	Add text "through EPADS or on the email provided in his Bidding Documents" after "any Bidder" in the 2nd line.
26.3	Text of opening paragraph is amended as under: "A substantially responsive Bid is one which (i) meets the eligibility requirements as per Clause IB.3.1 (ii) contains all the documents as given in Sub-Clause IB.12.1(A) &(B) of the Bidding Data (iii) includes signed Integrity pact as per Clause IB.37 (iv) conforms to all the terms and conditions and specifications of the Bidding Documents, without material deviation, reservation or omission. A material deviation is one that:"
26.5	In second line, the text "Sub-Clause IB.12.1(f)" is replaced with "schedule K and L to Bid".
26.7	New sub-clause 26.7 is added: "During the Technical Evaluation no amendments in Technical Bid shall be

	permitted".
29.1	Word "price" is placed after words "only the" in first line.
29.2(b),(c),(d)&(e)	Not applicable
29.3	Not applicable
35.1	The successful Bidder shall provide to the Employer a Performance Security of ten percent (10%) in the form of a Bank Guarantee from any Schedule Bank in Pakistan or a foreign bank duly counter-guaranteed by a Scheduled Bank in Pakistan, in accordance with IB-41, within a period of twenty-one (21) days after the receipt of Letter of Acceptance. Hence, total amounting to ten (10 %) percent of the Contract Price stated in the Letter of Acceptance.
37.1	"Schedule – J" is replaced with "Schedule – M" in the first line of this sub-clause.
39	In the las line words "prevailing Public Procurement Rules 2004" are replaced with "relevant Punjab Public Procurement Rules – 2014 (amended upto date)".
40	The following clause is added: **IB. 40 General Performance of the Bidders** 40.1 The Employer reserves the right to obtain information regarding performance of the bidders on their previously awarded contracts/works. The Employer may in case of consistent poor performance of any Bidder as reported by the employers of the previously awarded contracts, interalia, reject his bid and/or refer the case to the Pakistan Engineering Council (PEC). Upon such reference, PEC in accordance with its rules, procedures and relevant laws of the land take such action as may be deemed appropriate under the circumstances of the case including black listing of such Bidder and debarring him from participation in future bidding for similar works."
41	The following clause is added: **IB.41 Language and Documents Submitted with the Bid** The Bid, and all correspondence and documents related to the bidding process between the Applicant and the Procuring Entity, shall be in the English language. Any document or information furnished by the Applicant that is issued in a country other than Pakistan and is originally in the English language shall be submitted in the form of a copy duly notarized by a Notary Public and attested by the Pakistan Embassy/Consulate and the Ministry of Foreign Affairs, Pakistan in the country of origin, unless the Applicant submits a Foreign Apostille Certificate in accordance with the applicable laws. Where any such document is issued in a language other than English, it shall be accompanied by an English translation of its pertinent passages, which

	translation shall likewise be duly notarized by a Notary Public and attested by the Pakistan Embassy/Consulate and the Ministry of Foreign Affairs, Pakistan in the country of origin, unless the Applicant submits a Foreign Apostille Certificate in accordance with the applicable laws, and in case of any discrepancy between the original and the English translation, the English translation shall prevail for the purposes of interpretation and evaluation of the Application/Bid.

SCHEDULES AND FORMS TO BID

Form – 2A

Bidder Information Form

Date: ……

Bid Reference No. (if any) and title: .....……..

Page_____of _____ pages

Bidder's name
In case of Joint Venture (JV), name of each member:
Bidder's country of registration:
Bidder's year of incorporation:
Bidder's legal address:
Bidder's authorized representative information Name:_____ Address:_____ Telephone/Fax numbers: _____ E-mail address: _____
1. Attached are copies of original documents, in case of JV, JV agreement, in accordance withSub-Clause IB 3.1 & IB 41.

Form – 2B

Bidder's JV Information Form

(to be completed for each member of Bidder's JV)

Date: ……..
Bid Reference No. (if any) and title: ……..
Page…….of.....pages

Bidder's JV name:
JV member's name:
Position (Lead / Member) having percentage:
JV member's country of registration:
JV member's year of constitution:
JV member's legal address in country of constitution:
JV member's authorized representative information Name:_____ Address:_____ Telephone/Fax numbers: _____ E-mail address:_____

Form – 2C

Pending Litigation

Bidder's Name…….

Date: ……

JV Member's Name:

…….

Bid Reference No. (if any) and title……

Page…… of…….pages

Pending Litigation, in accordance with Eligibility and Qualification Criteria			
Year of dispute	**Amount in dispute (currency)**	**Contract Identification**	**Total Contract Amount (currency), Eq. PKR (exchange rate)**
		Contract Identification: _____ Name of Employer: _____ Address of Employer: _____ Matter in dispute: _____ Party who initiated the dispute: Status of dispute: _____	
		Contract Identification: Name of Employer: Address of Employer: Matter in dispute: Party who initiated the dispute: Status of dispute:	

Form – 2D

Financial Situation and Performance

Bidder's Name: ……

Date:……

JV Member's Name:……

Bid Reference No. (if any) and Title:……..

Page……..of……..pages

- **Financial Information**

Type of Financial informationin (currency)	**Historic information for previous three (03) year, (amount in currency, currency, exchange rate*, Eq. PKR)**		
	Year – 01	**Year- 02**	**Year -03**
Statement of Financial Position (Information from Balance Sheet)			
Available Credit Line Facility			
Total Assets (TA)			
Total Liabilities (TL)			
Total Equity/Net Worth (NW)			
Current Assets (CA)			
Current Liabilities (CL)			
Working Capital (WC)			
	Information from Income Statement		
Total Revenue (TR)			
Profits Before Taxes (PBT)			
	Cash Flow Information		
Cash Flow from OperatingActivities			

Form – 2E - 1
Project Information Format

Please provide list of similar projects undertaken during the last 10 years (Single Entity or JV) as per Form - 3L-1

Sr. No.	Name of Project	Status (Complete/Ongoing)	Experience (Constructor / Design or Both)	Year

Form – 2E -2
Project Information Format

Please provide Detail of each project mentioned above

Title of the Project:	**Project Value (in current PKR):**
Name of Client/ The Department:	**Region/ location of successfully completed assignment:**
Contractor Name as per Contract:	
Award Date (Letter of Award):	**Completion Date:**
Detail of the Project and Scope of Work & Role:	

Form – 2 G

LIST OF MAJOR EQUIPMENT

Equipment details

Item of equipment and No(s)		
Equipment information	Name of manufacturer	Model and power rating
	Capacity	Year of manufacture
Current status	Current location	
	Details of current commitments	
Source	Indicate source of the equipment ☐ Owned ☐ Rented ☐ Leased ☐ Specially manufactured	
The following information shall not be applicable for equipment owned by the Contractor		
Owner	Name of owner	
	Address of owner	
	Telephone	Contact name and title
	Fax	Telex
Agreements	Details of rental / lease / manufacture agreements specific to the project	

Note: Attach additional sheets, if necessary

Initials of Signatory:……

Form – 2 F

CV For Proposed Project Team as per Form - 3L-3

1. **Proposed Position** [*only one candidate shall be nominated for each position*]: _____
2. **Name of Firm** [*Insert name of firm proposing the staff*]: _____

_____

3. **Name of Staff** [*Insert full name*]: _____
4. **Date of Birth**: _____ **Nationality**: _____
5. **CNIC No (**if Pakistani**):**_____ **or Passport No:** _____
6. **Education** :

Degree	*Major/Minor*	*Institution*	*Date (MM/YYYY)*

7. **Membership of Professional Associations**: _____

_____

8. **Other Training** [*Indicate significant training since degrees under 6 - Education were obtained*]: _____

_____

_____

9. **Languages** [*For each language indicate proficiency: good, fair, or poor in speaking, reading, and writing*]:

_____

10. Employment Record [*Starting with present position, list in reverse order every employment held by staff member since graduation, giving for each employment (see format here below): dates of employment, name of employing organization, positions held.*]:

				Tasks undertaken relevant to	
Employer	***Position***	***From (MM/YYYY)***	***To (MM/YYYY)***	***General Experience along with time in years within the employment period***	***Specific Experience along with time in years within the employment period***

11. Detailed Tasks Assigned

[*List all tasks to be performed under this assignment*]

12. Work Undertaken that Best Illustrates Capability to Handle the Tasks Assigned

[*Among the assignments in which the staff has been involved, indicate the following information for those* ***minimum five (05) assignments*** *that best illustrate staff capability to handle the tasks listed under point 11.*]

Project No.

Name of assignment or project & Location:_____ Cost of Project in USD Millions_____ Date of Start(Month/Year): _____Date of Completion (Month/Year): Actual time spent on the project: _____in months.

Client: _____Main project features: _____

Positions held: _____

Activities performed: _____

[*Unroll the project details group and continue numbering 4, 5, 6 and so on,*]

13. Certification:

I, the undersigned, certify that to the best of my knowledge and belief, this CV correctly describes myself, my qualifications, and my experience. I understand that any willful misstatement described herein may lead to my disqualification or dismissal, if engaged.

_____ Date: _____

[Signature of staff member or authorized representative of the staff] *Day/Month/Year*

Full name of authorized representative(attach authority letter): _____

FORM – 3A

Bidder's Proposal

[*Bidder needs to submit its proposal fully complying against the Employer's Requirements***]**

Initials of Signatory:……

FORM – 3B

PROPOSED ORGANIZATION CHART OF THE BIDDER

The Bidder shall provide in this Form Organization chart indicating the key personnel he will employ for Head office and for Site office involved in management, supervision and Project Manager/Engineering of the Works and Operations to be done under the Contract to direct and execute the Works, together with their names, qualifications, experience, positions held and their nationalities.

Designation	Name of Person	Experience,	Present Position and Nationality	Summary of Qualifications,

1. Head Office:
   Design staff:
   Key Management Staff;
   Execution Staff.

2. Site Office:
   - Contractors Representative
   - Site Superintendent
   - Supervising Engineers
   - Plant Erectors
   - Construction supervisors
   - Other key staff

Initials of Signatory:……

FORM – 3C

PROPOSED PROGRAMME OF WORKS

Pursuant to sub-clause 8.3 of GCC & PCC, Bidder shall provide a programme in a CPM/PERT form showing the sequence of work items by which he proposes to complete the Work of the entire Contract. The programme should indicate the sequences of work items and the period of time during which he proposes to complete the Works including the activities like designing, schedule of submittal of drawings, ordering/procurement of materials, manufacturing, delivering, design & construction of associated civil works, installation/erection, testing and commissioning of Works to be executed under the Contract.

Initial programme and each revised programme shall be:

1. Developed and presented on Project Management Software Primavera Project Planner P6 or later.
2. Developed on the basis of Work Breakdown Structure provided or approved by Employer's Representative.
3. Detailed up to level 4 or as required by Employer's Representative.
4. Appropriate quantity of direct resources (material, labour, equipment) should be allocated to all activities and showed in submitted construction schedule. Labour resource should be divided according to related trades (e.g. Mason, Operator, helper etc.) Bidder should make sure that no resource is being overallocated.
5. Amount should be loaded to each construction activity. Earned Value Management Reporting to be ensured accordingly.
6. Identifying the critical path activities, showing all works including temporary works, the relation between early and late starting dates for each activity until completion, which will be the same as the specified Project end date.

Initials of Signatory:……

FORM – 3D

PROPOSED PROGRAMME FOR PROCUREMENT OF IMPORTED ITEMS

The order for procurement of imported items shall be placed by the Bidder within the period of Three (03) months from the date of signing of contract. The Bidder shall provide a program in a bar chart/ CPM/ PERT form showing the sequence of all the items to be imported. The program shall indicate the detail of all activities from opening of LC until the delivery of imported items at site.

Initials of Signatory:……

FORM – 3E

METHOD OF PERFORMING THE WORKS

The Bidder is required to submit a narrative outlining the method of performing the Works. The narrative should indicate in detail and include but not be limited to:

- The sequence and methods in which he proposes to carry out the Works, including the number of shifts per day and hours per shift, he expects to work.
- A list of all major items of constructional and erection plant, tools and vehicles proposed to be used in carrying out the Works at Site, including number of each kind, make, type, capacity of all equipment, working condition, which shall be deployed by him for Civil Work and Erection, Testing and Commissioning of the Works, in sufficient detail to demonstrate fully that the equipment will meet all the requirements of the Specifications.
- The procedure for installation/erection of equipment and transportation of equipment and materials to the site.
- Organization Chart indicating head office and field office personnel involved in design, management and supervision, Employer's Representative, equipment maintenance and purchasing. Quality Control/Quality assurance measures to be adopted including procedures to be followed for carrying out all tests required under specifications

Initials of Signatory:……

FORM – 3F

CONSTRUCTION CAMP AND HOUSING FACILITIES

The Bidder in accordance with Clause 6 of the Conditions of Contract shall provide description of his construction camp's facilities and staff housing requirements.

The Bidder shall be responsible for pumps, electrical power, water and electrical distribution systems, and sewerage system including all fittings, pipes and other items necessary for servicing the Bidder's construction camp.

The Bidder shall list or explain his plans for providing these facilities for the service of the Contract as follows:

1. Site Preparation (clearing, land preparation, etc.).

2. Provision of Services.

a) Electrical power (expected power load, etc.).

b) Water (required amount and system proposed).

c) Sanitation (sewage disposal system, etc.)

3. Construction of Facilities

a) Bidder's Office. Workshop and Work Areas (areas required and proposed layout, type of construction of buildings, etc.).

b) Warehouses and Storage Areas (area required, type of construction and layout).

c) Housing and Staff Facilities (Plans for housing for proposed staff, layout, type of construction, etc.).

4. Construction Equipment Assembly and Preparation (detailed plans for carrying out this activity).

5. Other Items Proposed (Security services, etc.)

1. Note:

The Bidder shall be responsible for pumps, electrical power, water and electrical distribution systems, and sewerage system including all fittings, pipes and other items necessary for servicing the Bidder's construction camp.

Initials of Signatory:……

FORM – 3G

SPECIFIC WORKS DATA

The main technical data is prescribed in the relevant sections of the Technical Provisions. However, the Bidder may supplement the main technical data by providing hereunder other salient parameters including main plant make, capacity and suitability for the works under consideration to enable the Employer/Employer's Representative to assess technical conformance of the proposed process and the means available with the Bidder to do it.

PUNJAB MASS TRANSIT AUTHORITY

Initials of Signatory:……

FORM – 3H

WORK TO BE PERFORMED BY SUBCONTRACTORS

I/ We intend to subcontract the following parts of the Work to subcontractors. In my/ our opinion,the subcontractors named hereunder are reliable and competent to perform that part of the work for which each is listed.

Enclosed are documentation outlining experience of subcontractors, the curriculum vitae and experience of their key personnel who will be assigned to the Contract, equipment to be supplied by them, size, location and type of contracts carried out in the past.

Note:

- No change of Sub-Contractor shall be made by the Bidder without prior approval of the Employer.
- The truthfulness and accuracy of the statement as to the experience of Subcontractors is guaranteed by the Bidder. The Employer's judgment shall be final as to the evaluation of the experience of Subcontractors submitted by the Bidder.
- Statement of similar works shall include description, location & value of work, year completed and name & address of the clients.
- This may include manufacturer(s) who are proposed here and their relevant details to be provided accordingly including make, capacity and salient features to make it particularly suitable for the works. The technology used should also be detailed adequately.

Initials of Signatory:……

FORM – 3I

DEVIATIONS

FROM TECHNICAL PROVISIONS

It is presumed that the Bidder shall not take any deviation. However, if he intends to take deviations to the specified technical provisions, those must be listed in the space provided below.

The proposed deviation must indicate in definite term the improvement in technical requirement with functional and operational advantage and the improvement in economy in terms of time and money.

Sr. No.	Clause No. / Section No.	Deviations/Clarifications

Note: Attach additional sheets, if necessary

Initials of Signatory:……

FORM – 3J

JV AGREEMENT

[Bidder to attach their executed form of Joint Venture Agreement]

Initials of Signatory:……

Note:

• For qualification of the Bidder (Single Entity/JV), Minimum 65% marks are necessary in each category and Minimum 70% overall marks are necessary for qualification requirement as per criteria given in Schedules – K & L to Bid.

K – 1
Schedule - K to Bid

FINANCIAL COMPETENCE AND ACCESS TO FINANCIAL RESOURCES

1. SOUNDNESS AND ACCESS TO FINANCIAL RESOURCES

Sr. #	DESCRIPTION	MAX MARKS	REMARKS
1.	**Available General Bank Credit Line Limit** **a)** Available Credit Limit ≥ PKR 30,000 Million = 15 marks; **b)** Available Credit Limit = PKR 27,000 Million = 09 marks; **c)** Available Credit Limit > PKR 27,000 Million but < PKR 30,000 Million, marks will be awarded as per [9 + (A/30,000) x 6] A= Available Bank Credit Line Limit in Million. **d)** Available Credit Limit < PKR 27,000 Million = 0 marks. Note: Bidder with a limit below PKR 27,000 million shall score zero (0) marks under this criterion **and shall be rejected as not meeting the minimum financial capacity requirement.**	15	***Bidder will provide required information using Form(s) – 2D.*** ***Evidence Required:*** • *Bidder shall provide the Certificate issued by the Bank.* • *Complete Audited Financial Statement of the Firm for the last three (03) years.* Available General Bank Credit Line Limit shall mean the unencumbered credit Line(s) available to the Bidder / JV, supported by certificate issued by the relevant bank(s), not older that 06 months from the date of submission of Bids on EPADS. Any Credit Line Certificate issued by a foreign bank shall be counter-guaranteed & authenticated by a scheduled bank in Pakistan and as per IB-41. In the case of a Foreign Bidder, any bank credit line facility issued by a bank outside Pakistan shall be confirmed/counter-guaranteed by a Scheduled Bank in Pakistan. Where the credit line is denominated in a currency other than Pak Rupees (PKR), its value for evaluation purposes shall be converted into Pak Rupees using the exchange rate published on xe.com on the date of issuance of the credit line certificate.

Sr. #	DESCRIPTION	MAX MARKS	REMARKS
2.	**Average Working Capital (AWC)** **a)** Average Working Capital ≥ PKR 30,000 Million = 10 marks; **b)** Average Working Capital = PKR 27,000 Million = 06 marks; **c)** Available Working Capital > PKR 27,000 Million but < PKR 30,000 Million, marks will be awarded as per [6 + (A/30,000) x 4] A= Available Bank Credit Line Limit in Million. **d)** Average Working Capital < PKR 27,000 Million = 0 marks. Note: Bidder with a limit below PKR 27,000 million shall score zero (0) marks under this criterion **and shall be rejected as not meeting the minimum financial capacity requirement.**	10	The bidder shall submit audited financial statements for the last three (03) years, duly certified by a Chartered Accountant firm. If any such financial statements are submitted on EPADS in a language other than English by the Foreign Bidder, they shall be submitted together with translations duly certified in accordance with Clause IB-41. Where the audited financial statements are denominated in a currency other than Pak Rupees (PKR) submitted through EPADS, all relevant figures shall, for evaluation purposes, be converted into Pak Rupees using the average exchange rate for the relevant financial year as published on xe.com. For the purposes of this evaluation, **Working Capital** for each financial year shall be calculated as: **Working Capital = Current Assets − Current Liabilities** as reported in the Bidder's audited financial statements for that year. The **Average Working Capital** shall be calculated as: **Average Working Capital = (WC_1 + WC_2 + WC_3) ÷ 3** where WC_1 … WC_5 are the annual Working Capital values for the last three (03) financial years, expressed in Pak Rupees in accordance with the currency conversion provisions of these Bidding Documents.

Sr. #	DESCRIPTION	MAX MARKS	REMARKS
3.	**Bid Capacity** [5 x working capital + Project/General specific lines of credit – 40% of current commitments] > Bid Price.	05	Note: If the Bidder's Bid Capacity is less than the Bid Price, the Bidder shall receive zero (0) marks under this criterion and the Bid shall be rejected for not meeting the minimum financial capacity requirement.
4.	**Average Annual Turnover** a) Full 5 marks if Average Annual Turnover is PKR 27,000 to 30,000 million or more. b) 4 marks if Average Annual Turnover is PKR 25,000 to 27,000 million. c) 2 marks if Average Annual Turnover is PKR 25,000 million. **Note: No marks if Average Annual Turnover of Last 03 years is less than PKR 24,000 million.**	05	
	Total Marks of Financial Position	**35**	

L – 1
Schedule - L to Bid

PAST PERFORMANCE COMMITMENT, MAJOR EQUIPMENT & PERSONNEL QUALIFICATION AND EXPERIENCE

1. Past Performance of the Bidder

Sr. #	DESCRIPTION	MAX MARKS	REMARKS
1.	**Construction of a straddle monorail, monorail system in mountainous / hilly terrain) completed in the last 10 years:** 1. If one (1) project carried out = 06 marks 2. If two (2) projects carried out = 08 marks 3. If three (3) or above project carried out = 12 marks **Note: if a project carried out in Hilly / Mountainous area, then Additional = 03 marks**	15	***Bidder will provide required information using Form(s) – 2 E-1 and E-2.*** ***Evidence Required:*** • *Bidder shall provide Completion Certificate / Performance Certificate / Taking Over Certificate / Substantial Completion Certificate / BOQ or any other valid evidence of information to substantiate the work done.* • *The Bidder shall demonstrate its in-house or outsourced design capability by submitting the relevant organisation chart, design entity registration/licence, CVs of key design staff and evidence of any JV / sub-contract / MoU or similar arrangements, in accordance with Clause IB-41.* No marks if such evidences are not provided. The documents uploaded on EPADS shall be as per the instruction given in the IB-41. ***Note:*** *This is the Mandatory Requirement if any Bidder(s) have not carried out such project(s) of a Straddle monorail or a monorail in mountainous/hilly terrain shall not be eligible to participate.*

Sr. #	DESCRIPTION	MAX MARKS	REMARKS
2.	**Technical / Design Capability** • **Multidisciplinary Design Team (structural, electrical, mechanical and signalling & telecommunication)** Full in-house team =10 Marks Partial in-house with JV partners= 08 Marks Fully outsourced =06 Marks	10	If the Bidder intends to carry out the design in-house, it shall demonstrate the availability of a multidisciplinary design team (covering, as a minimum, structural, electrical, mechanical, and signalling & telecommunication disciplines) and shall provide documentary evidence thereof. Required documentation includes organizational charts, CVs / employment contracts of all proposed team members. All documents shall be submitted in accordance with Clause IB-41. If the Bidder intends to outsource all or any part of the design to external design firm(s), it shall provide documentary evidence of its arrangements with such firm(s) in the form of a Joint Venture agreement / sub-contract / Memorandum of Understanding (MoU) / letter of intent or any other formal arrangement acceptable to the Employer. The Bidder shall also submit the external firm's valid registration, full details of the design disciplines to be provided, and the CVs of the key design specialists of such firm(s). All such documentation shall be prepared and submitted in accordance with Clause IB-41.
3.	**General Experience** • **Experience in Rail-Based projects.** 3 or above projects =06 Marks 2 projects = 04 Marks 1 project = 02 Marks • **Integration capability (Infrastructure, E&M, rolling stock, Signaling & Telecommunication)** 3 projects =04 Marks 2 projects = 02 Marks 1 project = 01 Marks	10	The bidder shall provide verifiable evidence of experience in Rail - Based projects, including Project Completion Certificate / Performance Certificate / Taking Over Certificate / Substantial Completion Certificate / BOQ or any other valid evidence of information to substantiate the work done is not attached. For evaluation of integration capability, the bidder must submit documentation demonstrating experience in coordinating multiple disciplines (infrastructure, E&M,

Sr. #	DESCRIPTION	MAX MARKS	REMARKS
			rolling stock, and signaling & telecommunication) on past projects. All such documentation shall comply with Clause IB-41.
	Total Marks of Working Experience	**35**	

PUNJAB MASS TRANSIT AUTHORITY

L – 2
Schedule - L to Bid

2. MAJOR EQUIPMENT LIST:

Sr. #	DESCRIPTION	MAX MARKS	REMARKS
1.	Monorail Beam Launcher / Erection Gantry (2 Complete sets)	4	***Bidder will provide required information using Form(s) – 2 G.*** ***Evidence Required:*** • *Bidder shall provide Ownership / Leased / Rented Proof along with the capacity of the equipment.* Proportionate marking if equipment is less than the minimum required number. **Note:** No marks shall be awarded if the desired evidences are not provided.
2.	Heavy Duty Mobile Crane (≥ 200T) (2 Units)	2	
3.	Segment Lifting Frame / Beam Trolley (1 Complete set)	2	
4.	Piling Rigs (Rotary / CFA) (2 Nos)	2	
5.	Geotechnical Drilling & Testing Equipment (1 Complete set)	2	
6.	Track / Guideway Alignment & Survey Equipment (Total Stations, GPS, Laser Track Measurement) (2 Complete sets)	1.5	
7.	Specialized E&M Installation Equipment (Cable Pulling Machines, Elevated Work Platforms) (1 Complete set)	1.5	
	Sub-Total of Tools & Plants	**15**	

L – 3
Schedule - L to Bid

3. PERSONNEL QUALIFICATION AND EXPERIENCE OF PROPOSED PROJECT TEAM

Sr. # ME	DESCRIPTION	MAX MARKS	REMARKS
1	Project Manager / Team Leader (Lead Member in case of JV) (1Nos) ○ Minimum Education Criteria = BSc. Civil / Mechanical / Electrical or any other relevant degree. ○ Maximum Education Criteria = Master's in Project Management or any other engineering degree. Experience = Overall 15 years with specific experience in managing large scale projects, leading technical teams, ensuring projects soundness, and stakeholder management.	**Education** Min. = 1.0 Max. = 1.5 **Experience** 15-18 years = 1.00 More than 18 yrs = 1.5 **Max Marks =3.0**	***Bidder will provide required information using Form(s) – 2F.*** **Note:** No marks if required documents are not attached.
2	Construction Manager (02 Nos) ○ Minimum Education Criteria = BSc. Civil or any other relevant degree. ○ Maximum Education Criteria = Master's in Construction Management or any other engineering degree. Experience = Overall 10 years with specific experience in construction of managing large projects, leading construction teams, and ensuring projects compliance.	**Education** Min. = 0.25 Max. =0.5 **Experience** 10-12 years = 0.25 More than 12 yrs = 0.5 **Max Marks =1.0**	
3	Expert Civil / Guideway / Structural Engineer (01 Nos) ○ Minimum Education Criteria = BSc. Civil or any other relevant degree. ○ Maximum Education Criteria = Master's in Structural or any other engineering degree. Experience = Overall 12 years with specific experience in design of large-scale structural projects, ensuring	**Education** Min. = 0.5 Max. = 1.0 **Experience** 12-15 years = 1.0 More than 15 yrs = 1.0 **Max Marks =2.0**	

Sr. # ME	DESCRIPTION	MAX MARKS	REMARKS
	structural integrity, leading and managing design.		
4	Mechanical & Rolling Stock Engineer (01 Nos) o Minimum Education Criteria = BSc. Mechanical or any other relevant degree. o Maximum Education Criteria = Master's in Transport & Power or any other relevant engineering degree. Experience = Overall 12 years with specific experience of analyzing the requirements, ensuring proper selection of rollingstock and maintenance of depots.	**Education** Min. = 0.5 Max. = 1.0 **Experience** 12-15 years = 1.0 More than 15 yrs = 1.0 **Max Marks =2.0**	
5	Geotechnical Expert (01 Nos) o Minimum Education Criteria = BSc. Civil Engineering degree. o Maximum Education Criteria = Master's in Geotechnical or any other relevant engineering degree. Experience = Overall 10 years with specific experience of managing geotechnical investigations, interprets soil and rock data, ensuring robust foundation designs, and oversees fieldwork.	**Education** Min. = 0.25 Max. = 0.5 **Experience** 10-12 years = 0.25 More than 12 yrs = 0.5 **Max Marks =1.0**	
6	Electrical Traction & Power Engineer (01 Nos) o Minimum Education Criteria = BSc. Electrical Engineering degree. o Maximum Education Criteria = Master's in Electrical or any other relevant engineering degree.	**Education** Min. = 0.5 Max. = 1.0 **Experience** 12-15 years = 1.0 More than 15 yrs = 1.0 **Max Marks =2.0**	

Sr. # ME	DESCRIPTION	MAX MARKS	REMARKS
	Experience = Overall 12 years with specific experience regarding designing of traction power systems to ensure efficient and safe energy supply for rail infrastructure, conducts electrical design, prepares wiring and power distribution plans, ensures safety and compliance.		
7	Signaling & Train Control Engineer (02 Nos) o Minimum Education Criteria = BSc. Electrical or Electronic Engineering degree. o Maximum Education Criteria = Master's in Electrical or Electronic or any other relevant engineering degree. Experience = Overall 12 years with specific experience of designing, management and implementation of signaling and train control systems to ensure safe and efficient train operations.	**Education** Min. = 0.5 Max. = 1.0 **Experience** 12-15 years = 1.0 More than 15 yrs = 1.0 **Max Marks =2.0**	
8	Communications Systems Engineer (02 Nos) o Minimum Education Criteria = BSc. Electrical or Electronic Engineering degree. o Maximum Education Criteria = Master's in Electrical or Electronic or any other relevant engineering degree. Experience = Overall 12 years with specific experience of designing, management and implementation of communication and train control systems to ensure safe and efficient train operations.	**Education** Min. = 0.5 Max. = 1.0 **Experience** 12-15 years = 1.0 More than 15 yrs = 1.0 **Max Marks =2.0**	
	Sub-Total of Personnel Capabilities	**15**	

Note:

- *The Bidder shall not alter or modify the prescribed CV format in any manner*.

FORM – 3M

ESTIMATED PROGRESS PAYMENTS

Bidder's estimate of the value of work which would be executed by him during each of the periods stated below, based on his Programme of the Works and the Rates in the Schedule of Prices, expressed in % thousands of PKR. Bidder is instructed to provide percentage (%) of bid price in each quarter.

Quarter	Percentage (%) of Contract Amount
1st	
2nd	
3rd	
4th	
5th	
6th	
7th	
8th	
9th	
10th	

Initials of Signatory:……

FORM – 3N

LUMP SUM COST BREAKUP FOR MAJOR COST ITEMS

The Bidder is to provide a detailed breakup of his Lump sum costs in a manner that the overall picture for the quoted price can be understood. It should include major heading wise cost breakup including rate analyses for at least 6 major cost items as required to analyze it.

Initials of Signatory:……

LETTER OF TECHNICAL & LETTER OF PRICE BID AND OTHER SCHEDULES

LTB-1

Letter of Technical Bid

Date: .....

Bid Reference No: .....
(Name of Contract/Works)

To: .....

We, the undersigned, declare that:

(a) We have examined and have no reservations to the Bidding Documents as per 12.1(A) provided in ***Bidding Data***, including Addenda issued in accordance with Instructions to Bidders (IB) 9 for the execution of Works;

(b) We offer to execute and complete in conformity with the Bidding Documents the following Works:

(c) Our Bid consisting of the Technical Bid and the Price Bid shall be valid for a period of …… days from the date fixed for the bid submission deadline in accordance with the Bidding Documents, and it shall remain binding upon us and may be accepted at any time before the expiration of that period;

(d) We meet the eligibility requirements in accordance with IB.3.

(e) We, including any Subcontractors for any part of the Contract, are not debarred/ blacklisted by the Employer, any Government/Semi Government/Public Department in Pakistan or foreign country, international organizations or other foreign institutions.

(f) Our subcontractors or suppliers for any part of the Contract, if any, shall have nationalities from eligible countries, in accordance with IB.4.4.

(g) We understand that all the Forms and Schedules attached hereto form part of this Bid.

(h) We undertake, if our Bid is accepted, to commence the Works and to complete the whole of the Works comprised in the Contract within the time stated in Contract Data.

(i) We agree to abide by this Bid for the period of days, inclusive of days beyond Bid validity period as mentioned in and it shall remain binding upon us and may be accepted at any time before the expiration of that period.

(j) Unless and until a formal Agreement is prepared and executed, this Bid, together with your written acceptance thereof, shall constitute a binding contract between us.

(k) We do hereby declare that the Bid is made without any collusion, comparison of figures or arrangement with any other Bidder for the Works.

(l) As security for due performance of the under takings and obligations of our Bid, we submit here with a Bid security, in the amount specified in ***Bidding Data***, which is valid (at least) 28 days beyond validity of Bid itself.

(m) We undertake that all the information and documents submitted with the Bid are genuine, and in case of incorrect information of fake documents we shall be liable for punitive action under the Applicable Law.

(n) We are not participating, as a Bidder or as a subcontractor, in more than one Bid in this Bidding process, other than alternative offers submitted in accordance with IB17 (as applicable).

(o) We agree to permit Employer or its representative to inspect our accounts and records and other documents relating to the Bid submission and to have them audited by auditors. This permission is extended for verification of any information provided in our Technical Bid which comprises all documents enclosed herewith in accordance with IB.12.1 (A) of the ***Bidding Data***.

Name .....

In the capacity of .....

Signed .....

.....

Duly authorized to sign the Bid for and on behalf of .....

Date .....

.....

Address……..

LPB-1

Letter of Price Bid

Date: .....

Bid Reference No: .....
(Name of Contract/Works)

To: .....

We, the undersigned, declare that:

(a) We have examined and have no reservations to the Bidding Documents as per 12.1(B) provided in Bidding Data, including Addenda issued in accordance with Instructions to Bidders (IB) 9 for the execution of Works;

(b) The total price of our Bid, excluding any discounts offered in item (c) below is:

(c) The discounts offered and the methodology for their application are:

(d) Our Bid shall be valid for a period of …….. days from the date fixed for the bid submission deadline in accordance with the ***Bidding Data***, and it shall remain binding upon us and may be accepted at any time before the expiration of that period;

(e) If our Bid is accepted, we commit to obtain a performance security in accordance with the Bidding Documents as specified in ***Bidding Data***;

(f) We understand that this Bid, together with your written acceptance thereof included in your notification of award, shall constitute a binding contract between us, until a formal contract is prepared and executed and we do hereby declare that the Bid is made without any collusion, comparison of figures or arrangement with any other bidder for the Works.

(g) We understand that you are not bound to accept the lowest evaluated Bid or any other Bid that you may receive.

(h) We agree to permit Employer or its representative to inspect our accounts and records and other documents relating to the Bid submission and to have them audited by auditors. This permission is extended for verification of any information provided in our Technical Bid which comprises all documents enclosed herewith in accordance with IB.12.1 (A) of the ***Bidding Data***.

(i) If awarded the contract, the person named below shall act as Bidder's Representative.

Name .....

In the capacity of .....

Signed .....

Duly authorized to sign the Bid for and on behalf of .....

Date .....

Address……..

BS-1

BID SECURITY

Security Executed on ……
(Date)
Expiry on ……..
(Date)
Name of Surety with Address: ……
……..
Name of Principal (Bidder) with Address …….....
……..
Penal Sum of Security PKR…….(Pak Rupees ……..
…….)
Bid Reference No. ……..

KNOW ALL MEN BY THESE PRESENTS, that in pursuance of the terms of the Bid and at the request of the said Principal (Bidder) we, the Surety above named, are held and firmly bound unto…… (hereinafter called the 'Employer') in the sum stated above for the payment of which sum well andtruly to be made, we bind ourselves, our heirs, executors, administrators and successors, jointlyand severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH, that whereas the Bidder has submitted the accompanying Bid dated……for ……*Particulars of Bid*) to the said Employer; and

(1) WHEREAS, the Employer has required as a condition for considering said Bid that the Bidder furnishes a Bid Security in the above said sum to the Employer, conditioned as under: that the Bid Security shall remain in force for a period twenty-eight (28) days beyond the Bid Validity date i.e., upto_____.

(2) that the Bid Securities of the Bidders except the lowest three will be returned by the Employer within twenty eight (28) days from the opening of Bids, provided a Bidder request for the return of its Bid Security, or on the expiry of original validity of Bid Security or as extended, whichever is earlier;

(3) that the Bid Security of the lowest three Bidders comprising the successful Bidder will be returned when the successful Bidder has furnished the required Performance Security; and

(4) that in the event of failure of the successful Bidder to furnish the required Performance Security, the entire said sum be paid immediately to the said Employer pursuant to IB.16 and IB.35 of the Instructions to Bidders for the successful Bidder's failure to perform.

NOW THEREFORE, if the successful Bidder shall, within the period specified therefor, on the prescribed form presented to him for signature enter into a formal Contract with the said Employer in accordance with his Bid as accepted and furnish within twenty eight (28) days of his being requested to do so, a Performance Security with good and sufficient surety, as may be required, upon the form prescribed by the said Employer for the faithful performance and proper fulfilment of the said Contract or in the event of non-withdrawal of the said Bid within the time specified for its validity then this obligation shall be void and of no effect, but otherwise toremain in full force and effect.

BS-2

PROVIDED THAT the Surety shall forthwith pay the Employer the said sum upon first written demand of the Employer (without cavil or argument) and without requiring the Employer to prove or to show grounds or reasons for such demand, notice of which shall be sent by the Employer by registered post duly addressed to the Surety at its address given above.

PROVIDED ALSO THAT the Employer shall decide, whether the Principal (Bidder) has duly performed his obligations to sign the Contract Agreement and to furnish the requisite Performance Security within the time stated above, or has defaulted in fulfilling said requirements and the Surety shall pay without objection the said sum upon demand from the Employer forthwith and without any reference to the Principal (Bidder) or any other person.

IN WITNESS WHEREOF, the above bounden Surety has executed the instrument under its seal on the date indicated above, the name and seal of the Surety being hereto affixed and these presents duly signed by its undersigned representative pursuant to authority of its governing body.

SURETY
(Scheduled Bank)

WITNESS: Signature ……

1. …… Name ……..
…… Title ……
Corporate Secretary (Seal) Corporate Guarantor (Seal)

2. ……..
……
Name, Title & Address

Schedule – A
To Bid

POWER OF ATTORNEY

(On a Legal / Revenue Stamp Paper of Rs. 300/-)

We [name of the company and address of the registered office] do hereby appoint and authorize Mr. / Ms. (full name and residential address) bearing National Identity Card (CNIC) of PAKISTAN OR equivalent as in Bidder's country of origin. (Ref No_____, copy enlosed) who is presently engaged with us and holding the position of _____, as our attorney, to do in our name and on our behalf, all such acts, deeds and things necessary in connection with or incidental to our proposal for [Name of the Tender] in response to the tenders invited by the Punjab Masstransit Authority including signing and submission of all documents and providing information/responses to Punjab Masstransit Authority in all matters in connection with our Bid.

We hereby agree to ratify all acts, deeds and things lawfully done by our said attorney pursuant to this Power of Attorney and that all acts, deeds and things done by our aforesaid attorney shall and shall always be deemed to have been done by us.

Dated this _____ day of ____ 20__

For _____

(Signature)

(Name, Designation and Address)

Accepted

(Signature)

(Name, Title and Address of the Attorney)

Date:

Instructions for preparation of power of attorney

a) *To be executed by an authorized representative of the bidder.*

b) *The mode of execution of the Power of Attorney should be in accordance with the procedure, if any, laid down by the applicable law and the charter documents of the executants and when it is so required the same should be under common seal affixed in accordance with the required procedure.*

c) *Also, wherever required, the Bidder should submit for verification of the extract of the charter documents and documents such as a resolution/power of attorney in favor of the Person executing this Power of Attorney for the delegation of power hereunder on behalf of the Bidder.*

d) *In case the Application is signed by an authorized Director / Partner or Proprietor of the Applicant, a certified copy of the appropriate resolution / document conveying such authority may be enclosed in lieu of the Power of Attorney.*

Schedule – B

(INTEGRITY PACT)
DECLARATION OF FEES, COMMISSION AND BROKERAGE ETC. PAYABLE BY THE SUPPLIERS OF GOODS, SERVICES & WORKS IN CONTRACTS WORTH RS. 10.00 MILLION OR MORE

Contract No._____ Dated _____

Contract Value: _____

Contract Title: _____

…… [Name of Supplier] hereby declares that it has not obtained or induced the procurement of any contract, right, interest, privilege or other obligation or benefit from Government of Pakistan (GoP) or any administrative subdivision or agency thereof or any other entity owned or controlled by GoP through any corrupt business practice.

Without limiting the generality of the foregoing, [name of Supplier] represents and warrants that it has fully declared the brokerage, commission, fees etc. paid or payable to anyone and not given or agreed to give and shall not give or agree to give to anyone within or outside Pakistan either directly or indirectly through any natural or juridical person, including its affiliate, agent, associate, broker, consultant, director, promoter, shareholder, sponsor or subsidiary, any commission, gratification, bribe, finder's fee or kickback, whether described as consultation fee or otherwise, with the object of obtaining or inducing the procurement of a contract, right, interest, privilege or other obligation or benefit in whatsoever form from GoP, except that which has been expressly declared pursuant hereto.

[Name of Supplier] certifies that it has made and will make full disclosure of all agreements and arrangements with all persons in respect of or related to the transaction with GoP and has not taken any action or will not take any action to circumvent the above declaration, representation or warranty.

[Name of Supplier] accepts full responsibility and strict liability for making any false declaration, not making full disclosure, misrepresenting facts or taking any action likely to defeat the purpose of this declaration, representation and warranty. It agrees that any contract, right, interest, privilege or other obligation or benefit obtained or procured as aforesaid shall, without prejudice to any other rights and remedies available to GoP under any law, contract or other instrument, be voidable at the option of GoP.

Notwithstanding any rights and remedies exercised by GoP in this regard, [name of Supplier] agrees to indemnify GoP for any loss or damage incurred by it on account of its corrupt business practices and further pay compensation to GoP in an amount equivalent to ten time the sum of any commission, gratification, bribe, finder's fee or kickback given by [name of Supplier] as aforesaid for the purpose of obtaining or inducing the procurement of any contract, right, interest, privilege or other obligation or benefit in whatsoever form from GoP.

Name of Buyer: ……	Name of Seller/Supplier: ……
Signature: ……	Signature: ……

Schedule – C
To Bid

Affidavit / Undertaking of Correctness of Information and Non-Falsification

(To be submitted on Rs. 300/-e-stamp paper of applicable value, signed by the Bidder / all JV Partners)

Project: _____
Package / Contract: _____
Bidder (Single Entity / JV): _____

We, the undersigned, being the Bidder / members of the Joint Venture submitting a Bid for the above-referenced Project, do hereby solemnly affirm, declare and undertake as follows:

1. That all information, data, statements, forms, documents and certificates submitted by us as part of our Bid, including those pertaining to our legal status, financial capacity, technical qualifications, past experience, human resources, equipment, and any other aspect or Bid evaluation, are **true, correct, complete and accurate in all respects** as of the Bid submission date.
2. That **no material fact has been misstated, concealed, suppressed or falsified**, and no forged, fabricated or altered document has been submitted in support of our Bid.
3. That all financial figures, audited accounts, credit line certificates, work experience certificates, CVs, licences, registrations and any other supporting documents have been issued by the competent authorities / entities and are genuine to the best of our knowledge and belief.
4. That, in the case of a Joint Venture, **each JV member** individually and collectively confirms, represents and undertakes the correctness and authenticity of the information and documents submitted on its behalf and acknowledges that this Undertaking is binding on all members, jointly and severally.
5. That we fully understand that, **if at any stage** (Bid evaluation, award of Contract or during Contract execution) any information or document submitted by us is found to be incorrect, false, misleading, incomplete or forged, the Employer shall, without prejudice to any other rights and remedies available under the Bidding Documents and applicable law, be entitled to:
    - ❖ reject our Bid / disqualify us from the Bidding process;
    - ❖ forfeit our Bid Security and/or Performance Security, as applicable;
    - ❖ terminate the Contract, if already awarded; and
    - ❖ take any further action including but not limited to blacklisting / debarment in accordance with Punjab Public Procurement Rules – 2014 (amended up to date).
6. That this Undertaking is made with full understanding of the consequences of submitting any false or misleading information and is executed on behalf of the Bidder / each JV / Consortium member by duly authorized signatory(ies).

Signed for and on behalf of:

Bidder / JV Member: _____
Name of Authorized Signatory: _____
Designation: _____
CNIC / Passport No.: _____
Signature: _____ Date: _____
Official Seal / Stamp: _____

PS-1

SCHEDULE OF PERFORMANCE SECURITY

Guarantee No.....

Executed on …….

Expiry date …….

[Letter by the Guarantor to the Employer]

Name of Guarantor with address: ……..

……

Name of Principal (Bidder) with address:…….

……

Penal Sum of Security (express in words and figures) ……

……..

Letter of Acceptance No……Dated ……..

KNOW ALL MEN BY THESE PRESENTS, that in pursuance of the terms of the Bidding Documents and above said Letter of Acceptance (hereinafter called the Documents) and at the request of the said Principal we, the Guarantor above named, are held and firmly bound unto the …… (hereinafter called the Employer) in the penal sum of the amount stated above for the payment of which sum well and truly to be made to the said Employer, we bind ourselves, our heirs, executors, administrators and successors, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH, that whereas the Principal has accepted the Employer's above said Letter of Acceptance for……

…….. (*Name of Contract*) for the ……

……. (*Name of Project*).

NOW THEREFORE, if the Principal (Bidder) shall well and truly perform and fulfil all the undertakings, covenants, terms and conditions of the said Documents during the original terms of the said Documents and any extensions thereof that may be granted by the Employer, with or without notice to the Guarantor, which notice is, hereby, waived and shall also well and truly perform and fulfil all the undertakings, covenants terms and conditions of the Contract and of any and all modifications of said Documents that may hereafter be made, notice of which modifications to the Guarantor being hereby waived, then, this obligation to be void; otherwise to remain in full force and virtue till the date certified in Taking-Over Certificate issued in accordance with Clause – 10, Employer's Taking Over of Condition of Contract and half of it i.e. (05%) five percent of Contract Price, shall remain valid till the time all requirements of Clause 11, Defects After Taking Over, of Conditions of Contract are fulfilled.

Our total liability under this Guarantee is limited to the sum stated above and it is a condition of any liability attaching to us under this Guarantee that the claim for payment in writing shall be received by us within the validity period of this Guarantee, failing which we shall be discharged of our liability, if any, under this Guarantee.

PS-2

We,…… (the Guarantor), waiving all objections and defense under the Contract, do hereby irrevocably and independently guarantee to payto the Employer without delay upon the Employer's first written demand without cavil or arguments and without requiring the Employer to prove or to show grounds or reasons for such demand any sumor sums up to the amount stated above, against the Employer's written declaration that the Principalhas refused or failed to perform the obligations under the Contract which payment will be effected bythe Guarantor to Employer's designated Bank & Account Number.

PROVIDED ALSO THAT the Employer shall decide, whether the Principal (Bidder) has duly performed his obligations under the Contract or has defaulted in fulfilling said obligations and the Guarantor shall pay without objection any sum or sums up to the amount stated above upon first written demand from the Employer forthwith and without any reference to the Principal or any other person.

IN WITNESS WHEREOF, the above-bounden Guarantor has executed this Instrument under its seal on the date indicated above, the name and corporate seal of the Guarantor being hereto affixed and these presents duly signed by its undersigned representative, pursuant to authority of its governing body.

Guarantor
(Schedule Bank)

WITNESS: Signature ……

1. …… Name ……..

…… Title ……

Corporate Secretary (Seal) Corporate Guarantor (Seal)

2. ……..

……
Name, Title & Address

LOA-1

Letter of Acceptance

[Letterhead paper of the Employer]

NAME OF CONTRACT:…….
CONTRACT NUMBER:……..

TO : .....

Date: .....

Your Reference: .....

Our Reference: .....

We thank you for your Bid dated _____for the design, execution and completion of the Works comprising the above-named Contract and remedying of defects therein so that they are fit for the purposes defined in the Contract, all in conformity with the terms and conditions contained in the Contract .

We have pleasure in accepting your Bid for the Accepted Contract Amount of:

……
[currency and amount in figures]

……
[currency and amount in words]

This amount is made up of the following components:

For the Engineering – Procurement – Construction of the Works, the amount of:_____

……
[currency and amount in figures]

……
[currency and amount in words]

In consideration of you properly and truly performing the Contract, we agree to pay you the Accepted Contract Amount or such other sums to which you may become entitled under the terms of the Contract, at such times and as prescribed by the Contract.

We acknowledge that this Letter of Acceptance creates a binding Contract between us, and we undertake to fulfil all our obligations and duties in accordance with the terms of this Contract.

Signature:…….

Signed by: ……

For and on behalf of:……...

Date:……

CONTRACT AGREEMENT

THIS CONTRACT AGREEMENT (hereinafter called the "Agreement") made on the _____ day of _____ (month) 20____ between _____ _____(hereinafter called the "Employer") ofthe one part and_____(hereinafter called the "Contractor") of the other part.

WHEREAS the Employer is desirous that certain Works, viz.,_____ _____ should be for design, execution, completion and operation and maintenance of these Works, and the remedying of any defects therein,

NOW this Agreement witnessed as follows:

1. In this Agreement words and expressions shall have the same meanings as are respectively assigned to them in the Conditions of Contract hereinafter referred to.

2. The following documents, in the order of priority, after incorporating addenda, if any, except those parts relating to Instructions to Bidders shall be deemed to form and be read and construed as part of this Agreement:

   a. the Letter of Acceptance;
   b. the Contract Agreement;
   c. the Letter of Technical Bid & Letter of Price Bid;
   d. the Particular Conditions Part A - Contract Data;
   e. the Particular Conditions Part B - Special Provisions;
   f. the General Conditions of Contract;
   g. Completed All Schedule & Forms of Bids;
   h. JV Undertaking (if any);
   i. Bidder's Proposal;
   j. Employer's Requirements;
   k. or any other documents.

   The addenda/corrigenda, if any, (Excluding part relating to Instructions to Bidders along with ***Bidding Data***) shall be deemed to have been incorporated at the appropriate places in the "Documents forming the Contract".

3. In consideration of the payments to be made by the Employer to the Contractor as hereinafter mentioned, the Contractor hereby covenants with the Employer to design, execute, complete, operate and maintain the Works and remedy defects therein in conformity and in all respects with the provisions of the Contract .

4. The Employer hereby covenants to pay the Contractor, in consideration of the design, execution, completion, and maintenance of the Works and remedying of defects therein, as per provisions of the Contract, the Contract Price at the times and in the manner prescribed by the Contract.

IN WITNESS WHEREOF the parties hereto have caused this Agreement to be executed on the day, month and year first before written in accordance with their respective laws.

Signature of Contactor	Signature of Employer
(Seal)	(Seal)

Signed, Sealed and Delivered in the presence of:

Witness	Witness
(Name, Title and Address)	(Name, Title and Address)

DAB-1

DAAB AGREEMENT

Name and details of the Contract _____

_____

This Agreement made the_____day of_____[*month*],_____[*year*], between

Name and contact details of the Employer _____ (name)

_____ (*address*)

_____ (*telephone*)

_____(*email / other contact details*);

Name and contact details of the Contractor _____ (name)

_____ (*address*)

_____(*telephone*)

_____(*email / other contact details*);

Name and contact details of the DAAB Member _____ (name)

_____(*address*)

_____ (*telephone*)

_____(*email / other contact details*);

("**DAAB Agreement**")

Whereas:

A. the Employer and the Contractor have entered (or intend to enter) into the Contract;
B. under the Contract, the "**DAAB**" or "**Dispute Avoidance/Adjudication Board**" means the sole member or three members (as stated in the Contract Data of the Contract) so named in the Contract, or appointed under Sub-Clause 21.1 [*Constitution of the DAAB*] or Sub-Clause 21.2 [*Failure to Appoint DAAB Members*] of the Conditions of Contract;
C. the Employer and the Contractor desire jointly to appoint the above-named DAAB Member to act on the DAAB as:
    a. the sole member of the DAAB, and where this is the case, all references to the "Other Members" do not apply; or
    b. one of three members / chairman [*delete the one which is not applicable*] of the DAAB and, where this is the case, the other two persons are:

DAAB-2

_____ *(name)*	_____ *(name)*
_____ *(address)*	_____ *(address)*
_____*(telephone)*	_____*(telephone)*
_____*(email/ other contact details)*	_____ *(email/ other contact details)*

the "**Other Members**"; and

D. the DAAB Member accepts this appointment.

2. The Employer, Contractor and DAAB Member jointly agree as follows:

1. The conditions of this DAAB Agreement comprise:

   (a) Clause 21 [*Disputes and Arbitration*] of the Conditions of Contract, and any other provisions of the Contract that are applicable to the DAAB's Activities; and

   (b) the "General Conditions of Dispute Avoidance/Adjudication Agreement", which is appended to the General Conditions of the "Conditions of Contract for Construction" Second Edition 2017 published by FIDIC ("GCs"), as amended and/or added to by the following provisions.

2. [Details of amendments to the GCs, if any. For example:

   In the procedural rules annexed to the GCs, Rule _ is deleted and replaced by: "… "]

3. The DAAB Member shall be paid in accordance with Clause 9 of the GCs. The currency of payment shall be_____.

   In respect of Sub-Clauses 9.1 and 9.2 of the GCs, the amounts of the DAAB Member's monthly fee and daily fee shall be:

   monthly fee_____per month, and

   daily fee of_____per day

   (or as otherwise set under Sub-Clause 9.3 of the GCs).

4. In consideration of the above fees, and other payments to be made to the DAAB Member in accordance with the GCs, the DAAB Member undertakes to act as DAAB Member in accordance with the terms of this DAA Agreement.

5. The Employer and the Contractor shall be jointly and severally liable for the DAAB Member's fees and other payments to be made to the DAAB Member in accordance with the GCs.

6. This DAA Agreement shall be governed by the law of_____(if not stated, the law that governs the Contract under Sub-Clause 1.4 of the Conditions of Contract).

DAAB-3

SIGNED by:_____	SIGNED by:_____	SIGNED by:_____
Print name:_____	Print name:_____	DAAB Member
Title:_____	Title:_____	Title:_____
for and on behalf of the Employer	for and on behalf of the Contractor	
in the presence of	in the presence of	in the presence of
Witness:_____	Witness:_____	Witness:_____
Name:_____	Name:_____	Name:_____
Address:_____	Address:_____	Address:_____
_____	_____	_____
Date:_____	Date:_____	Date:_____

MG-1

SCHEDULE OF MOBILIZATION ADVANCE GUARANTEE/ BOND

Guarantee No._____Date _____

WHEREAS_____(hereinafter called the 'Employer')

has entered into a Contract for _____
(Particulars of Contract)
with_____(hereinafter called the "Contractor').

AND WHEREAS, the Employer has agreed to advance to the Contractor, at the Contractor's request, an amount of Pak Rupees……..(PKR…….) which amount shall be advanced to the Contractor as per provisions of the Contract.

AND WHEREAS, the Employer has asked the Contractor to furnish Guarantee to secure the mobilization advance for the performance of his obligations under the said Contract.
AND WHEREAS, ……

(hereinafter called the "Guarantor") at the request of the Contractor and in consideration of the Employer agreeing to make the above advance to the Contractor, has agreed to furnish the said Guarantee.

NOW, THEREFORE, the Guarantor hereby guarantees that the Contractor shall use the advance for the purpose of above mentioned Contract and if he fails and commits default in fulfilment of any of his obligations for which the advance payment is made, the Guarantor shall be liable to the Employer for payment not exceeding the aforementioned amount.

Notice in writing of any default, on the part of the Contractor, of which the Employer at his discretion of making decision, shall be given by the Employer to the Guarantor, and on such first written demand, payment shall be made by the Guarantor of all sums then due under this Guarantee without any reference to the Contractor and without any objection.
This Guarantee shall remain in force until the advance is fully adjusted against payments from theInterim Payment Certificates of the Contractor or until……whicheveris earlier. *(Date)*

The Guarantor's liability under this Guarantee shall not in any case exceed the sum of PKR …….).(Pak Rupees ……This Guarantee shall remain valid up to the aforesaid date and shall be null and void after the aforesaid date or earlier if the advance made to the Contractor is fully adjusted against payments from Interim Payment Certificates of the Contractor provided that the Guarantor

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agrees that the aforesaid period of validity shall be deemed to be extended if on the above mentioned date the advance payment is not fully adjusted.

Guarantor
(*Scheduled Bank*)

WITNESS: Signature _____

1. _____ Name _____

_____ Title _____

Corporate Secretary (Seal) Corporate Guarantor (Seal)

2. _____

_____

Name, Title & Address

IB-1

INDEMNITY BOND FOR SECURED ADVANCE AGAINST MATERIAL BROUGHT AT SITE

(ON RS. 300 NONJUDICIAL STAMP PAPER)

This Deed of Indemnity is issued by M/s. _____ in favour of M/s._____ Whereas _____ has paid the Secured Advance against the cost of material through any Bank or like agency by any other method by virtue of the terms of the contract existing between the parties. The details of the material and their price for which secured advance is being sought for the period _____ till consumption of the material is as under :-

1. _____ at Rs._____ per _____ = Rs.
2. _____ at Rs._____ per _____ = Rs.
3. _____ at Rs._____ per _____ = Rs.
4. _____ at Rs._____ per _____ = Rs.

THEREFORE THIS DEED OF INDEMNITY WITHNESSETH AS FOLLOWS:

I/We_____ of M/s. _____ do hereby indemnify M/s _____ for all losses due to thefts, arson, pilferage, loss due to flood and inundation, shortage, deterioration and depreciation etc. through any act of Man or God or slump in the Market of any or all the materials financed or paid by the Employer on our request for financing payment against material. I/We _____ shall indemnify _____ against any or all claims, action damages arising out of or resulting to the said material.

I/We _____further declare that we will faithfully abide by the above declaration and solemnly affirm that we will not remove, sell, pilferage any of the materials against which M/s _____ has paid us such a secured advance and will not pledge the same with any Bank, Finance Corporation, Firm, Company, Individual or the like agency or create any change whereon in any from what so ever.

I/We _____ do hereby also declare that in the event of my/our infringement of the declaration made above _____ will be entitled to forfeit all such material and also proceed against me/us according to the relevant clause pertaining to breach of contract and further invoke the power of seek any remedies secured of _____ _____ under the contract Agreement signed with us or otherwise available under law.

Place _____

Dated _____

Contractor _____

GENERAL CONDITIONS OF CONTRACT

CONDITIONS OF CONTRACT FOR ENGINEERING, PROCUREMENT AND CONSTRUCTION

GENERAL CONDITIONS

FIDIC

2017 Silver Book, First Edition

(To be procured by the Contractor)

Copies of the FIDIC Conditions of Contract can be obtained from:

World Trade Center II - Geneva Airport
P. O. Box 311
CH-1215 Geneva 15 Switzerland
Email: fidic@fidic.org, fidic.pub@fidic.org
Website: https://fidic.org/bookshop

PARTICULAR CONDITIONS
PART A – CONTRACT DATA

PUNJAB MASSTRANSIT AUTHORITY

Part A - Contract Data

Sub-Clause	Data to be Given	Data
1.1.17	Where the contract allows for Cost Plus Profit, percentage profit to be added to the cost:	N/A
1.1.18	Country	Islamic Republic of Pakistan
1.1.24	Defects Notification Period (DNP):	365 days
1.1.27	Employer's name and address:	***Name:*** *Punjab Masstransit Authority (PMA)* ***Address:*** *5th Floor, Arfa Software Technology Park, 346-B Ferozpur Road, Lahore* ***Attention:*** *Managing Director*
1.1.30	Employer's Representative name and address:	***Name:*** *Punjab Masstransit Authority (PMA)* ***Address:*** *5th Floor, Arfa Software Technology Park, 346-B Ferozpur Road, Lahore* ***Attention:***
1.1.76	Time for Completion:	**Design Phase:** 120 Days from the Commencement Date **Construction Phase:** 720 Days from Approval of Detail Design and Issuance of For Construction Drawings
1.3(a)(ii)	Agreed methods of electronic transmission:	*Email:* *For Notices, Electronic Transmission System is not permitted. For other communications, Electronic Transmission System is permitted, as and when installed.* *All electronic communications are to be supported by hardcopies of letter with reference no duly signed by the authorized personnel and should be posted on the same day.*
1.3(d)	Address of Employer for communications:	***Name:*** *Punjab Masstransit Authority (PMA)* ***Address:*** *5th Floor, Arfa Software*

		Technology Park, 346-B Ferozpur Road, Lahore
	Address of Employer's Representative for communications	***Name:*** ***Address:*** ***Attention:*** *[To be filled at the time of signing of the Contract Documents.]*
	Address of Contractor for communications:	***Name:*** ***Address:*** ***Attention:*** *[To be filled at the time of signing of the Contract Documents.]*
	Contract shall be governed by the law of:	Islamic Republic of Pakistan
1.4	Ruling language:	English
	Language for communications:	English
1.6	Contract Agreement	Within 21 days from the date of furnishing of acceptable Performance Security.
1.8	Number of additional paper copies of Contractor's Documents:	*05 Nos.*
2.1	After receiving the Letter of Acceptance, the Contractor shall be given right of access to all or part of the Site within:	No later than the Commencement Date, except for the following parts: 21 days after commencement date.
2.4	Employer's financial arrangements	*Employer's own funds through its Annual Development Plan of Government of the Punjab*
3.3 (c)(vii)	Delegated Persons [Employer's Representative]	Variation resulting in an increase of the Accepted Contract Amount in excess of one percent (1%) subject to accumulative Variations not exceeding two percent (2%) of the Accepted Contract Amount.
4.2	Performance Security (as percentage of the Accepted Contract Amount in Currencies)	Ten percent (10%) of the amount stated in the Letter of Acceptance.

	Percent: 10% Currency: PKR	
4.7 (b)	Period for notification of errors in the items of reference	Twenty-Eight (28) days
4.19	Period of payment for temporary utilities	N/A
4.20	Number of additional paper copies of progress reports	*06 Nos.*
6.5	Normal working hours on the Site	*08 Hrs per shift.*
8.1	Commencement of Works	Within 21 days from the Employer's Representative Notice to Commence.
8.3	number of additional paper copies of programmes	*03 Number of copies.*
8.8	Delay Damages payable for eachday of delay	0.05% of the Contract Price stated in the Letter of Acceptance for each day of delay from completion of the works.
8.8	Maximum amount of Delay Damages	Ten percent (10%) of the Accepted Contract Amount stated in the Letter of Acceptance.
8.14	Bonus payable for each day of earlier completion	N/A
14.2	Total Advance Payment (as percentage of Final Contract Price)	Mobilization Advance of Total 10% of Contract Price stated in Letter of Acceptance to be paid as per Sub Clause 14.2.2.
	Currency or Currencies of Advance Payment	Pak Rupees.
14.2.1	List of Insurance Companies	Companies having rating AA (+) rated by PACRA.
14.2.3	Percentage deductions for the repayment of the Advance Payment	Deduction shall be made at the amortization rate of 17.5 % of the value of the Works executed of each IPC as provided in paragraph (i) of Sub-Clause GCC 14.3, starting from 1st IPC generated against work done provided that the advance payment shall be completely repaid prior to the time when 90% of the Accepted Contract Amount less Provisional Sums has been certified forpayment.
14.3	Period of payment	21 Days
14.3(b)	Number of additional paper copies of Statements	*05 Nos.*
14.3 (iii)	Percentage of Retention	Ten percent (10%)

14.3 (iii)	Limit of Retention Money (as a percentage of the Contract Price.	Five percent (05%)
14.5 (b)(i)	Plant and Materials for payment when shipped	N/A
14.5 (c)(i)	Plant and Materials for payment when delivered to the site	N/A
14.7(a)	Period of payment of Advance Payment to the Contractor	21 days
14.7b(i)	Period for the Employer's Representative to make interim payments to the Contractor under Sub-Clause 14.6 [InterimPayment]	07 days.
14.7b(ii)	Period for the Employer to make interim payments to the Contractor under Sub-Clause 14.13 (Final Payment)	14 days.
14.7(c)	Period for the Employer to make final payment to the Contractor	56 days
14.8	Financing charges for delayed payment	N/A
14.11.1(b)	Number of additional paper copies of draft Final Statements	05
14.15	Currencies of payment of Contract Price	*Pak Rupees*
14.15(a)(i)	Proportions or amounts of Local and Foreign currencies	N/A
14.15(c)	Currencies and proportions for payment of Delay Damages	*Pak Rupees*
14.15(g)	Rates of exchange	N/A
17.2(d)	Forces of nature, the risks of which are allocated to the Contractor	N/A
19.1	Permitted deductible limits: i) Insurance required for the works ii) Insurance required for goods iii) Insurance required for liability for breach of professional duty iv) Insurance required against liability for fitness for purpose (if any is required) v) Insurance required for injury to persons and damage to property vi) Insurance required for injury to employees Other insurances required by laws and by local practice	Ten percent (10%) of loss amount on each & every loss

19.1	Periods for submission of insurance: a. Evidence of insurance Relevant policies	Not later than the Commencement Date Within twenty-eight (28) day from the Commencement Date
19.2.1(b)	b. Additional amount to be insured (as a percentage of the replacement value)	15% of the replacement value (Accepted Contract Amount)
19.2.2	Extent of insurance required for Goods Amount of insurance required for Goods	from Ex-Works (i.e., works, factory, warehouse, etc) to delivery at the Site Full replacement value
19.2.3(a)	Amount of insurance required for liability for breach of professional duty	Full replacement value of the Works to be designed by the Contractor
19.2.3(b)	Insurance required against liability for fitness for purpose	Yes
19.2.3	Period of insurance required for liability for breach of professional duty	Until the date of issuance of Performance Certificate
19.2.4	Amount of insurance required for injury to persons and damage to property	Injury to person and Fatal case: in accordance with Workmen Compensation Act Damage to Property: as per Third Party Assessment and the number of incident is unlimited.
19.2.6	Other insurances required by Laws and by local practice	All insurances as applicable, to the extent of execution of the project, under Federal and Provincial laws of Islamic Republic of Pakistan.
21.1	Time for appointment of the DAAB	Within 28 days from the Commencement Date.
21.1	The DAAB shall comprise	*"Three Members"*
21.2	Appointing entity (official) for DAAB members	Registrar, Pakistan Engineering Council
21.6	Rules of Arbitration	PEC Rules of Conciliation and Arbitration or Pakistan Arbitration Act of 1940, if the former is inactive. The place of Arbitration shall be in the Employer's country: Lahore, Punjab, Pakistan

PARTICULAR CONDITIONS
PART B – SPECIAL PROVISIONS

PUNJAB MASSTRANSIT AUTHORITY

PART B - SPECIAL PROVISIONS

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PUNJAB MASSTRANSIT AUTHORITY

PART B - SPECIAL PROVISIONS

1.1 Definitions

1.1.1. Advance Payment means the payment to be made by the Employer pursuant to Clause 14.2 (*Advance Payment*).

1.1.2. Advance Payment Guarantee means the guarantee under Sub-Clause 14.2.1 [Advance Payment Guarantee].

1.1.3. Arbitration Act means the Arbitration Act, 1940 and shall include modifications to or any re-enactment thereof as in force from time to time.

1.1.4. Claim means a request or assertion by one Party to the other Party for an entitlement or relief under any Clause of these Conditions or otherwise in connection with, or arising out of, the Contract or the execution of the Works.

1.1.5. Change in Law means: (a) the adoption, bringing into effect, promulgation, modification, repeal or reinterpretation after the Effective Date by any Relevant Authority of any Laws of Pakistan (including, without limitation, a final and binding decision of a Relevant Authority after the Effective Date), which amends such laws established or in effect as of the Effective Date; or (b) the imposition by a Relevant Authority in Pakistan of any material term or condition in connection with the issuance, renewal, extension, replacement or modification of any Consent after the Effective Date, that in each case establishes requirements for the Project or the Works that are materially more restrictive or more onerous than the most restrictive or most onerous requirements: (i) in effect as of the date of Effective Date; or (ii) to the extent more restrictive or more onerous than the requirements in (i) above, specified in any applications or other documents filed in connection with such applications for any Consent filed by the Contractor on or before the date of the Performance Release Certificate, so long as such requirements are consistent with the Laws of Pakistan in effect as of the Effective Date and to the extent not inconsistent with such laws.

1.1.6. Commencement Date means the date as stated in the Employer's Notice issued under Sub-Clause 8.1 [Commencement of Works].

1.1.7. Construction Period means the period commencing on the Commencement Date and ending upon the Taking-Over Date which in this case is 840 calendar days from the Commencement Date.

1.1.8. Compliance Verification System means the compliance verification system to be prepared and implemented by the Contractor for the Works in accordance with Sub-Clause 4.9.2 [Compliance Verification System].

1.1.9. Construction Programme is defined in Clause 8.3 (*Programme*).

1.1.10. Conditions of Contract or **these Conditions** means these General Conditions as amended by the Particular Conditions.

1.1.11. **Contract** means, subject to Clause 1.5 (*Priority of Documents*), this Contract and all Schedules and Annexes hereto.

1.1.12. **Contract Data** means the pages, entitled contract data which constitute Part A of the Particular Conditions.

1.1.13. **Contract Period** means the period commencing on the Commencement Date and ending upon the issuance of the Performance Release Certificate.

1.1.14. **Contract Price** means the sum of PKR **111,234 Million**/- (Pakistani Rupees One Hundred Eleven Thousand Two Hundred and Thirty-Four Million), being the total fixed lump-sum amount payable to the Contractor for the design, project management, QA/QC, construction, and commissioning of the Works, including the one (01) year Defects Notification Period, as per Employer's Requirements;

1.1.15. **Contractor** means the person(s) named as contractor in the Contract Agreement and the legal successors in title of such person(s).

1.1.16. **Contractor's Documents** means the calculations, computer programs and other software, drawings, specifications, manuals, models and other documents of a technical nature supplied by the Contractor under the Contract; as described in Clause 5.2 (*Contractor's Documents*).

1.1.17. **Contractor's Equipment** means all apparatus, machinery, vehicles and other things (including cranes that are inspected, calibrated and certified by an accredited body acceptable to the Employer) required for the execution and completion of the Works and the remedying of any Defects or Deficiencies. However, Contractor's Equipment excludes Temporary Works, Plant, Materials and any other things intended to form or forming part of the Permanent Works.

1.1.18. **Contractor's Personnel** means the Contractor's Representative and all personnel whom the Contractor utilises on Site, who may include the staff, labour and other employees of the Contractor, including the Contractor's home office management and administration staff and any other personnel assisting the Contractor in the execution of the Works.

1.1.19. **Contractor's Representative** means the person specified in Clause 4.3 (*Contractor's Representative*) or such other person appointed from time to time by the Contractor thereunder, who acts on behalf of the Contractor.

1.1.20. **Cost** means all expenditure reasonably and properly incurred (or to be incurred) by the Contractor, whether on or off the Site, including taxes, overhead and similar charges, but does not include profit.

1.1.21. **Cost Plus Profit** means Cost plus the applicable percentage for profit stated in the Contract Data (if not stated, ten percent (10%)). Such

percentage shall only be added to Cost-, and Cost-Plus Profit shall only be added to the Contract Price, where the Contractor is entitled under a Sub-Clause of these Conditions to payment of Cost-Plus Profit.

1.1.22. **Country** means the country in which the Site (or most of it) is located, where the Permanent Works are to be executed.

1.1.23. **DAAB** or **Dispute Avoidance/Adjudication Board** means the sole member or three members (as the case may be) so named in the Contract, or appointed under Sub-Clause 21.1 [Constitution of the DAAB] or Sub-Clause 21.2 [Failure to Appoint DAAB Member(s)].

1.1.24. **DAAB Agreement** means the agreement signed or deemed to have been signed by both Parties and the sole member or each of the three members (as the case may be) of the DAAB in accordance with Sub-Clause 21.1 [Constitution of the DAAB] or Sub-Clause 21.2 [Failure to Appoint DAAB Member(s)], incorporating by reference the General Conditions of Dispute Avoidance/Adjudication Agreement contained in the Appendix to these General Conditions with such amendments as are agreed.

1.1.25. **Date of Completion** means the date stated in the Taking-Over Certificate issued by the Employer; or, if the last paragraph of Sub-Clause 10.1 [Taking Over the Works and Sections] applies, the date on which the Works or Section are deemed to have been completed in accordance with the Contract; or, if taking over of part(s) of the Works is permitted under Sub-Clause 10.2 [Taking Over of Parts of the Works], the date on which such part(s) are taken over or used by the Employer.

1.1.26. **Day** means a calendar day.

1.1.27. **Daywork Schedule** means the document entitled daywork schedule (if any) included in the Contract, showing the amounts and manner of payments to be made to the Contractor for labour, materials and equipment used for daywork under Sub-Clause 13.5 [Daywork].

1.1.28. **Defects Notification Period** or **DNP** means the period for notifying defects and/or damage in the Works or a Section (or a part of the Works, if Sub-Clause 10.2 [Taking Over of Parts of the Works] applies), as the case may be, under Sub-Clause 11.1 [Completion of Outstanding Work and Remedying Defects], as stated in the Contract Data (if not stated, one year), and as may be extended under Sub-Clause 11.3 [Extension of Defects Notification Period]. This period is calculated from the Date of Completion of the Works or Section (or part of the Works).

1.1.29. **Delay Damages** means the damages for which the Contractor shall be liable under Sub-Clause 8.8 [Delay Damages] for failure to comply with Sub-Clause 8.2 [Time for Completion].

1.1.30. **Defects or Deficiencies** means any Works (or any part thereof) that fail

to conform to the Standards in any manner (including any services, performance, materials, execution, engineering and/ or workmanship in respect of such Works) and/or are not Fit for the Purpose; and any grammatical forms of such terms shall be construed accordingly.

1.1.31. **Dispute** means means any situation where: (a) one Party makes a claim against the other Party (which may be a Claim, as defined in these Conditions, or a matter to be determined by the Employer's Representative under these Conditions, or otherwise); (b) the other Party (if the Employer, under Sub-Clause 3.5.2 [Employer's Representative's determination] or otherwise) rejects the claim in whole or in part; and (c) the first Party does not acquiesce (if the Contractor, by giving a NOD under Sub-Clause 3.5.5 [Dissatisfaction with Employer's Representative's determination] or otherwise), provided however that a failure by the other Party to oppose or respond to the claim, in whole or in part, may constitute a rejection if, in the circumstances, the DAAB or the arbitrator(s), as the case may be, deem it reasonable for it to do so.

1.1.32. **Effective Date** means the date this Contract comes into full force and effect.

1.1.33. **Employer** is, Punjab Masstransit Authority (PMA), Arfa Kareem Tower, Lahore., represented by:

Managing Director, PMA

1.1.34. **Employer's Equipment** means the apparatus, equipment, machinery, construction plant and/or vehicles (if any) to be made available by the Employer for the use of the Contractor under Sub-Clause 2.6 [Employer Supplied Materials and Employer's Equipment]; but does not include Plant which has not been taken over under Clause 10 [Employer's Taking Over].

1.1.35. **Employer's Personnel** means the Employer's Representative, the assistants described in Sub-Clause 3.2 [Other Employer's Personnel] and all other staff, labour and other employees of the Employer and of the Employer's Representative, engaged in fulfilling the Employer's obligations under the Contract; and any other personnel identified as Employer's Personnel, by a Notice from the Employer or the Employer's Representative to the Contractor.

1.1.36. **Employer's Representative** means a competent person appointed by the Managing Director, Punjab Masstransit Authority (PMA) to act as the Employer's Representative on its behalf for the purpose of the Contract, or any replacement appointed under Sub-Clause 3.1 [The Employer's Representative].

1.1.37. **Employer's Requirements** means the document entitled employer's requirements, as included in the Contract as **Volume - III**, and any additions and modifications to such document in accordance with the Contract. Such document describes the purpose(s) for which the Works are intended, and specifies Key Personnel (if any), the scope, and/or design and/or other performance, technical and evaluation criteria, for the Works.

1.1.38. **Employer-Supplied Materials** means the materials (if any) to be supplied by the Employer to the Contractor under Sub-Clause 2.6 [Employer-Sup plied Materials and Employer's Equipment].

1.1.39. **Employer's Interconnection Facilities** means the facilities and equipment to be constructed or installed by or on behalf of the Employer.

1.1.40. **Exceptional Event** means an event or circumstance as defined in Sub-Clause 18.1 [Exceptional Events].

1.1.41. **Extension of Time** or **EOT** means an extension of the Time for Completion under Sub-Clause 8.5 [Extension of Time for Completion].

1.1.42. **Facility** means the complete Islamabad–Murree Tourist Glass Train System, including all civil works, track, stations, depots, rolling stock, power supply, signalling, control, ticketing, IT and ancillary infrastructure to be designed, constructed, tested, commissioned and handed over under this Contract..

1.1.43. **Facility Commercial Operations Test** means the commissioning of the Facility.

1.1.44. **Facility Final Commissioning Tests** means the tests required for the commissioning of the Facility, as detailed in Schedule 1 (*Employer's Requirements*).

1.1.45. **Final Statement** means the Statement defined in Sub-Clause 14.11.2 [Agreed Final Statement].

1.1.46. **Foreign Currency** means a currency in which part (or all) of the Contract Price is payable stated in the Contract Data.

1.1.47. **Fit for the Purpose** shall mean:

(a) in relation to the Works or any part thereof, that all Works to be performed by the Contractor hereunder shall be fit and appropriate for the purposes of the Facility;

(b) in relation to the Facility, that the Facility shall meet the Performance Guarantees and shall be fit to operate and to deliver Murree Glass Train and Allied Infrastructure in respective cities, in each case, in full compliance with the:

(i) Contract Agreement;

(ii) Employer's Requirements;

(iii) Laws;

provided, however, in the event of any discrepancy or contradiction in any of the above, requirements and criterion set out in the abovementioned, the most stringent standards, requirements and criterion, as contained in any of the above-mentioned, shall apply.

1.1.48. **FIDIC** means the Fédération Internationale des Ingénieurs-Conseils, the International Federation of Consulting Engineers.

1.1.49. **Force Majeure Event** is defined in Clause 18.1 (*Exceptional Events*).

1.1.50. **General Conditions** means this document entitled "Conditions of Contract for EPC/Turnkey Projects", as published by FIDIC.

1.1.51. **Goods** means Contractor's Equipment, Materials, Plant and Temporary Works, or any of them as appropriate.

1.1.52. **Hazardous Material** means any pollutant, contaminant, solid waste, hydrocarbon product, toxic or hazardous substance, materials or waste, any flammable, explosive or radioactive materials defined, listed, classified or regulated as such in or under, or subject to, any applicable Laws (including environmental Laws) including:

(a) any petroleum or petroleum products (including gasoline or crude oil or any fraction of them, but excluding small quantities of lubricating greases), flammable explosives, radioactive materials, asbestos in any form that is or could become friable, urea formaldehyde foam insulation and polychlorinated biphenyl;

(b) any chemicals, materials or substances defined as or included in the definition of "hazardous substances", "hazardous wastes", "hazardous materials", "extremely hazardous wastes", "restricted hazardous wastes", "toxic substances", "toxic pollutants", "contaminants" or "pollutants", or words of similar import, under any applicable environmental Law;

(c) any other chemical, material or substance, exposure to or release of which is prohibited, limited or regulated by any Relevant Authority; and

(d) any hazardous material or substance identified as such or otherwise regulated under the Environmental and Social Standards.

1.1.53. Hyperinflation means extremely high and abnormal rate of inflation, notified by the Finance Department, Government of the Punjab.

1.1.54. Interim Payments means instalments of the Contract Price payable in such amounts and on completion of such Milestones as set out in **Volume - II** *(Milestone Payments)*.

1.1.55. Key Persons is defined in Sub-Clause 6.12.

1.1.56. Laws means all national (or state, provincial or local) legislation, statutes, ordinances and other laws, and all regulations, by-laws, rules, orders, decrees, judicial decisions, delegated legislation, directives, guidelines (to the extent mandatory) policies or code of any legally constituted Relevant Authority.

1.1.57. Local Currency means the currency of the Islamic Republic of Pakistan.

1.1.58. Loss means any loss, claim, damage, liability, judgment, payment or obligation (excluding any indirect or consequential loss, damage, liability, payment or obligation), and all costs and expenses (including without limitation reasonable attorneys' fees) related thereto and amounts in settlement in lieu thereof.

1.1.59. Materials means means things of all kinds (other than Plant), whether on the Site or otherwise allocated to the Contract and intended to form or forming part of the Permanent Works, including the supply-only materials (if any) to be supplied by the Contractor under the Contract.

1.1.60. Month is a calendar month (according to the Gregorian calendar).

1.1.61. No-objection means that the Employer has no objection to the Contractor's Documents, or other documents submitted by the Contractor under these Conditions, and such Contractor's Documents or other documents may be used for the Works.

1.1.62. Notice means a written communication identified as a Notice and issued in accordance with Sub-Clause 1.3 [Notices and Other Communications].

1.1.63. Notice of Dissatisfaction or **NOD** means the Notice one Party may give to the other Party if it is dissatisfied, either with an Employer's Representative's determination under Sub-Clause 3.5 [Agreement or Determination] or with a DAAB's decision under Sub-Clause 21.4 [Obtaining DAAB's Decision].

1.1.64. Notice to Proceed means the notice to commence the Works to be issued by the Employer to the Contractor in accordance with this Contract.

1.1.65. **Particular Conditions** means the document entitled particular conditions of contract included in the Contract, which consists of Part A - Contract Data and Part B – Special Provisions.

1.1.66. **Party** means the Employer or the Contractor, as the context requires. **Parties** means both the Employer and the Contractor.

1.1.67. **Performance Certificate** means the certificate issued by the Employer (or deemed to be issued) under Sub-Clause 11.9 [Performance Certificate].

1.1.68. **Performance Damages** means the damages to be paid by the Contractor to the Employer for the failure to achieve the guaranteed performance of the Plant and/or the Works or any part of the Works (as the case may be), as set out in the Schedule of Performance Guarantees.

1.1.69. **Performance Security** means the security under Sub-Clause 4.2 [Performance Security].

1.1.70. **Permanent Works** means the permanent works, services and obligations to be performed by the Contractor by the Taking-Over Date, including, construction, rehabilitation, procurement, installation, testing and commissioning as more fully described in **Schedule** 1 (*Employer's Requirements*).

1.1.71. **Plant** means means the apparatus, equipment, machinery and vehicles (including any components) whether on the Site or otherwise allocated to the Contract and intended to form or forming part of the Permanent Works.

1.1.72. **Programme** means a detailed time programme prepared and submitted by the Contractor to which the Employer has given (or is deemed to have given) a Notice of No-objection under Sub-Clause 8.3 [Programme].

1.1.73. **Provisional Sum** means a sum (if any) which is specified in the Contract by the Employer as a provisional sum, for the execution of any part of the Works or for the supply of Plant, Materials or services under Sub-Clause 13.4 [Provisional Sums].

1.1.74. **Project** means the execution of the Works and the development of the Facility in accordance with the detailed investigations, design, procurement, construction, as per **Volume - III** (*Employer's Requirements*).

1.1.75. **QM System** means the Contractor's quality management system (as may be updated and/or revised from time to time) in accordance with Sub-Clause 4.9.1 [Quality Management System].

1.1.76. **Prudent Practices** means that degree of skill and judgment and the use of equipment, practices, techniques, standards and methods that are generally expected of skilled and experienced engineering and construction firms in the international water supply industry including, without limitation, as required to comply with applicable industry codes, standards, and regulations in Pakistan: (i) to protect the Employer's and Contractor's system, employees, agents, and customers from malfunctions occurring at the Works; and (ii) to protect the Works and the Employer's and Contractor's employees and agents at the Works, from malfunctions occurring on the Facility.

1.1.77. **Punch List** means the list submitted by the Contractor and approved by the Employer of items that are not completed on or before the Taking-Over Date; provided that the items on such list shall be limited to completion of insulation, painting, final clean-up, final grading and any other portion of the Works which do not constitute Defects or Deficiencies and which do not affect the operability, safety or mechanical integrity of the Works and has no impact on the ability of the Facility to meet the Performance Guarantees.

1.1.78. **Punch List Items** means the items mentioned in the Punch List.

1.1.79. **Retention Money** means the accumulated retention moneys which the Employer retains under Sub-Clause 14.3 [Application for Interim Payment] and pays under Sub-Clause 14.9 [Release of Retention Money].

1.1.80. **Review** means examination and consideration by the Employer of a Contractor's submission in order to assess whether (and to what extent) it complies with the Contract and/or with the Contractor's obligations under or in connection with the Contract.

1.1.81. **Relevant Authority** means the department, authority, instrumentality, agency, entity or body of Pakistan from which a Consent is to be obtained and any authority having jurisdiction under the Laws of Pakistan with respect to the Employer, the Contractor, the Project, and/or the Facility.

1.1.82. **Schedules** means the document(s) entitled schedules prepared by the Employer and completed by the Contractor, as attached to the Tender and included in the Contract. Such document(s) may include data, lists and schedules of payments and/or rates and prices, and guarantees.

1.1.83. **Schedule of Payments** means the document(s) entitled schedule of payments (if any) in the Schedules showing the amounts and manner of payments to be made to the Contractor.

1.1.84. **Schedule of Milestones** means the schedule set out in **Volume - II** *(Milestone Payments)* stipulating the Milestone Dates (as may be revised in accordance with this Contract) to be used for the calculation of

Interim Payments.

1.1.85. **Schedule of Performance Guarantees** means the document(s) entitled schedule of performance guarantees (if any) in the Schedules showing the guarantees required by the Employer for performance of the Works and/ or the Plant or any part of the Works (as the case may be), and stating the applicable Performance Damages payable in the event of failure to attain any of the guaranteed performance(s).

1.1.86. **Schedule of Rates and Prices** means the document(s) entitled schedule of rates and prices (if any) in the Schedules.

1.1.87. **Site** means the place or places where the Permanent Works are to be executed and to which Plant and Materials are to be delivered and any other places as may be specified in the Contract as forming part of the Site.

1.1.88. **Statement** means a statement submitted by the Contractor as part of an application for payment under Sub-Clause 14.3 [Application for Interim Payment], Sub-Clause 14.10 [Statement at Completion] or Sub-Clause 14.11 [Final Statement].

1.1.89. **Standards** all standards, requirements, obligations, specifications relating to the Contractor's obligations, Facility and the Works as specified in this Contract and the Employer's Requirements.

1.1.90. **Section** means a part of the Works specified in the Contract Data as a Section (if any).

1.1.91. **Special Provisions** means the document (if any), entitled special provisions which constitutes Part B of the Particular Conditions.

1.1.92. **Taking-Over Certificate** means a certificate issued (or deemed to be issued) by the Employer in accordance with Clause 10 [Employer's Taking Over].

1.1.93. **Taking-Over Criteria** means the minimum set of technical, functional, and contractual conditions that must be fulfilled by the Contractor for the Works, or any Section thereof, to be deemed complete and ready for taking over by the Employer. This includes the completion of all works in accordance with the Contract and Employer's Requirements, the successful passing of all tests on completion, verified compliance with the design performance and functional requirements, and the Facility being in a condition that is safe, operable, and fit for beneficial use by the Employer. Compliance with these criteria shall be confirmed and certified by the Employer's Representative in accordance with Sub-Clause 10.1 [Taking Over of the Works and Sections].

1.1.94. **Taking-Over Date** means the date on which the Contractor has achieved the Taking-Over Criteria set out in **Volume - III** (*Employer's*

Requirements) and the Employer has confirmed achievement of the Taking-Over Date in accordance with Clause 10 (*Employer's Taking-Over*) of the Contract.

1.1.95. **Technical Limits** means technical limits and constraints relating to, from and after the Taking-Over Date, the despatch of the Facility, as such limits and constraints are described in **Volume - III** (*Employer's Requirements*).

1.1.96. **Temporary Works** means all temporary works of every kind (other than Contractor's Equipment) required on Site for the execution and completion of the Permanent Works and the remedying of any Defects or Deficiencies.

1.1.97. **Tests after Completion** means the tests (if any) which are stated in the Specification and which are carried out in accordance with the Special Provisions after the Works or a Section (as the case may be) are taken over under Clause 10 [Employer's Taking Over].

1.1.98. **Tests on Completion** means the tests which are specified in the Contract or agreed by both Parties or instructed as a Variation, and which are carried out under Clause 9 [Tests on Completion] before the Works or a Section (as the case may be) are taken over under Clause 10 [Employer's Taking Over].

1.1.99. **Time for Completion** means the time for completing the Works or a Section (as the case may be) under Sub-Clause 8.2 [Time for Completion], as stated in the Contract Data as may be extended under Sub-Clause 8.5 [Extension of Time for Completion], calculated from the Commencement Date.

1.1.100. **Variation** means any change to the Employer's Requirements or the Works, which is instructed or approved as a variation under Clause 13 (*Variations and Adjustments*).

1.1.101. **Workers** means, collectively, the individuals that perform continuous on-site work that is either: (i) of substantial duration; or (ii) material to the primary operations of the Project.

1.1.102. **Works** means project management, QA/QC, construction, and commissioning of the Facility and shall include the Temporary Works and the Permanent Works, or either of them as appropriate.

1.1.103. **Tender** is synonymous to "Bid"; wherever written or applicable in this Contract.

1.1.104. **Taxes, Duties and Fees** means and includes (not limited to) the following items: Custom Duty, Sales Tax, Consumption Tax, Additional tax, Anti-Dumping Duty / Tax, Withholding Tax, as levied by the Laws of the Islamic Republic of Pakistan on the Contractor.

1.2 Interpretation

In the Contract, except where the context requires otherwise:

(a) words indicating one gender include all genders;

(b) words indicating the singular also include the plural and words indicating the plural also include the singular;

(c) provisions including the word “agree”, “agreed” or “agreement” require the agreement to be recorded in writing;

(d) “written” or “in writing” means hand-written, type-written, printed or electronically made, and resulting in a permanent record;

(e) references to Clauses, Schedules and Annexes are, unless the context otherwise requires, references to Clauses, Schedules and Annexes to this Contract;

(f) a reference to any legislation or legislative provision includes any statutory modification, amendment, or re-enactment of or legislative provision substituted for, and any subordinate legislation under that legislation or legislative provision;

(g) unless otherwise provided herein, whenever a consent or approval is required by one Party from the other Party, such consent or approval shall not be unreasonably withheld or delayed;

(h) except as provided in Clause 1.11 (*Confidentiality*), nothing shall be construed or interpreted as limiting, diminishing or prejudicing in any way the rights of the Employer to claim any benefit provided under applicable Laws (whether in effect now or in the future);

(i) headings shall not be taken into consideration in the interpretation of this Contract;

(j) the words “including”, “includes” and any variants of those words will be read as if followed by the words “without limitation;

(k) any reference to a party includes its respective successors in interest and permitted assigns, from time to time;

(l) unless otherwise specifically provided in the Contract, a reference to an agreement shall be a reference to that agreement as amended, re-stated, supplemented, modified or novated from time to time; and

(m) a reference to business day(s) hereunder will be construed as a reference to a day on which banks are legally permitted to be open for business in Pakistan

1.3 Notices and Other Communications

(a) Except as expressly provided in this Contract, every certificate, notice, instruction, direction, order, consent or decision to be given under this Contract shall be given in writing to the respective addressee at the corresponding address specified below (or such other address and/or addressee as the Contractor may notify to the Employer or the Employer may notify to the Contractor (as the case may be) in writing upon seven (7) days advance notice

and shall be effective when received) and shall be deemed effective as follows:

(i) if delivered personally, upon delivery;

(ii) if sent by post, upon certified receipt;

(iii) if sent by a courier service, upon receipt; or

(iv) if sent by e-mail, upon a returned receipt.

(b) If to Contractor:

Name:
Address:

Attention:

If to Employer:

Name: *Punjab Masstransit Authority (PMA)*
Address: *Arfa Kareem Tower, Lahore.*
Attention: *Managing Director*

Approvals, certificates, consents and determinations shall not be unreasonably withheld or delayed.

1.5 Priority of Documents

The documents listed at (a) through (k) of this Sub-Clause are deleted and substituted with the following:

a) The Letter of Acceptance;
b) the Contract Agreement;
c) Letter of Technical Bid and Letter of Priced Bid;
d) the Particular Conditions Part A - Contract Data;
e) the Particular Conditions Part B - Special Provisions;
f) the General Conditions of Contract;
g) the Employer's Requirements;
h) Completed Schedules to Bids;
i) the Referenced Bill of Quantities;
j) the Referenced Drawings;
k) EMP
l) or any other documents forming part of the Contract.

1.6 Contract Agreement

The text of the sub-clause is deleted in its entirety and substituted with the following:

Until and unless a formal Agreement is prepared and executed, the Letter of Acceptance / Award, together with the Contractor's written acceptance thereof, shall constitute a binding contract between the Employer and the Contractor.

The Contract shall come into full force and effect on the date stated in the Contract Agreement. The costs of stamp duties and similar charges (if any) imposed by law in connection with entry into the Contract Agreement shall be borne by the Contractor.

If the Contractor comprises a JV, the authorised representative of each member of the JV shall sign the Contract Agreement.

1.9 Employer's Use of Contractor's Document

The last paragraph of this sub-clause is deleted and replaced with the following paragraph:

The Contractor's Documents and other design documents made by (or on behalf of) the Contractor may be used, copied, or communicated by (or on behalf of) the Employer to any third party, without the Contractor's prior consent, for any purpose related to the Project, including but not limited to design review, construction, operation, maintenance, future development, or procurement of related works.

2.1 Right of Access to the Site

The following paragraph is added at the end of 1st paragraph:

The possession of portion of site shall be given in consistent to and commensurate with the approved work program and methodology for execution of the works, without any prejudice to the Employer's right to give possession of the site in full at its discretion.

The following paragraphs are added at the end of this sub-clause:

The Employer shall provide the Site to the Contractor free from all encumbrances, including clearance of all relevant underground and above-ground utilities and services, to the extent specified in the Contract.

If, notwithstanding the foregoing, the clearance, protection, diversion or relocation of any existing utility or service is expressly instructed in writing by the Employer's Representative, then, after the Employer's Representative has obtained the necessary permission from the relevant utility owner/organization, the Contractor shall carry out such removal or relocation. The actual cost of such

works, based on the work done and costs reasonably and properly incurred by the Contractor and duly verified/certified by the Employer's Representative, shall be paid to the Contractor under the Provisional Sum.

The Contractor shall at all times conduct its operations, make all necessary arrangements, take suitable precautions and perform all work required to protect and avoid interference with power transmission lines, telecommunication lines, natural gas and oil pipelines, water supply and sewerage mains and all other utilities within or adjacent to the areas of its operations in connection with this Contract.

If any harm or damage is caused to existing utility lines or services as a result of the Contractor's works, the entire cost of repair, reinstatement and any associated losses shall be borne by the Contractor and shall not be reimbursable. The Contractor shall keep the Employer indemnified and hold the Employer harmless from and against all claims, demands, proceedings, damages, costs, charges and expenses whatsoever arising out of or in relation to such operations or interference with utilities.

3.1 The Employer's Representative

In fourth paragraph after the text "where the Employer's Representative is legal entity," the following is added "or a professional engineer having suitable qualifications, experience and competence to act as the Employer's Representative under the aegis of Pakistan Engineering Council Act, 1975 (Act No. V of 1976)".

3.3 Delegated Persons

The following text is added at the end of this sub-clause:

(c) The Delegated Person shall obtain the consent in writing of the Employer/Employer's Representative before carrying out his duties in accordance with the following Clauses:

(i) any action under clause 3.5 [Agreement or Determination];

(ii) Any action under Sub-Clause 4.2 [Performance Security] and Clause 19 [Insurances]

(iii) Any action under sub-Clause 8.5 [Extension of Time for Completion]

(iv) Any action under Sub-Clauses 8.9 [Employer's Suspension] and 8.12 [Prolonged Suspension]'

(v) Issuance of "Taking Over Certificate" under Sub-Clause 10.1 [Taking Over the Works and Sections];

(vi) Issuing the "Performance Certificate" under Sub-Clause 11.9 [Performance Certificate];

(vii) Sub-Clause 13.1 [Right to Vary]: instructing a Variation, except;

a. in an emergency situation as determined by the Delegated Person, or

b. if such a Variation would increase the Accepted Contract Amount by less than the percentage specified in the Contract Data.

(viii) Sub-Clause 13.3 [Variation Procedure]: approving a proposal for Variation submitted by the Contractor in accordance with Sub-Clause 13.3.2 [Variation by Request for Proposal] or 13.2 [Value Engineering];

(ix) Certifying release of second half of the Retention Money under Sub-Clause 14.9 [Release of Retention Money];

(x) Issuing Final Payment Certificate under Sub-Clause 14.13 [Final Payment];

(xi) Any action under Clause 15 [Termination by Employer] & Clause 16 [Suspension and Termination by Contractor];

(xii) Any action under Clause 20 [Employer's and Contractor's Claims]

(Note: Employer may further vary according to need of the project)

(d) Notwithstanding the obligation, as set out above, to obtain approval, if in the opinion of the Delegated Persons [Employer's Representative] an emergency occurs affecting the safety of life or of the Works or of adjoining property, he may, without relieving the Contractor of any Of his duties and responsibilities under the Contract, instruct the Contractor to execute all such work or to do all such things as may, in the opinion of the Delegated Person, be necessary to abate or reduce the risk. The Contractor shall forthwith comply with any such instruction of the Delegated Person. The Employer's Representative shall determine an addition to the Contract Price, in respect of such instruction, in accordance with Clause 13 and shall notify the Contractor accordingly, with a copy to the Employer.

PUNJAB MASSTRANSIT AUTHORITY

4.1 Contractor's General Obligations

The following paragraph is added at the end of this sub-clause:

"All Equipment shall be warranted by the Contractor in accordance with the applicable provisions. The scope, duration, and terms of warranty services—including parts replacement, labor, field service, transportation, and related obligations—shall be governed by the relevant warranty provisions stipulated therein.

Unless otherwise specified or not addressed under Agreement, all Equipment shall carry a minimum warranty period of one (01) year. The warranty period shall commence from the date of issuance of the Taking-Over Certificate (TOC)

by the Employer. No Equipment shall be accepted without a valid manufacturer's warranty certificate.. No additional cost shall be payable for warranty services.

4.2 Performance Security

4.2.1 "Contractor's Obligation"

The first paragraph of this sub-clause is deleted and replaced with the following text:

The Contractor shall provide Performance Security to the Employer in the prescribed form. The said Security shall be furnished or caused to be furnished by the Contractor within 14 days after the receipt of the Letter of Acceptance. The Performance Security shall be of an amount equal to ten percent (10%) of the Contract Price stated in the Letter of Acceptance.

Such Security shall be in the form of either (a) bank guarantee from any Scheduled Bank in Pakistan or (b) bank guarantee from a bank located outside Pakistan duly counter-guaranteed by a Scheduled Bank in Pakistan; and Performance Security for the full amount of ten percent (10%) shall remain valid twenty-eight (28) days beyond the issuance of Performance Certificate.

The cost of complying with requirements of this Sub-Clause shall be borne by the Contractor.

4.3 Contractor's Representative

In second paragraph the text "professional engineer as defined in the Pakistan Engineering Council Act, 1975 (Act No. V of 1976) (having temporary licence in case of foreign engineer under Section 12 of the Pakistan Engineering Council Act, 1975 (Act No. V of 1976)" are added after the words "qualified, experienced".

In the 3rd paragraph the words "28 days" are substituted by "14 days".

4.8 Health and Safety Obligations

The following text is added at the end of this Sub-Clause:

In the event of work being carried out outside the normal working hours and in the event of work being carried out at night, the Contractor shall at his own cost, provide and maintain such good and sufficient light as will enable the work to proceed satisfactorily and without danger. The approaches to the Site and the Works where the night work is being carried out shall be sufficiently lighted. All arrangement adopted for such lighting shall be to the satisfaction of the Employer's Representative.

The Contractor shall:

- Prevent all road accidents that might arise as a consequence of its activities;

- Adhere to the following principles of Environmental Management Guidelines;
- Minimize gaseous emissions, liquid effluents and discharge of solid waste that is known to have a negative impact on the environment;
- Within fourteen (14) days of the commencement date the Contractor shall submit his (Project Health and Safety Plan) to the Employer/Employer's Representative review, He should nominate the key person in his organization who will be responsible for administrating the plan;
- In order to provide for the safety, health and welfare of persons, and for prevention of damage of any kind, all operations for the purposes of or in connection with the Contract shall be carried out in compliance with the Safety Requirements of the Government of Pakistan with such modifications thereto as the Employer/Employer's Representative may authorise or direct and the Contractor shall take or cause to be taken such further measures and comply with such further requirements as the Employer/Employer's Representative may determine to be reasonably necessary for such purpose;
- All employees shall be physically qualified for performing the duties to which they are assigned, Operators of equipment and vehicles shall be qualified (licensed) they shall be able to read and understand the signs, signals and operating instructions in use;
- Contractor shall protect all people involved with or potentially affected by its operation from the adverse consequences of fire or explosions and shall safeguard all Employer/ Employer's Representative's assets to a level commensurate with their criticality;
- Contractor must also provide adequate protective clothing and equipment PPE's to prevent, so far reasonably practicable risk of accidents or adverse effect on safety and health;
- Contractor is required to ensure that, so far as is reasonably practicable, the workplace, machinery, equipment and process under control are safe and without a risk to health;
- Prior to start of work, Contractor must provide measures to deal with emergencies and accidents, including adequate first aid arrangements, in the ratio of one (01) unit each twenty-five(25) persons or less, also and emergency vehicle, doctor and equipped clinic in case of exceeding 500 workers or providing private personnel health card for each worker at close clinic to the project as per prevailing Pakistan Labour Law;
- Contractor shall recognize the responsibility to protect the environment in order that the future well-being of society is safeguarded and make every effort to minimize the impact of its operations on the environment and people;
- Contractor's liability insurance should satisfy requirements to carry appropriate insurance so that a worker who is harmed is assured of receiving compensation. Other cost that be incurred relate to:

  - Damage to properties, goods and equipment

- Accident investigations
- Possible fines and associated legal fees

- Qualified and experienced safety officers and the number of officers and safety staff that comply to international safety practices as applicable, one officer for each 150 workers shall be deployed at the site;
- The Contractor and his supervisors/foremen are responsible for administration of comprehensive Project HSE plan. The Project HSE Plan shall embody prevention of accidental injury, occupational illness and property damage. The Contractor shall provide and maintain a safe hazard free workplace for their employees, for fellow workers and general public. The project HSE plan shall ensure the involvement and active participation of all project employees by requiring safety training, which shall promote recognition of unsafe acts, unsafe conditions and potential and actual hazards, and the immediate corrective action to be taken. All the employees shall be constantly aware of their responsibilities to work in a safe manner;
- The Contractor shall identify the hazards involved in the Project during the Contract execution and shall implement the necessary controls to eliminate or mitigate these hazards.
- Expeditious response in case of injury, fire, security and natural disaster etc. to be ensured;
- Water sprinkling within the Project boundary to be ensured on as required basis;
- Adequate number of manpower to be deployed depending upon the weight and extent of the material/equipment to be lifted;
- Fall protection above 1.8 m (6 ft.) to be provided with guard / handrails, full body harness and safety nets;
- Guard rails and toe boards above 20 m (65 ft.) required to cordon off the Project site to be provided;
- Scaffolding and ladder not to be used without approval from safety staff;
- Angle of repose to be calculated and implemented where the depth of excavation exceeds 1.2 m;
- Drilling bore holes and pits to be covered and barricaded;
- Noise exceeding 85 dBA to be avoided for daily exposure and 140 dBA for peak exposure, Ear plugs and earmuffs to be ensured for peak exposure;
- 3-wire type extension cords to be used for electrical works and worn electrical cables to be discarded;
- Waste disposal at Government approved locations to be done on daily basis.

Notwithstanding the provisions contained under this Sub-Clause, any additional cost with regard to HSE as incurred will be the responsibility of the Contractor.

4.9 Quality Management and Compliance Verification Systems

4.9.1 Quality Management System

In the Third Paragraph 2nd line “after every 6 months” is replaced with “after every 3 months”.

4.11 Sufficiency of the Contract Price

The following paragraphs are added at the end of this sub-clause:

The Contractor is deemed to have made his own calculations for the determination of the quantities for the item of work for which lump sum cost is given in the Contract. The information and data provided by the Employer is to assist the bidder and shall in no way be used as a basis for determination of such quantities and/or reason for increase in cost or time for completion of the Works.

The Contractor and his employees shall be responsible for payment of all their income tax, super tax and other taxes on income arising out of the Contract and the rates and prices stated in the Contract shall be deemed to cover all such taxes.

4.12 Unforeseeable Difficulties

The following paragraph is added at the end of this sub-clause:

The Contractor shall also be deemed to have inspected and examined the Site, and its surroundings and information available in connection with the Project and to have satisfied himself, so far as is practicable, before submitting the Bid, as to the form and nature thereof, including the hydrological and climate conditions, the extent and nature of work and materials necessary for the completion of the Works, the means of access to the Site and accommodation he may require.

4.16 Transport of Goods

At the end of sub-paragraph (c) the word “and” is deleted and at the end of sub-paragraph (d) the full stop (.) is replaced with “;”, and the following new sub-paragraphs are added as:

(e) The Contractor shall obtain the Employer's Representative's permission prior to delivering to the Site any item of Goods which is identified in the Employer's Requirements as requiring such permission. The Employer’s Representative shall grant permission within three (3) working days after receipt of the Contractor’s request. No such Goods shall be delivered without this permission, which shall not relieve the Contractor from any duty, obligation or responsibility under or in connection with the Contract. Prior to the delivery of Goods at project site, proper arrangement for the storage shall be made and informed to the Employer’s Representative for his approval before giving permission for delivery of Goods."

4.20 Progress Report

At the start of sub-paragraph (a) add "Executive summary, Contract Startup Activities, salient contractual and project information,"

At the end of sub-paragraph (g) the word "and" is deleted and at the end of sub-paragraph (h) the full stop (.) is replaced with ";", and the following new sub-paragraphs are added as:

(i) planned programme for the execution of the Works for next 56 days to enable the Employer's Representative to determine its programme of inspection and testing;

(j) monthly summery of daily job record indicating weather conditions, deployment of Contractor's Equipment, labour employment, local material procurement and material import, if any;

(k) Risk Management;

(l) Performance Security / Guarantees & Insurances Details;

(m) Change Management;

(n) Financial Management;

(o) Completion of Works and Contract Closure;

(p) Drone Video Progress Documentary; and

(q) Time Lapse & Real Time Web Based Progress Centre.

During the period of the Contract, the Contractor shall keep a daily record of the work progress, which shall be made available to the Employer's Representative as and when requested. The daily record shall include particulars of weather conditions, number of men working, deliveries of materials, quantity, location and assignment of Contractor's equipment.

1. Drone Video Progress Documentary:

   The Contractor shall document the entire project development from various position and capture a complete video documentary on monthly basis with high resolution drone cameras. Properly comprehensive progress video as required by The Employer/ Employer's Representative.

   Drone video Progress Documentary must be submitted on Monthly Basis as per satisfaction of The Employer / Employer's Representative along with Monthly Progress Report on 8th Day of Each Month.

2. Time Lapse & Realtime Web Based Progress Centre

   The Contractor shall document the entire project development and project assets from various static angles by placing several Time Lapse high resolutions cameras and setup an un-interrupted web-based progress centre.

Following sub-clauses 4.24, 4.25, and 4.26 are added:

4.24 Lighting Work at Night

In the event of work being carried out at night, the Contractor shall, at his own cost, provide and maintain such good and sufficient light as will enable the work to proceed satisfactorily and without dangers. The approaches to the Site and Works where the night work is being carried out shall be sufficiently lighted. All arrangements adopted for such lighting shall be to the satisfaction of the Employer's Representative.

4.25 Dangerous Materials

The Contractor and his sub-contractors shall convey, store and make use of the dangerous materials, brought to the Site, in strict accordance with the provision of all laws, orders and regulations that are in force at the Site or may be issued from time to time by the Government.

4.26 Notices to Contractor

The Contractor shall, immediately after receipt of Letter of Acceptance, intimate in writing to the Employer and the Employer's Representative by registered post, the address of his principal place of business or any change in such address during the period of the Contract.

5.2 Contractor's Documents

The following text is added at the end of sub-clause 5.2.1:

The Contractor shall prepare and submit to the Employer / Employer's Representative all Contractor's Documents for review and No-objection, in accordance with the Design Submission Schedule, which shall be within 120 days after the date on which the Contract comes into full force and effect under sub-Clause 1.6 [*Contract Agreement*], and the Employer's Requirements. These documents shall be sufficient to demonstrate the compliance of the design with the Contract and shall include, but not be limited to, the following:

(a) Site Physical and Topographic Survey Drawings

Surveys documenting all existing physical, man-made, and natural features, including elevation, layout, and boundary mapping. Drawings shall be developed at appropriate scales using approved software.

(b) Geo-Technical Investigation Report

Subsoil survey and geotechnical investigation plans shall be submitted in advance for approval. The final report shall include test locations, methodologies, field/lab results, and foundation design recommendations.

(c) Design Criteria Reports and Calculations

Detailed design reports documenting criteria, assumptions, loadings, and calculations for:

- Process and functional design
- Architectural and structural elements
- Electrical systems
- Mechanical systems
- ICT, instrumentation, and automation systems
- Firefighting, HVAC, and public health services

(d) Construction Drawings

Detailed construction-ready drawings incorporating Employer's Representative's comments. These shall include all plans, elevations, sections, and detailing required for execution of each work component. No drawing shall be used for construction until No-objection is issued.

(e) Format and Submission

All drawings shall be prepared using the latest approved version of AutoCAD or BIM software (if needed), in A2 size (where required) or as instructed.

Documents shall be in the language of the Contract (as defined in Sub-Clause 1.4).

- Each submission shall include:
- 02 hard copies
- 01 editable soft copy (DWG, Excel, etc.)
- 01 PDF version
- Summary cover sheet listing all documents in the submission

The following paragraph of sub-clause 5.2.2 is deleted:

"*If the Employer gives no Notice…. a Notice of No-objection)*"

5.3 Contractor's Undertaking

The existing text is substituted with the following:

The Contractor shall and undertakes that the design of the Works, all Contractor's Documents, the execution of the Works, and the completed Works shall:

- comply in all respects with the Laws of the Pakistan, including all rules,

regulations, standards, environmental laws, labor codes, safety regulations, environmental compliance, and requirements of any applicable public or utility authority;

- strictly conform to the Contract, including the Employer's Requirements, Contractor's Proposal, and any modifications or Variations;
- be fit for the purpose for which they are intended, as defined expressly or implied in the Contract; and
- be the sole responsibility of the Contractor, regardless of any review, comment, or No-objection issued by the Employer or Employer's Representative.
- The Contractor shall obtain and comply with all necessary permits, consents, and approvals required under applicable law.

Any failure by the Contractor to meet the obligations in this Clause shall constitute a default under the Contract, and the Employer shall be entitled to all remedies available, including withholding of payments, imposition of penalties, or termination under Clause 15 [Termination by Employer].

6.1 Engagement of Staff and Labour

The paragraph is added at the end of this sub-clause:

The list of key personnel for execution of the Works and their CVs shall be submitted by the Contractor within Fifteen (15) days from the date of signing of the Contract Agreement and shall be approved by the Employer's Representative within 14 days of receipt of CVs from the Contractor. The list of key personnel mentioned in form Schedule - L to Bid is minimum.

6.8 Contractor's superintendence

The following text is added at the end of this Sub-Clause:

"The Contractor's authorized representative and his other engineers working at site shall possess valid registration with the Pakistan Engineering Council.

The Contractor's authorized representative at Site shall be authorized to exercise adequate administrative and financial powers on behalf of the Contractor so as to achieve completion of the Works as per the Contract."

6.12 Key Personnel

The following is inserted at the end of the last paragraph:

The list of key personnel for execution of the Works and their CVs shall be submitted by the Contractor within Fifteen (15) days from the date of signing of the Contract Agreement and shall be approved by the Employer's Representative within 14 days of receipt of CVs from the Contractor. The list of key personnel mentioned in form Schedule - L to Bid is minimum. If any of

the Key Personnel are not fluent in this language, the Contractor shall make competent interpreters available during all working hours in a number deemed sufficient by the Employer/Employer's Representative.

The following Sub-Clauses 6.13 to 6.26 are added at the end of Sub-Clause 6.12:

6.13 Foreign Personnel

The Contractor may bring in to the Country any foreign personnel who are necessary for the execution of the Works to the extent allowed by the applicable Laws. The Contractor shall ensure that these personnel are provided with the required residence visas and work permits. The Employer will, if requested by the Contractor, use all reasonable endeavours in a timely and expeditious manner to assist the Contractor in obtaining any local, state, national, or government permission required for bringing in the Contractor's personnel.

The Contractor shall be responsible for the return of these personnel to the place where they were recruited or to their domicile. In the event of the death in the Country of any of these personnel or members of their families, the Contractor shall similarly be responsible for making the appropriate arrangements for their return or burial. The Contractor shall also be responsible for the safety of these personnel during their stay in the Country. The Employer shall provide security arrangements as per standard operating procedures of the Government of Pakistan.

6.14 Supply of Food stuffs

The Contractor shall arrange for the provision of a sufficient supply of suitable food at reasonable prices for the Contractor's Personnel as well as to the Employer's Personnel, Employer's Representative and his Delegated Persons deployed and posted at Project site for the purposes of or in connection with the Contract

6.15 Supply of Water

The Contractor shall, having regard to local conditions, provide on the Site an adequate supply of drinking and other water for the use of the Contractor's Personnel.

6.16 Measures against Insect and Pest Nuisance

The Contractor shall at all times take the necessary precautions to protect the Contractor's Personnel employed on the Site from insect and pest nuisance, and to reduce the danger to their health. The Contractor shall comply with all the regulations of the local health authorities, including use of appropriate insecticide.

6.17 Alcoholic Liquor or Drugs

The Contractor shall not, otherwise than in accordance with the Laws of the

Country, import, sell, give, barter or otherwise dispose of any alcoholic liquor or drugs, or permit or allowimportation, sale, gift, barter or disposal thereto by Contractor's Personnel.

6.18 Arms and Ammunition

The Contractor shall not give, barter, or otherwise dispose of, to any person, any arms or ammunition of any kind, or allow Contractor's Personnel to do so.

6.19 Festivals and Religious Customs

The Contractor shall respect the Country's recognized festivals, days of rest and religious or other customs.

6.20 Funeral Arrangements

The Contractor shall be responsible, to the extent required by local regulations, for making any funeral arrangements for any of its local employees who may die while engaged upon the Works.

6.21 Forced Labour

The Contractor, including its Subcontractors, shall not employ or engage forced labour which consists of any work or service, not voluntarily performed, that is exacted from an individual under threat of force or penalty, and includes any kind of involuntary or compulsory labour, such as indentured labour, bonded labour or similar labour-contracting arrangements.

6.22 Child Labour

The Contractor, including its Subcontractors, shall not employ or engage child labour in accordance with relevant law(s) in force in Islamic Republic of Pakistan.

6.23 Employment Records of Workers

The Contractor shall keep complete and accurate records of the employment of labour at the Site. The records shall include the names, ages, genders, hours worked and wages paid to all workers. These records shall be summarized on a monthly basis and submitted to the Employer's Representative. These records shall be included in the details to be submitted by the Contractor under Sub-Clause 6.10 (*Contractor's Records*).

6.24 Worker's Organization

The Contractor shall comply with the relevant labour laws of Pakistan.

6.25 Non-Discrimination and Equal Opportunity

The Contractor shall not make decisions relating to the employment or treatment of Contractor's Personnel on the basis of personal characteristics unrelated to inherent job requirements. The Contractor shall base the employment of Contractor's Personnel on the principle of equal opportunity and fair treatment, and shall not discriminate with respect to any aspects of the employment relationship, including recruitment and hiring, compensation (including wages and benefits), working conditions and terms of employment, access to training, job assignment, promotion, termination of employment or retirement, and disciplinary practices.

Special measures of protection or assistance to remedy past discrimination or selection for a particular job based on the inherent requirements of the job shall not be deemed discrimination. The Contractor shall provide protection and assistance as necessary to ensure nondiscrimination and equal opportunity, including for specific groups such as women, persons with disabilities, migrant workers and children (of working age in accordance with Sub-Clause 6.22).

6.26 Epidemics

In the event of any out-break of illness of epidemic nature, the Contractor shall comply with and carry out such regulations, orders and requirements as may be made by the Government or the local medical or sanitary authorities for the purpose of overcoming the same.

7.7 Ownership of Plant and Materials

The following is added before the first paragraph:
"Except as otherwise provided in the Contract,"

The following is added at the end of the Sub-Clause:

"No Plant and/or Materials that is the property of the Employer shall be removed from the Site. In case of procurement of plant/equipment, Contractor shall be responsible for transportation of equipment / plant at site. It will be the responsibility of contractor to ensure the safety of delivered equipment / plant at site. Employer will in no case be held liable for any damage or loss of equipment delivered or erected at site. Moreover, contractor will not be allowed to relocate or install the delivered equipment / plant without the permission of Employer. If it becomes necessary to:

(i) remove any item of such Plant from the Site for the purposes of repair, the Contractor shall give a Notice, with reasons, to the Employer's Representative requesting consent to remove the defective or damaged item off the Site. This Notice shall clearly identify the item of defective or damaged Plant, and shall give details of: the defect or damage to be repaired; the place to which defective or damaged item of Plant is to be taken for repair; the transportation to be used (and insurance cover for such transportation); the

proposed inspections and testing off the Site; and the planned duration required before the repaired item of Plant shall be returned to the Site. The Contractor shall also provide any further details that the Employer may reasonably require; or

(ii) replace any item(s) of such Plant and/or Materials, the Contractor shall give a Notice, with reasons, to the Employer's Representative clearly identifying the item(s) of Plant and/or Materials to be replaced, and giving details of the due date of delivery to the Site of the replacement item(s).

Where any item of Plant and/or Materials has become the property of the Employer under this Sub-Clause before it has been delivered to the Site, the Contractor shall ensure that such an item is not moved except for its delivery to the Site.

The Contractor shall indemnify and hold the Employer harmless against and from the consequences of any defect in title or encumbrance or charge (except any reasonable restriction arising from the intellectual property rights of the manufacturer or producer) on any item of Plant and/or Materials that has become the property of the Employer under this Sub-Clause."

The Contractor shall be allowed to reutilize the existing materials available at site in the name of value engineering, with the prior consent of the Employer / Employer's Representative. The value of such existing materials, to be adjusted in the Contractor's payments, shall be determined by the Employer / Employer's Representative as per Sub-Clause 3.5 [Agreement or Determination].

The following Sub-Clause 7.9 is added after Sub Clause 7.8:

7.9 Use of Pakistani Materials and Services

The Contractor shall, so far as may be consistent with the Contract, make the maximum use of materials, supplies, plant and equipment indigenous to or produced or fabricated in Pakistan and services available in Pakistan provided such materials, supplies, plant, equipment and services shall be of required standard.

8.1 Commencement of Works

In the second paragraph the text "the Commencement Date shall…and effect under Sub-Clause 1.6 [*Contract Agreement*]" is replaced with the following text(s):

…the Commencement Date for Construction of Works shall not be later than 150 days after the date on which the Contract comes into full force and effect under Sub-Clause 1.6 [*Contract Agreement*] or Contractor's receipt of 'No-Objection' from the Employer / Employer's Representative for the construction of such part(s) under Sub-Clause 5.2.3 [*Construction*], whichever is earlier.

The following paragraph is added after the third paragraph.

Provided that the following conditions have been fulfilled:

- The Contract Agreement has been duly signed by both Parties;
- The Contractor has submitted and the Employer has accepted the Performance Security;
- The Employer has granted access to the Site; and
- The Contractor has submitted the Contractor's Documents to the satisfaction of the Employer.

8.3 Programme

The following text is added after the first paragraph:

The initial programme and each revised programme shall be:

1) Developed and presented on Project Management Software Primavera Project Planner P6 or later.
2) Developed on the basis of Work Breakdown Structure provided or approved by the Employer / Employer's Representative.
3) Detailed up to the level required by the Employer / Employer's Representative.
4) Appropriate quantity of direct resources (material, labour, equipment) should be allocated to all activities and showed in submitted construction schedule. Labour resource should be divided according to related trades (e.g. Mason, Operator, helper etc.) Contractor should make sure that no resource is being overallocated.
5) Identifying the critical path activities, showing all works including temporary works, the relation between early and late starting dates for each activity until completion, which will be the same as the specified Project end date.
6) Specifically reflect the division of the Works into four (04) sections, comprising approximately 4 × 10 km (total length about 41 km) from Lake View, Rawalpindi to Murree, and demonstrate that all four sections are to be taken up and executed simultaneously, with corresponding deployment and balancing of machinery, equipment, tools, key personnel and manpower across all sections.

<u>For the procurement of imported items:</u>

1) The Bidder/Contractor shall place all orders for imported items within a period of three (03) months from the date of signing of the Contract Agreement.

2) The Contractor shall prepare and submit a procurement programme, in bar-chart, CPM or PERT form, showing the sequence of all activities related to the imported items. The programme shall clearly indicate all steps from opening of the Letter(s) of Credit up to the delivery of the imported items at Site.

10.1 Taking Over the Works and Sections

In the Last Paragraph 2nd line “28 days,” is replaced with “42 days”.

11.11 Clearance of Site

The following paragraph is added at the end of this sub-clause:

Should any part of the Contractor’s Equipment be required by the Employer, such equipment shall be sold and handed over to the Employer at the cost thereof agreed between the Parties.
Any of the useable/serviceable (except which is not required for re-utilizing) or any of the material released from the Permanent Works, having salvage value, shall be sole property of the Employer and be transported and properly stacked by the Contractor at the nearby station or storage site as directed by the Employer’s Representative

13.7 Adjustments for Changes in Cost

This sub-clause is deleted in its entirety.

14.2 Advance Payment

14.2.1 Advance Payment Guarantee

The following text is added before the first paragraph:

The entity issuing the Advance Payment Guarantee and its form shall be as under:

The Advance Payment Guarantee shall be in the form of Guarantee issued by (a) a Scheduled Bank in Pakistan or (b) a foreign bank duly counter-guaranteed by a Scheduled Bank in Pakistan for the amount of the Total Advance Payment in accordance with Sub-Clause 14.2.

14.2.2 Advance Payment

The text of the first paragraph of the Sub-Clause is deleted and replaced with the following text:

“The Employer shall sanction an interest free Advance Payment equal to ten percent (10%) of the Contract Price stated in the Letter of Acceptance. Initially, the Employer’s Representative shall issue an Advance Payment equal to five percent (05%) for the advance payment within 21 days after:

The text of sub-paragraph (a) is deleted and replaced with the following text:

i. submission of the Performance Security, in the form and issued by an entity in accordance with Sub-Clause 4.2.1 *[Contactor's Obligations]*;
ii. signing of the Contract Agreement between the Parties in accordance with Sub-Clause 1.6 *[Contract Agreement]*;
iii. the Advance Payment Guarantee for the Total Amount of the Advance Payment, in the form and issued by an entity in accordance with Sub-Clause 14.2.1 *[Advance Payment Guarantee]*;
iv. submission of initial programme under Sub-Clause 8.3 *[Programme]*;"

The word "and" at the end of the sub-paragraph (a) is deleted.

The character "." at the end of sub-paragraph (b) is deleted and replaced with the character ";"

Following sub-paragraphs (c) & (d) are added after sub-paragraph (b):

(c) A further sum equal to five percent (5%) of the Contract Price shall be paid to the Contractor upon the certification of the Employer's Representative to the effect that Contractor's mobilization is complete in the following aspects and he is ready to commence the works:

i. Approval of initial programme under Sub-Clause 8.3 *[Programme]*;
ii. Submission of all guarantees and insurances as required by the Contract.
iii. Establishment of Employer's, Employer's Representative and Contractor's site office.
iv. Deployment of Contractor's technical as well as managerial staff as per requirement of site.
v. Proper taking over of the site.
vi. Installation of project boards.
vii. Completion of safety arrangements for the traffic and public in general.
viii. The Advance Payment shall not be subject to retention; and

(d) the Employer's Representative has received a copy of the Contractor's application for the second tranche of advance payment under Sub-Clause 14.2.1 [Advance Payment Guarantee]

14.6 Interim Payments

14.6.1 Notice of Interim Payment

In the first line of the 1st paragraph the words "28 days" are substituted by "21 days"

14.8 Delayed Payment

This sub-clause is deleted in its entirety.

15.2 Termination for Contractor's Default

"15.2.1 Notice"

Following text is added at the end of sub-paragraph (h) of this Sub-Clause:

"For the purposes of this Contract, corrupt and fraudulent practices have been defined in accordance with the Punjab Public Procurement Authority Procurement Regulations – 2014 (amended time to time)."

15.4 Payment after Termination

The following text is added at the end of this Sub-Clause:

"The Employer shall be entitled to sell any of the Contractor's Equipment, Temporary Works and unused materials and apply the proceeds of sale towards payment of any debt due from the Contractor to the Employer under this Clause including any outstanding payments to the Subcontractors.

16.2 Termination by Contractor

16.2.1 Notice

The sub-paragraph (i) is deleted in its entirety.

At the end of sub-paragraph (h) "; or" is replaced with "." and at the end of sub-paragraph (g) ";" is replaced with "; or".

17.1 Responsibility for Care for the Works

After the two instances of "Goods" in the last paragraph, the words "Employer-Supplied Materials and/or Employer's Equipment" are added.

The following Sub-Clause 17.7 is added after Sub-Clause 17.6:

17.7 Use of Employer's Accommodation / Facilities

The Contractor shall take full responsibility for the care of the items of the Employer's facilities and/or accommodation, if any, as detailed in the Specification, from the date of use and/or occupation by the Contractor until the date on which such use and/or occupation is re-vested in the Employer.

If any loss or damage happens to any of the above items during a time while the Contractor is responsible for its care, arising from any cause other than a cause for which the Employer is responsible or liable, the Contractor shall promptly rectify the loss or damage at the Contractor's risk and cost.

18.1 Exceptional Events

The words "or disorder" are replaced with "disorder or sabotage" in sub-paragraph (c) of the Clause.

The following is added after sub-paragraph (f):

(g) Hyperinflation.

18.4 Consequence of an Exceptional Event

The following is added at the end of sub-paragraph (b) after deleting the ".":

", including the costs of rectifying or replacing the Works and/or Goods damaged or destroyed by Exceptional Events, to the extent they are not indemnified through the insurance policy referred to in Sub-Clause 19.2 [*Insurance to be provided by the Contractor*]."

18.5 Optional Termination

In sub-paragraph (c), the words "and necessarily" are added after the words "was reasonably".

19.1 General Requirements

Following text is added at the end of first paragraph:

"The Contractor shall immediately after the date of the Letter of Acceptance submit the draft of insurance policies for the Employer's consent."

Following text is added at the end of third paragraph:

"The Contractor shall, within the respective periods stated in the Contract Data submit to the Employer and the Employer's Representative a) evidence that the insurances described in this Clause have been effected, and b) copies of policies of the insurances described in Sub-Clauses 19.2.1, 19.2.2, 19.2.3, 19.2.4 and 19.2.5."

19.2 Insurance to be Provided by the Contractor

The following Sub-Clause is added after Sub-Clause 19.2.6:

19.2.7 Insurance Company

"The Contractor shall be obliged to place all insurances described in this Clause with insurers rated by PACRA/VIS of AA(+) rating.

21.6 Arbitration

The word "international" is deleted in the sixth line of first paragraph. The text of sub-paragraph (a) is substituted with the following:

"the Dispute shall be finally settled under the Rules of Arbitration, specified in the

Contract Data;"

The following Clause is added after Clause 21.

22 Integrity Pact

If it is found and established at any stage that the Contractor or any of his agents or servants have violated or involved in violation of the Integrity Pact signed by the Contractor then the Employer shall be entitled to:

(a) recover from the Contractor an amount equivalent to ten times the sum of any commission, bribe, finder's fee or kickback given by the Contractor or any of his Subcontractors, agent or servants;

(b) terminate the Contract; and

(c) recover from the Contractor any loss or damage to the Employer as a result of such termination or of any other corrupt business practices of the Contractor or any of his Subcontractors, agent or servants.

The termination under sub-paragraph (b) of this Sub-Clause shall proceed in the manner prescribed under Sub-Clause 15.1 to 15.4 and the payment under Sub-Clause 15.4 shall be made after having deducted the amounts due to the Employer under sub- paragraph (a) and (c) of this Sub-Clause.

PUNJAB MASSTRANSIT AUTHORITY

Punjab MASSTRANSIT AUTHORITY (PMA)



TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

December - 2025

BIDDING DOCUMENTS – VOLUME II

- Preamble to BOQ
- Milestone Payments
-Referenced Bill of Quantities (Ref. BOQ)

National Engineering Services Pakistan (Pvt.) Limited
Construction Manamgement Division, NESPAK House,
1-C, Block N, Model Town Extension, Lahore

Clearance Code	4768/13/BD/1225	Doc. No.	4768 – 02	Rev No.	00

SCHEDULE OF PRICES

PREAMBLE

1. The Schedule of Prices shall be read in conjunction with the Conditions of Contract together with the Specifications and Bid Drawings
2. The Bidder shall quote for all items of the Works executed on EPC basis and the prices shall be quoted for the complete scope of Work as described or implied from these Bidding Documents.
3. The Schedule of Prices only identifies major components of the structure and it does not restrict the responsibility of the Contractor to furnish all equipments, materials and services as deemed necessary by the Employer/Employer's Representative for making the structure operationally complete and satisfactory as specified and/or implied in the Bidding Documents and subsequent revisions thereto.
4. The quantities as shown in the Schedule of Prices are estimated quantities and provisional only being given as an indication of the Scope of Work to enable the Bidder to bid for different items of the Works in accordance with his estimate of costs. The estimated quantities shall be used for comparing the Bids. It is, however, be noted that the basis of payment will be the actual quantities of work executed and measured by the Contractor and verified by the Employer's Representative.
5. The sizes & dimensions mentioned and/or specified in the various technical descriptions and specifications including Referenced Bid Drawings are tentative and not final as the responsibility for detailed design rests with the Contractor under the Contract. If, in the opinion of the Employer / Employer's Representative, at the time of review of Contractor's detailed drawings/designs for approval, certain sizes & dimensions of some items have to be increased for proper completion and/or operation of the Works, then revised sizes & dimensions shall be supplied by the Contractor at no extra cost to the Employer.
6. Except as otherwise expressly provided under the Conditions of Contract, the unit rates and lump sum amounts entered in the Schedule of Prices will be the rates at which the Contractor will be paid, and shall be deemed to include for the full scope and all costs incurred by the Contractor in the performance of the Works, the provision of services including his overheads, income tax, super tax, other indirect costs, customs & other duties, profits and costs of accepting the general risks, liabilities and obligations set forth or implied in the Contract, except for such costs which are specified as reimbursable under the Contract.

7. The unit rates shall be extended to show the total amount for each item. The total of the Schedule of Prices is the Total Bid Price and shall be entered in the specified document provided in the bidding document. Where a discrepancy exists between the unit rate and the extended total amount, the unit rate shall be taken as correct and the total amount adjusted accordingly.
8. Unless otherwise stipulated in the Conditions of Contract, the rates and prices entered by the Bidder shall be fixed and firm and shall not be subject to adjustment during the performance of the Contract.
9. The whole cost of complying with the provisions of the Contract shall be included in the items provided in the priced Schedule of Prices, and where no items are provided in the Schedule of Prices for any work required to be executed by the Contractor on EPC basis under single responsibility for the completion of the Works and to make the structure operationally complete, the cost of such item(s) shall be deemed to be distributed among the rates and prices entered for the related items of the Works and no separate payment will be made by the Employer for those items executed by the Contractor.
10. The rates, prices and amounts shall be entered against each item in the Schedule of Prices. Where a Bidder fails to quote a price of any item of the Schedule of Prices, the Employer will consider that the price of that item is included among other items and the Contractor will be obligated to furnish that item at no extra cost to the Employer, if awarded the Contract.
11. The Bidder shall be deemed to have obtained all information as to port clearance facilities and charges, loading and unloading facilities and charges, storage facilities and charges, transportation facilities and charges, congestion and/or other conditions to be expected at Karachi Port and or any other seaport of Pakistan and all requirements related thereto. The Contractor shall be responsible to make complete arrangements for the transportation of the Plant to the Site. The Bidder shall be deemed to have included all clearing, forwarding and other incidental costs in this regard in his Bid. The Contractor will have the option to use either Karachi Port or any other seaport of Pakistan.

12. The Contractor shall provide all parts of the Works to be completed in every respect for commercial operation. Notwithstanding that any details, accessories, etc. required for the complete installation and satisfactory operation of the Plant, are not specifically mentioned in the Schedule of Prices, Specifications including Bid Drawings, such details shall be considered as included in the Contract Price. All charges for the supply of

goods, materials, accessories or work not specifically mentioned herein but necessary for the completion and operation of the Works shall be deemed to have been included in the quoted prices.

13. All costs in connection with inspection and witnessing of Factory Acceptance Tests within and out side Pakistan as per provisions of Sub-Clause 9 of Particular Conditions of Contract shall be borne by the Contractor and shall be deemed to have been included in the quoted prices. All costs in connection with the holding of meetings shall be borne by the Contractor.

Payment Milestone Summary – Murree Glass Train

Milestone No.	Milestone Title	% Allocation
M1	Detailed Design, IFC Drawings, & Mobilization Plan Approved	3.00%
M2	Earthwork and Compaction	0.50%
M3	Elevated Guideway - Sub-structure Pile Works	20.00%
M4	Elevated Guideway - Sub-structure Pile Caps Works	5.00%
M5	Elevated Guideway - Super Structure Piers Works	10.00%
M6	Elevated Guideway - Super Structure Transoms Works (Casting and Placing)	5.00%
M7	Elevated Guideway - Super Structure Guide Beams Works (Casting and Placing)	13.50%
M8	DC Traction & Third Rail Systems	2.50%
M9	Station No 01	1.00%
M10	Station No 02	1.00%
M11	Station No 03	1.00%
M12	Station No 04	1.00%
M13	Depot 01 No.	4.50%
M14	Electrical Power Works	7.00%
M15	Signalling & Telecommunication Systems Installed	5.00%
M16	Rolling Stock	20.00%
	Total	100.00%

Payment Milestone Summary – Murree Glass Train

Milestone No.	Milestone Title	% Allocation
M1	**Detailed Design, IFC Drawings, & Mobilization Plan Approved**	**3.00%**
M1.1	IFC Drawings Approved	2.50%
M1.2	Mobilization Plan Accepted	0.50%
M2	**Earthwork and Compaction**	**0.50%**
M2.1	Grading & Compaction for Stations and Depot	0.25%
M2.2	Grading & Compaction for Elevated Bridge Structure & Road Work	0.25%
M3	**Elevated Guideway - Sub-structure Pile Works**	**20.00%**
M3.1	Sub-structure (Piles Works) - 10 % Completed	2.00%
M3.2	Sub-structure (Piles Works) - 20 % Completed	2.00%
M3.3	Sub-structure (Piles Works) - 30 % Completed	2.00%
M3.4	Sub-structure (Piles Works) - 40 % Completed	2.00%
M3.5	Sub-structure (Piles Works) - 50 % Completed	2.00%
M3.6	Sub-structure (Piles Works) - 60 % Completed	2.00%
M3.7	Sub-structure (Piles Works) - 70 % Completed	2.00%
M3.8	Sub-structure (Piles Works) - 80 % Completed	2.00%
M3.9	Sub-structure (Piles Works) - 90 % Completed	2.00%
M3.10	Sub-structure (Piles Works) - 100 % Completed	2.00%
M4	**Elevated Guideway - Sub-structure Pile Caps Works**	**5.00%**
M4.1	Sub-structure (Pile Caps) - 20 % Completed	1.00%
M4.2	Sub-structure (Pile Caps) - 40 % Completed	1.00%
M4.3	Sub-structure (Pile Caps) - 60 % Completed	1.00%
M4.4	Sub-structure (Pile Caps) - 80 % Completed	1.00%
M4.5	Sub-structure (Pile Caps) - 100 % Completed	1.00%
M5	**Elevated Guideway - Super Structure Piers Works**	**10.00%**
M5.1	Super Structure (Piers) - 10 % Completed	1.00%
M5.2	Super Structure (Piers) - 20 % Completed	1.00%
M5.3	Super Structure (Piers) - 30 % Completed	1.00%
M5.4	Super Structure (Piers) - 40 % Completed	1.00%
M5.5	Super Structure (Piers) - 50 % Completed	1.00%
M5.6	Super Structure (Piers) - 60 % Completed	1.00%
M5.7	Super Structure (Piers) - 70 % Completed	1.00%
M5.8	Super Structure (Piers) - 80 % Completed	1.00%
M5.9	Super Structure (Piers) - 90 % Completed	1.00%
M5.10	Super Structure (Piers) - 100 % Completed	1.00%
M6	**Elevated Guideway - Super Structure Transoms Works (Casting and Placing)**	**5.00%**
M6.1	Super Structure (Transoms) - 20 % Completed	1.00%

Payment Milestone Summary – Murree Glass Train

Milestone No.	Milestone Title	% Allocation
M6.2	Super Structure (Transoms) - 40 % Completed	1.00%
M6.3	Super Structure (Transoms) - 60 % Completed	1.00%
M6.4	Super Structure (Transoms) - 80 % Completed	1.00%
M6.5	Super Structure (Transoms) - 100 % Completed	1.00%
M7	**Elevated Guideway - Super Structure Guide Beams Works (Casting and Placing)**	**13.50%**
M7.1	Super Structure (Guide Beams) - 15 % Completed	2.00%
M7.2	Super Structure (Guide Beams) - 30 % Completed	2.00%
M7.3	Super Structure (Guide Beams) - 45 % Completed	2.00%
M7.4	Super Structure (Guide Beams) - 60 % Completed	2.00%
M7.5	Super Structure (Guide Beams) - 75 % Completed	2.00%
M7.6	Super Structure (Guide Beams) - 90 % Completed	2.00%
M7.7	Super Structure (Guide Beams) - 100 % Completed	1.50%
M8	**DC Traction & Third Rail Systems**	**2.50%**
M8.1	DC Traction & Third Rail Systems - 20 % Completed	0.50%
M8.2	DC Traction & Third Rail Systems - 40 % Completed	0.50%
M8.3	DC Traction & Third Rail Systems - 60 % Completed	0.50%
M8.4	DC Traction & Third Rail Systems - 80 % Completed	0.50%
M8.5	DC Traction & Third Rail Systems - 100 % Completed	0.50%
M9	**Station No 01**	**1.00%**
M9.1	Structure, Civil Works and Road Structure Complete in all respect	0.75%
M9.2	Finishes, Fire Fighting, PSDs, Ticket Counters, Escalators, Elevators & HVAC Completed	0.25%

Payment Milestone Summary – Murree Glass Train

Milestone No.	Milestone Title	% Allocation
M10	**Station No 02**	**1.00%**
M10.1	Structure, Civil Works and Road Structure Complete in all respect	0.75%
M10.2	Finishes, Fire Fighting, PSDs, Ticket Counters, Escalators, Elevators & HVAC Completed	0.25%
M11	**Station No 03**	**1.00%**
M11.1	Structure, Civil Works and Road Structure Complete in all respect	0.75%
M11.2	Finishes, Fire Fighting, PSDs, Ticket Counters, Escalators, Elevators & HVAC Completed	0.25%
M12	**Station No 04**	**1.00%**
M12.1	Structure, Civil Works and Road Structure Complete in all respect	0.75%
M12.2	Finishes, Fire Fighting, PSDs, Ticket Counters, Escalators, Elevators & HVAC Completed	0.25%
M13	**Depot 01 No.**	**4.50%**
M13.1	Structure and Civil Works Completed	2.00%
M13.2	Stabling Yard Completed	1.00%
M13.3	Public Health, Electrical, Finishes, Fire Fighting & HVAC	1.50%
M14	**Electrical Power Works**	**7.00%**
M14.1	Grid Station (132 / 33 kV) Completed	3.00%
M14.2	Sub-station (33 / 1.5kV) Completed along with Feeder Cable	2.00%
M14.3	SCADA, Automation, Remote Comms,fiber optic cabling, trenching, foundations,Earthing , Lightning Protection, UPS System, DG Sets, Transformers & Ring Main Units ,Section Boxes	1.50%
M14.4	Allied Works Completed	1.00%
M15	**Signalling & Telecommunication Systems Installed**	**5.00%**
M15.1	CBTC Signalling System (Moving Block – 40 km, dual line)	2.00%
M15.2	Train-Borne & Way-Side Communication Equipment	0.50%
M15.3	OCC & Centralized Supervisory System (Command and Control Center)	0.50%
M15.4	Depot Signalling Integration (Interlocking + SCADA)	0.50%
M15.5	Automatic Fare Collection System and its integration with SCADA	0.50%
M15.6	Platform Communication Systems (PA, PIS, CCTV, etc.)	0.50%
M15.7	Testing, Commissioning & Safety Certification	0.50%

Payment Milestone Summary – Murree Glass Train

Milestone No.	Milestone Title	% Allocation
M16	**Rolling Stock**	**20.00%**
M16.1	Pre-shipment Inspection and Purchase Order	5.00%
M16.2	Delivery of Set of four vehicles each consisting of two motorized and two trailors	5.00%
M16.3	Machinery and equipment required for cleaning/Washing and maintenance of Rolling Stock in the Depot	1.00%
M16.4	Testing and Commissioning	4.00%
M16.5	Final Acceptance Certificate (DNP Closure) Issued	5.00%
	Total	**100.00%**

PUNJAB MASSTRANSIT AUTHORITY

PUNJAB MASSTRANSIT AUTHORITY (PMA)

TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

MAIN SUMMARY (BOQ)

Sr. No	Description
A	**Civil Works**
1	Construction of Elevated Structure
2	Construction of Stations (04)
3	Fire Fighting Works for Stations
4	Construction of Depot (01)
5	Platform Screen Door (PSD) for Stations
6	Ticket Counters for Stations
7	Escalator for Stations (08)
8	Elevators for Stations (08).
9	HVAC for Stations
B	**Electric Power Works**
C	**Signalling & Telecommunication**
D	**HSE**
E	**Procurement Works (ROLLING STOCK)**
	TOTAL CONSTRUCTION & PROCUREMENT COST (Inclusive of All Applicable Govt Taxes)

Reference Only
PUNJAB MASSTRANSIT AUTHORITY

PUNJAB MASSTRANSIT AUTHORITY (PMA)

TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

BILL OF QUANTITIES (CIVIL WORKS)

Sr. No.	Item Description	Unit	Quantity
1	Excavation in foundation of building, bridges and other structures, including dagbelling, dressing in layers around structure with excavated earth, watering and ramming lead upto one chain (30 m) depth upto 5 ft (1.5m). 2) a) By Excavator ii) Ordinary soil	CM	249,800.00
2	Providing and laying good quality / local sand cushion from approved source (compacted in layers not exceeding 6" thickness) by mechanized means including the cost of front end loader, viberatory roller and all lead and lifts, dressing, watering complete in all respect as approved and directed by the Engineer Incharge	CM	24,980.00
3	Cement concrete plain including placing, compacting, finishing and curing complete (including screening and washing of stone aggregate): **(i) Ratio 1: 4: 8**	CM	10,050.00
4	Placing, compacting, finishing and curing of concrete using Ordinary Portland Cement / Sulphate resisting cement / Slag cement as may be required; including screening, washing of aggregates and mixing of constituents using batching plant, Transportation by transit mixer, pouring with pump in the required proportions to achieve a nominal cylindrical strength in the field as per ACI214, with the specified consistency. i/c the cost of shuttering, compaction with Viberator, excluding the cost of Admixture, as approved and directed by the Engineer Incharge.		
	(a) Superstructure (Slabs, Beams, Columns and others requiring formwork) **(iv) 4000 Psi**	CM	72,076.00
	(c) Substructure (**Foundations, Raft,** Strip and Footing Beams) **(iv) 4000 Psi**	CM	117,699.00
5	Placing, compacting, finishing and curing of concrete using Ordinary Portland Cement / Sulphate resisting cement / Slag cement as may be required; including screening, washing of aggregates and mixing of constituents using batching plant, Transportation by transit mixer, pouring with pump in the required proportions to achieve a nominal cylindrical strength in the field as per ACI214, with the specified consistency. i/c the cost of shuttering, compaction with Viberator, excluding the cost of Admixture, as approved and directed by the Engineer Incharge.		
	5000 Psi (Girder)	CM	103,275.00
6	Fabrication of mild steel reinforcement for cement concrete including cutting, bending, laying in position, making joints and fastenings including cost of binding wire and labour charges for binding of steel reinforcement (also includes removal of rust from bars):-		
	Deformed bars (Grade-60)	Tons	56,064.32
7	Providing and casting in situ bored premixed reinforced concrete piles with specified type of premixed concrete using course sand, including all labour and materials, boring, rig machine, crane, excavator, welding plant, batching plant, transit mixer, I-Land etc (except the cost of steel reinforcement, its labor for bending and laying in position and boat plateform etc) which will be paid separately, including, screening & washing of shingle and curing as approved by Engineer Incharge:- In Ordinary Soil. **(b) (4000 Psi Cylindrical Strength)**		
	(vi) 1.22 m / 48 inch	M	324,240.00
8	Fabrication of mild steel reinforcement deformed bar cage of specified yield strength for R.C.C bored piles including cutting bending, lowering of cage with crane in position, welding and fastening, including the cost of binding wire, Crane machine (also includes removal of rust from the bars) as approved and directed by the Engineer Incharge ii) Deformed Bars Grade-60	Tons	64,402.81

PUNJAB MASSTRANSIT AUTHORITY (PMA)

TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

BILL OF QUANTITIES (CIVIL WORKS)

Sr. No.	Item Description	Unit	Quantity
9	Lifting, transporting and placing precast prestressed concrete Beam, Girder and other members (excluding battens) etc., in position on the bridge to correct alignment and level, etc., complete in all respect as directed by the Engineer Incharge.	Per Ton	258,187.50
10	Fabrication of high tensile steel prestressing cables for prestressed (post tensioned) concrete, including assembling by drawing the H.T. wire through metal spacer plate, inserting in helix core and taping or tying, sheathing in longitudinally welded metal corrugated sheath, positioning , anchorage with male and female set of anchorage cone, forming ducts for transverse cable, stressing cables with jack at both ends as per stressing schedule, maintaining stressing record and supply the same in the approved proforma to the Engineer-in-charge, making loop at blind end, including all materials required for it, grouting the cable ducts with cement, cutting projected ends and making good recesses, etc., complete in all respects.	Per Ton	7,229.25
11	Providing and laying Elastomeric Neoprene Bearing Pads of specified grade, Specific gravity, hardness, elongation, min tensile strength of 2250 psi, and compressive strength of 2000 psi conforming to ASTMD 2240 standard test method for rubber as approved and directed by the Engineer Incharge II- Grade 60 (b) Laminated (i) Without Anchrage	Cu.cm	93,960,000.00
12	Bitumen coating to plastered or cement concrete surface:- i) 20 lbs. per 100 Sft. (9.07 Kg per Sq.m)	SM	294,248.00
13	Extra for Kentledge and loading arrangments for test pile to ensure structural and GeoTechnical soundness of pile upto a maximum test load applying in stages i/c the hiring of machinary required for complete job and furnishing a report in this regard by a qualified / authorized GeoTechnical Engineering by studying the data of at least seven days as approved and directed by the Engineer Incharge. **Pile Load Test (upto 2.5 Times the design load)**	Per M. Ton	2,400.00
14	Small iron work, such as gusset plates, knees, bends stirrups, straps, rings, etc. including cutting, drilling, riveting, handling, assembling and fixing including erection in position.	Kg.s	3,240,000.00
	Road Works	Job	
Total Cost			

Reference Only
PUNJAB MASSTRANSIT AUTHORITY

PUNJAB MASSTRANSIT AUTHORITY (PMA)

TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

SUB SUMMARY (ROAD)

Sr. No.	Item Description
1	Earthwork and Allied Activities
2	Sub-base & Base Course
3	Surface Courses & Pavement
4	Ancillary Works
5	Internal Drainage Work
6	Electrical Works
	TOTAL CONSTRUCTION COST

Reference Only
PUNJAB MASSTRANSIT AUTHORITY

PUNJAB MASSTRANSIT AUTHORITY (PMA)

TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

BILL OF QUANTITIES

Sr. No.	Item Description	Unit	Quantity
Bill No. 1	**Earthwork and Allied Activities**		
1	Jungle clearance and removing within 100 ft. (30 m).		
	a) Ordinary	SM	16,001.30
	b) Heavy	SM	6,857.70
2	Compaction of earthwork with power road roller, including ploughing, mixing, moistening earth to optimum moisture content in layers, etc. complete:		
	i) 95% to 100% maximum modified AASHTO dry density.	CM	2,873.00
	ii) 90% maximum modified AASHTO dry density.	CM	1,231.00
3	Earthwork excavation undressed lead upto a single throw of Kassi, phaorah or shovel:-		
	b) In ordinary soil.	CM	4,180.00
4	Earthowrk in ordinary soil for embankments, including ploughing, mixing and compaction by mechanical means at optimum moisture content and dressing to designed section including all lead and lift, complete in all respects:-		
	i) 95% to 100% maximum modified AASHTO dry density	CM	3,676.00
6	Providing and laying good quality / local sand cushion from approved source (compacted in layers not exceeding 6" thickness) by mechanized means including the cost of front end loader, viberatory roller and all lead and lifts, dressing, watering complete in all respect as approved and directed by the Engineer Incharge	CM	836.00
7	Turfing slopes of banks or lawns with grass sods including ploughing, laying, setting and watering (Turf got from within a distance of 5 miles (8 Km.) and maintenance for 15 days).	CM	1,500.00
	TOTAL BILL No. 1		

Reference Only
PUNJAB MASSTRANSIT AUTHORITY

PUNJAB MASSTRANSIT AUTHORITY (PMA)

TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

BILL OF QUANTITIES

Sr. No.	Item Description	Unit	Quantity
Bill No. 2	**Sub-base & Base Course**		
1	Providing and laying **sub-base** course of stone product of approved quality and grade, including placing, mixing, spreading and compaction of sub-base material to required depth, camber, grade to achieve 100% maximum modified AASHO dry density, including carriage of all material to site of work except gravel and aggregate.		
	ii) Crushed stone aggregate.	CM	4,877.00
2	Providing and laying **(WBM)** base course of crushed stone aggregate of approved quality and grade, and supply and spreading of stone screening, including placing, mixing, spreading and compaction of base course material to required depth, camber and grade to achieve 100% maximum modified AASHO dry density, including carriage of all materials to site of work except gravel and aggregate.	CM	7,315.35
TOTAL BILL No. 2			

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TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

BILL OF QUANTITIES

Sr. No.	Item Description	Unit	Quantity
Bill No.3	**Surface Courses & Pavement**		
1	Providing and laying bituminous priming coat, using 10 lbs. kerosene oil and 10 lbs. binder per 100 Sft. or 0.5 Kg kerosene and 0.5 Kg binder per square metre.	SM	24,001.95
2	(Asphaltic Base Course) Providing and laying plant premixed bituminous carpet, including compaction and finishing to required camber, grade and density. iii) 4% Bitumen	CM	1,829.10
3	Providing and laying bituminous tack coat, using 10 lbs. of bitumen per 100 Sft (0.49 Kg of bitumen per sq.m.)	SM	2,400.30
4	(Asphaltic Wearing Course) Providing and laying plant premixed bituminous carpet, including compaction and finishing to required camber, grade and density. iv) 4.5% Bitumen	CM	1,219.05
TOTAL BILL No. 3			

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PUNJAB MASSTRANSIT AUTHORITY (PMA)

TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

BILL OF QUANTITIES

Sr. No.	Item Description	Unit	Quantity
Bill No. 4	**Ancillary Works**		
1	Providing and laying Tuff Pavers, having 7000 PSI, crushing strength of approved manufacturer, over 2" to 3" sand cushion i/c grouting with sand in joints i/c finishing to require slope . complete in all respect. (50% Grey / 50% Coloured) b) 60-mm thick	SM	1,829.00
2	Painting Traffic Lane Marking of specified width (1.5mm thick), with Thermoplastic (TP) Paint including Glass Beads, complete in all respect, as approved and directed by Engineer incharge. Ii) (6" wide)	RM	1,575.00
3	Providing and laying road edging of 3" (75 mm) wide and 9" (225 mm) deep brick on end, complete in all respects	P.M	3,150.00
4	Providing & fixing precast Edge Kerb Stone (4" to 6" thick) and 14" high of Compressive Strength of 3500 PSI laid in cement sand mortar (1:3) over pre-laid brick masonary for drain cum footpath etc complete in all respect. **(i) With Painting**	RM	1,575.00
TOTAL BILL No. 4			

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PUNJAB MASSTRANSIT AUTHORITY

PUNJAB MASSTRANSIT AUTHORITY (PMA)

TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

BILL OF QUANTITIES

Sr. No.	Item Description	Unit	Quantity
Bill No. 5	**Internal Drainage Work**		
1	Earthwork excavation in open cutting for storm water channels, drains,sullage drains in open areas, roads, streets, lanes, including under pinning of walls and shoring to protect existing works, shuttering and timbering the trenches, dressed to designed level and dimensions, trimming, removal of surface water from trenches, back filling and surplus excavated material disposed of and dressed within 50 ft. (15 m) lead:-		
	1) Upto 5' (1.5 meter) depth B) By Mechanical means i) Ordinary	CM	593.00
	1) From 5.01 ft. (1.5 m) to 10.0 ft. (3.0 m) depth D) By Mechanical means i) Ordinary	CM	479.00
2	Rehandling of earthwork: b) Upto a lead of 50 ft. (15 m).	CM	518.00
3	Compaction of earthwork (soft, ordinary or hard soil) :-		
	a) Mixing, moistening earth to optimum moisture content in layers for compaction, etc. complete.	CM	518.00
	c) Ramming earthwork (all types of soil).		518.00
4	Supplying and filling sand under floor; or plugging in wells.	CM	111.00
5	Transportation of earth all types when the total distance including the lead covered in the item of work	CM	447.00
6	Cement concrete plain including placing compacting, finishing and curing complete (including screening and washing of stone aggregate): (i) Ratio 1: 4: 8	CM	8.00
7	Placing, compacting, finishing and curing of concrete using Ordinary Portland Cement/ Sulphate resisting cement/ Slag cement as maybe required; including screening, washing of aggregates and mixing of constituents using batching plant, Transportation by transitmixer, pouring with pump in the required proportions to achieve a nominal cylindrical strength in the field as per ACI214, with the specified consistency. i/c the cost of shuttering, compaction with Viberator, excluding the cost of Admixture, as approved and directed by the Engineer Incharge		
	(a) Reinforced cement concrete in **roof slab**, beams, columns lintels, girders and other structural members laid in situ or precast laid in position, or prestressed members cast in situ, complete in all respects:- **(iv) 4000 PSI**	CM	21.00
	(b) Retaining/ Shear walls laid in situ or precast laid in position, or prestressed members cast (Formwork on both sides) **4000 PSI**		
	(i) Upto 9" thick	CM	51.00
	(c) Substructure (Foundations, Raft, Strip and Footing Beams) **(iv) 4000 PSI**	CM	21.00
8	Fabrication of mild steel reinforcement for cement concrete including cutting, bending, laying in position, making joints and fastenings including cost of binding wire and labour charges for binding of steel reinforcement (also includes removal of rust from bars):-		
	Deformed bars (Grade-60)	Ton	11.00
9	Providing and embedding 10" (250mm) wide PVC water stopper in expansion joints of RCC structures (Retaining walls, water tanks, Slabs) complete in all respect. ii) 10" wide 10 mm thick	M	215.00
10	Bitumen coating to plastered or cement concrete surface: i) 20 lbs. per 100 Sft. (9.07 Kg per Sq.m)	SM	519.00
11	Other civil & architectural works	P.S	1.00
	TOTAL COST		

Reference Only

PUNJAB MASSTRANSIT AUTHORITY (PMA)

TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

BILL OF QUANTITIES FOR STATIONS WORKS

ITEM NO.	DESCRIPTION	UNIT	Nos	QUANTITY
(a)	(b)	(c)	(d)	(e)
1	04 No Stations	Nos.	4	1050
	TOTAL (PKR)			

Reference Only
PUNJAB MASSTRANSIT AUTHORITY

PUNJAB MASSTRANSIT AUTHORITY (PMA)

TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

BILL OF QUANTITIES FOR FIRE FIGHTING WORKS

Sr. No.	DESCRIPTION OF ITEM	QUANTITY
1	Fire Fighting	1
	TOTAL	

Reference Only
PUNJAB MASSTRANSIT AUTHORITY

PUNJAB MASSTRANSIT AUTHORITY (PMA)

TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

BILL OF QUANTITIES FOR DEPOT

Sr. No.	DESCRIPTION OF ITEM	QUANTITY
1	Construction of Depot	1
	TOTAL	

Reference Only
PUNJAB MASSTRANSIT AUTHORITY

PUNJAB MASSTRANSIT AUTHORITY (PMA)

TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

BILL OF QUANTITIES FOR PLATFORM SCREEN DOOR (PSD) WORKS

Sr. No.	DESCRIPTION OF ITEM	QUANTITY
	Supply, installation, testing, commissioning and operation & maintenance of including taxes and duties:	
1	PSD (size 1.4x2 m), IP-55 with glass 12mm tempered	12
2	Kit positioning, communication, indicators and all accessories	4
3	SCADA for PSD system	1
4	Operation and Maintenance during 1-year DLP	12
	TOTAL	

Reference Only
PUNJAB MASSTRANSIT AUTHORITY

PUNJAB MASSTRANSIT AUTHORITY (PMA)

TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

BILL OF QUANTITIES FOR TICKET WORKS

ITEM NO.	DESCRIPTION	UNIT	QUANTITY
(a)	(b)	(c)	(d)
1	08 No Stations	Nos.	8
	TOTAL (PKR)		

Reference Only
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PUNJAB MASSTRANSIT AUTHORITY (PMA)

TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

BILL OF QUANTITIES FOR ESCALATOR WORKS

ITEM NO.	DESCRIPTION	UNIT	QUANTITY
(a)	(b)	(c)	(d)
1	**ESCALATORS**		
	FROM ROAD LEVEL TO PLATFORM BASE		
a)	Supply, Installation, Testing & Commissioning of **Indoor Escalators** able to move **6000 persons/hr** complying all EN-115 standards minimum but not limited to VVVF controller, tempered glass ballustrade, handrail, floor cover switch, float switch, antistatic brushes, handrail entrance protection, step anti upthurst protection, communicaton/interface card to integrate with BMS including relevant electrical works, two (02) year manufacturer warranty, One (01) years of defect liability period, safety and security & storage before and during installation including all taxes & duties. (complete in all respect)		
	ES-1= 11 Meter Approx.	NO	8
2	Pre shipment Inspection as specified in bidding documents	LOT	1
3	Third party validation for Testing & commissioning of escalator in Pakistan	NO	8
4	Regular daily operation (18 hours/day, 7 days/week) during One (01) year of Defects Liability Period Forty Eight (48) Operator for each shift)	Month	12
	TOTAL (PKR)		

Reference Only
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PUNJAB MASSTRANSIT AUTHORITY (PMA)

TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

BILL OF QUANTITIES FOR ELEVATOR WORKS

Item No.	Description	Unit	Quantity
1	**Elevators**		
	FROM ROAD LEVEL TO PLATFORM BASE		
a)	Supply, installation, testing & commissioning of imported brand new **Simplex Control System Passenger Elevator**, **Machine Room Less** (MRL) type, heavy duty fully complied and certified by **EN 81-20, EN 81-50 and EN 81-70** standards with minimum features including but not limited to VVVF high efficiency motor, complete inside stainless steel hairline finish or as approved by the Engineer, indoor type for ambient condition of **0~40 °C**, capacity of **1000 kg**, Cabin Size **W 1600 mm × D 1400 mm × H 2,300 mm,** speed **1.00 m/s**, **02 stops/02 openings**, approximate total travel height **11 m**, entrance **W 1000 mm × H 2,100 mm**. Lift shall minimum include car, hoisting machinery, counter weights, supports, brackets, TFT/LED displays in Call Operating Panel and Landing Indicators, automatic controls, embedded parts, access ladder, separator screen & trap door, electric overload, shaft lightening, intercom system, gong, emergency operation for cabin/door, emergency rescue device (ups/battery), RFID Interface provision, Access Control system (Biometric/Bar Code), Communication module/Controller based on BACNet over IP for integration with IBMS, safety devices & manual emergency operation lever as well as all the essential spare parts as per Appendix-III Essential and Recommended Spare Parts for **One (01) years during defects liability period** complete in all respect as per specification, drawings and according to EN 81 standard compliance. All taxes, levies & duties shall be included.	Each	8
2	**Supply, installation, testing & commissioning of propeller type exhaust fans (Minimum Capacity = 1000 CFM)**	Each	8
3	**Pre-shipment Inspection of elevators equipment at manufacturers permises/Factory.**	Lot	1
4	**Third party validation for testing & commissioning of elevators in Pakistan. (One Visit/Year)**	Each	8
5	**Regular daily operation (18 hours/day, 7 days/week) during One (01) year of Defects Liability Period Forty (48) Operator for each shift)**	Months	12
	Total Amount (PKR)		

Reference

PUNJAB MASSTRANSIT AUTHORITY (PMA)

TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

BILL OF QUANTITIES FOR ELECTRICAL POWER WORKS

Sr. No	Description	Unit	Nos	Quantity
1	GSS 132/33kV, TPSS (33/1.5kV DC)	Job	1	6
2	33kV XLPE Underground Cable (Ring Loop),DC Feeder Cable (1500V)	Km	1	130
3	Third Rail Equipment (insulators, brackets)	Km	1	80
4	Ring Main Units ,Section Boxes	Set	1	20
5	UPS Systems (200 kVA), DG Sets (500 kVA with auto switchgear)	Job	1	8
6	Substation SCADA, Automation, Remote Comms ,fiber optic cabling, trenching, foundations ,Earthing , Lightning Protection	Job	1	1
7	Station Auxiliary Power RMU ,Panels, Station Cabling , Lighting	Job	1	6
8	Depot Electrical , Rolling Stock ,Command & Control Power System (HVAC, servers)	Job	1	1
	TOTAL COST			

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PUNJAB MASSTRANSIT AUTHORITY (PMA)

TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

Bill of Quantities of Signalling & Telecommunication System

Sr. No	Description	Unit	Nos	Quantity
1	CBTC Signalling System (Moving Block – 40 km, dual line)	Job	1	1
2	Train-Borne & Way-Side Communication Equipment	Job	1	1
3	OCC & Centralized Supervisory System	Job	1	1
4	Depot Signalling Integration (Interlocking + SCADA)	Job	1	1
5	Providing Lying ,Fixing, testing and Complete in all Respect integraded with other equipment optical fiber cabling 24-core armored single-mode fiber.	Km	50	1
6	Platform Communication Systems (PA, PIS, CCTV, etc.)	Job	1	1
7	Testing, Commissioning & Safety Certification	Job	1	1
	TOTAL COST			

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TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

BILL OF QUANTITIES FOR HVAC

Sr. No.	DESCRIPTION OF ITEM	QUANTITY
1	Construction of Depot	1
	TOTAL	

Reference Only
PUNJAB MASSTRANSIT AUTHORITY

PUNJAB MASSTRANSIT AUTHORITY (PMA)

TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

BILL OF QUANTITIES FOR ROLLING STOCK

Sr. No	Description	Unit	Nos	Quantity
A	**Rolling Stock**			
1	Set of four vehicles each consisting of two motorized and two trailors	Job	1	8.00
2	Mechanical Works	Job	1	1.00
3	Machinery and equipment required for cleaning/Washing and maintenance of Rolling Stock in the Depot	Job	1	1.00
	Total Cost			

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PUNJAB MASSTRANSIT AUTHORITY (PMA)

TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

Break up of Machinery, Equipment and Mechanical Works

Sr. Nos	Description of Equipment	Unit	QTY
1	Automated Tire Truing & Balancing Line (Rubber Monorail Tires)	Each	1
2	Bogie Drop Table	Each	1
3	Heavy-Duty Train Lifting Jacks (2 set of 4×50T)	set	2
4	Automatic Car Washing Plant	Each	1
5	Pit Jib Cranes (5T)	Each	2
6	Mobile Access Platforms	Each	4
7	Tire Press / Mounting Machine	Each	1
8	Hydraulic Test Bench (Brakes)	Each	1
9	HVAC Service Station	Each	1
10	Cleaning & Vacuum Systems	Each	2
11	Power Electronics Test Bench (IGBT/Inverter)	Each	1
12	Structure Health Monitoring Tools (laser scanners, crack detectors) one each	Nos	2
13	Signal & Communication Diagnostic Tools	Each	1
14	Traction Motor Test Stand (PMSM)	Each	1
15	Battery Test & Charging Bench	Each	1
16	Door Mechanism Test Rig	Each	1
17	Third Rail Shoe Test Stand	Each	1
18	Hand Tools, Hydraulic Jacks, Torque Tools	L.S	1
19	Portable Diagnostic Laptops with OEM Software	Each	4
20	Depot Management System (CMMS)	Each	1
21	Set of four vehicles each consisting of two motorized and two trailors	Job	8
	Grand Total		
	Say		

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TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

optical fiber cabling
24-core armored single-mode fiber.

#	Description	Specification	Qty (Approx.)
1	Optical Fiber Cable	24-core, Armored, Single-Mode, ITU-T G.652D, steel wire armoring, PE sheath	50 km
2	HDPE Duct (110 mm)	ISI/IEC certified, double wall corrugated	50 km
3	Cable Pulling Accessories	Pulling socks, swivels, lubricants	Lump sum
4	Joint Enclosures / Splice Closures	IP68, armored cable compatible	60 sets
5	Fiber Patch Panels (ODF)	24-core capacity, rack mount	20 sets
6	Fiber Patch Cords (LC/SC)	SM duplex	100 pcs
7	Cable Warning Tape	Printed “Optical Fiber Below”	50 km
8	Marker Posts	RCC/Plastic	200
9	Excavation of Trench (1 m depth)		50 km
10	Laying of HDPE Duct & Fiber Cable		50 km
11	Backfilling & Compaction		50 km
12	Installation of Joint Enclosures & ODF		Lump sum
13	Integration with Telecom/Signalling Racks		Lump sum
14	OTDR Testing (Bi-directional)		50 km
15	Power Meter Testing		Lump sum
16	Documentation & As-Built Drawings		Lump sum

Total Cost

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TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

(7) Testing, Commissioning & Safety Certification – Material & Activity-Wise Utilization

Sr. No.	Item / Activity	Description
1	System Integration Testing (SIT)	Complete pre-commissioning testing of CBTC, signaling, onboard & wayside equipment
2	Factory Acceptance Testing (FAT)	FAT for CBTC components, OCC hardware/software, interlocking and SCADA equipment at manufacturer sites
3	Site Acceptance Testing (SAT)	Field tests of installed CBTC, PIS, CCTV, interlocking, depot & OCC connectivity
4	Dynamic Testing with Racks	Real-time testing using rolling stock for movement simulation, speed profiles, fail-safe operations
5	CBTC Communication Link Verification	End-to-end latency, jitter, failover, handover and loss simulation testing for CBTC wireless system
6	Point Machine & Crossover Functional Testing	Testing point machines, motors, switches at terminal station and depot crossovers
7	Onboard Equipment Calibration (6 Trains)	Calibration of train-borne CBTC controllers, speed sensors, antennas, brake interface
8	Depot Interlocking & SCADA Testing	Integration tests for depot control logic, point actuation, SCADA feedback
9	System Performance & Reliability Testing (Soak)	72–168 hours of continuous run to verify uptime, real-world passenger simulation
10	Independent Safety Assessment (ISA)	3rd party safety audit for CBTC system compliance (e.g., EN 50126/50128/50129 standards)
11	RAMS (Reliability, Availability, Maintainability, Safety) Certification	RAMS modeling, simulations, and compliance checks
12	Operational Safety Drills & Trials	Mock operations with OCC/station staff, emergency procedures, and response time evaluations
13	Documentation & Test Reports Compilation	Final test sheets, certifications, user manuals, software validation documentation
14	Training for Operations & Maintenance Staff	Hands-on and classroom training on CBTC software, diagnostics, OCC, and depot signaling
		Total Cost

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TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

(3) OCC & Centralized Supervisory System – Itemized Material & Cost Breakdown

Sr.No	Item	Description
1	OCC Control Consoles & Operator Terminals	Ergonomic operator consoles, monitors, HMI terminals for train, station, and alarm supervision
2	CBTC Central Servers	Redundant central processing units (main + backup), time sync servers (NTP), CBTC master servers
3	ATS (Automatic Train Supervision)	Real-time train tracking, dispatch scheduling, routing, timetable enforcement, delay analysis
4	SCADA Servers & RTU Interfaces	Supervisory control for power, environment (HVAC), depot, stations, fire, tunnel systems
5	Video Wall System & Controller	High-definition LED/LCD multi-screen for situational awareness, integrated with SCADA & CCTV
6	Interlocking & Diagnostic Server Gateway	Integration with depot and wayside interlocking systems
7	Redundant Core Network Switches	Layer-3 backbone switches (core ring), routers, gateway firewalls for secure OCC networking
8	Voice Communication Systems (VoIP)	OCC-to-driver, OCC-to-station VoIP intercom systems, dispatcher panels
9	UPS & Power Backup (OCC Building)	Online UPS systems, battery banks (min 2 hours backup), automatic switchover
10	Building Management System Integration	Interface to manage lighting, access control, HVAC, etc.
11	Data Storage & Redundancy Infrastructure	SAN/NAS units, RAID arrays, cloud/hybrid backup for logs & video
12	Fire Alarm & Suppression System (Server Room)	VESDA, fire panels, FM200 gas suppression
13	Software Licensing & System Integration	ATS/SCADA/CBTC software, configuration, security hardening, testing
14	Installation, Testing & Commissioning	Equipment mounting, wiring, integration testing, FAT, SAT, and OCC validation
		Total Cost

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TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

(4) Depot Signalling Integration – Itemized Material & Cost Breakdown

Sr. No.	Component	Description
1	Electronic Interlocking System (EIS)	SIL-4 certified interlocking logic for depot turnouts, signal route locking, depot access safety control
2	Depot Local Control Panels (LCPs)	Workstations/panels at the depot for manual operation in degraded mode or local shunting
3	Depot Turnout Motors (Point Machines)	Motorized point machines for 12 depot tracks (6 train racks), with heating for cold weather
4	SCADA RTU Panels (Depot Area)	Remote Terminal Units for controlling power, lighting, HVAC, fans, UPS, depot fire systems
5	Wayside Signal Units for Depot	Shunt signals, entry/exit signals for depot tracks, route indicators
6	Depot Signal Cabling & Wiring	Signal/power cables, cable ducts, termination kits, route tagging, loops
7	Fiber Connectivity to OCC/Backup	Fiber links for depot interlocking to main OCC and backup control center
8	Data Acquisition & Fault Monitoring	Systems for monitoring turnout failure, track occupancy, and diagnostics
9	Depot SCADA Interface Workstation	Operator HMI workstation for depot energy management, train allocation
10	CCTV Integration for Depot Movement Supervision	Surveillance cameras integrated with SCADA & interlocking for visual checks
11	Fire Detection & Alarm Panels	Addressable fire alarms for relay rooms, signaling rooms, track area monitoring
12	Depot Power Supply System (UPS + Redundancy)	Dedicated UPS, battery packs for 4 hours operation, auto cutover switches
13	Testing, Commissioning & Safety Validation	Factory Acceptance Test (FAT), Site Acceptance Test (SAT), integration and fail-safe validation
		Total Cost

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TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

(2) Train-Borne & Way-Side Communication Equipment – Itemized Breakdown

Sr.No	Item	Description
1	Train-to-Wayside Communication (TWC) Units	Onboard radios and antennas (802.11p or LTE-based) for continuous data exchange with wayside units
2	Onboard Ethernet Switches & Network Devices	Redundant managed switches, firewalls, routers for internal train network
3	Wi-Fi Access Points (APs) & Base Stations	Wayside APs at intervals (~500m), dual redundant for uninterrupted comms
4	Wireless Communication Backbone Equipment	Sector antennas, transceivers, signal boosters, repeaters
5	Router/Switches (Trackside and Station)	Layer-3 industrial grade switches for control center and field networking
6	Radio Network Controller (RNC)	Central controller to manage all train–track communication links
7	Onboard HMI & Control Panels	Touchscreen panels inside train cabins for control/supervision
8	Data Loggers and Diagnostic Units	Real-time fault monitoring, event recording, black box interface
9	Antennas (Roof-Mounted Onboard)	GPS + comms + fallback modules for train localization
10	Installation & Integration Services	Mounting, cabling, EMI/EMC tests, configuration, validation
		Total Cost

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TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

(6) Platform Communication Systems – Detailed Material Utilization

S. No.	Component	Description
1	Public Address (PA) System	High-power amplifiers, platform speakers (weatherproof), microphone panels, voice priority matrix
2	Passenger Information System (PIS)	LED/LCD train arrival boards, station clocks, multilingual scrolling displays, audio announcements
3	CCTV Surveillance System	Fixed & PTZ IP cameras, network video recorders (NVR), video analytics (facial detection, line crossing)
4	Emergency Intercom Panels (ECP)	Emergency help points with vandal-resistant audio/mic, integration to OCC, all platforms
5	Platform Networking and Switches	Ethernet switches, PoE devices for camera power, patch panels, structured cabling
6	Central PIS/PA Control Software	Central server-based control software for audio/video PIS/PA system, automated announcements
7	UPS & Backup Power Units	UPS for all communication equipment (minimum 4-hour backup)
8	Platform Display & Speaker Mounting	Mounting poles, brackets, waterproof enclosures, vandal-resistant housings
9	CCTV Storage and Server Rack (Station-wise)	30 days storage capacity for 5 stations, central storage NVRs, structured server racks
10	Control Room Consoles for Monitoring	Station-specific PA/PIS/CCTV monitoring consoles, emergency override buttons
11	LAN/Fiber Backbone for Platforms	Redundant fiber cables between PIS/PA/CCTV systems to station server room
12	Testing, Configuration & Integration	Full-system integration, factory & site acceptance tests, field alignment
13	Commissioning & Training	Operator training, troubleshooting manuals, system handover
		Total Cost

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TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

(1) CBTC Signalling System – Material & Equipment Breakdown

Sr.No	Component	Description / Role
1	Onboard CBTC Equipment (6 Train Racks)	ATP/ATO modules, Vehicle Control Units (VCU), Vital Communication Links, Speed Sensors, HMI
2	Wayside Zone Controllers	Trackside computers that communicate with onboard units; handles train localization
3	Interlocking Controllers	Digital Interlocking for depot, station turnouts, and crossovers
4	Wayside Beacons & Balises	Passive transponders for position referencing along guideway
5	Axle Counters (Redundant Use)	Used for fallback train detection and track occupancy
6	Fiber Optic Network Backbone	24-core armored cable + patch panels, trays, FDH, ODF, terminations
7	OCC System (Workstations + Servers + SCADA)	Operator terminals, Automatic Train Supervision (ATS), SCADA dashboards, redundancy servers
8	Communication Network (Fiber + Wireless)	Radio base stations, Train-to-Wayside Communication (TWC), routers, switches, Wi-Fi Access Points
9	Depot Signaling System	Turnouts, switch machines, depot interlocking, axle counters, SCADA interface
10	Platform Systems (PA, PIS, CCTV)	Emergency Intercoms, Passenger Info Displays, Public Announcement systems
11	Testing, Commissioning & Safety Certification	Functional safety audit (SIL-4), system integration, field testing
12	CBTC Software Licensing & SLA	Vendor licensing for software platform, updates, support contract (5–10 years)
13	Installation & Integration Services	Cable laying, hardware installation, configuration, field testing
14	Preventive Maintenance Equipment & Tools	Condition Monitoring tools, diagnostic software, spare circuit boards, maintenance kits
15	Spare Parts (Initial Stock)	10% redundancy: onboard modules, power supplies, relays, field units
16	Staff Training & Documentation	OEM training, O&M manuals, diagnostic tool training
		Total Cost

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TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

Maintenance Tools & Plants – Electrical Workshop / Substation

Sr	Equipment / Tool	Units	Qty
1	Insulation Resistance Tester (Megger)	Job	2
2	Earth Resistance Tester		2
3	Transformer Oil Testing Kit		1
4	Thermal Imager (Infrared Camera)		1
5	Multimeter & Clamp Meter	Sets	4
6	33kV Cable Crimping & Termination Kit		2
7	Cable Fault Locator (TDR / Thumper)		1
8	Portable Load Analyzer		1
9	Cable Drum Rollers & Jacks	Sets	4
10	Panel Testing Kits (LV/MV)		2
11	PPE Kits (Electrical Rated)	Sets	10
12	Portable Earthing Device		2
13	Ladder, Trolley, and Material Handling Carts	Lump	1
14	Hydraulic Crimping Tool (up to 33kV)		1
15	Work Benches, Vices, Tools Racks	Lump	1
16	Fire Extinguishers (Class ABC/CO_2)	Sets	10
17	First Aid Kit & Emergency Response Gear	sets	5
18	Lighting & Extension Boards	lump	1
	Total Cost		

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TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

Depot Electrical , Rolling Stock ,Command & Control Power System (HVAC, servers)

#	Equipment	Unit	Quantity
1	Depot Main Power Distribution Panels		5
2	Rolling Stock Charging Stations		20
3	Depot Lighting System	Lump sum	1
4	Power Cables & Wiring	Lump sum	1
5	Auxiliary Transformers		3
6	Protection Devices & Relays	Lump sum	1
7	Installation, Testing & Commissioning	Lump sum	1
8	Uninterruptible Power Supply (UPS)		2
9	HVAC Power Panels & Controls		1
10	Backup Generator (DG Set)		1
11	Power Distribution Units (PDU)		4
12	Power Cables & Wiring	Lump sum	1
13	Power Monitoring & Control Systems		1
14	Installation & Commissioning	Lump sum	1
	TOTAL		

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TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

Tools & Equipment for Signalling Maintenance

#	Item Description	Qty
1	Point Machine Alignment Kit	2 sets
2	Cable Fault Locator (TDR)	1
3	Signal Aspect Tester	2
4	Track Circuit Analyzer	1
5	Digital Multimeter (CAT III/IV)	5
6	Relay Testing Kit	1
7	Manual Point Operating Lever	2
8	Mechanical Tools Set (Sockets, Wrenches, Spanners, etc.)	3 sets
9	Portable Drilling/Cutting Machines	2 sets
10	Portable Earth Resistance Tester	1
11	Battery-operated Crimping Tool (for signaling cables)	2

Total Cost

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TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

Tools & Equipment for Telecommunication Maintenance

#	Item Description	Qty
1	OTDR (Optical Time Domain Reflectometer)	1
2	Optical Power Meter + Light Source	1 set
3	Fusion Splicer	1
4	Optical Fiber Cleaver	1
5	Network Cable Tester (CAT6, RJ45)	2
6	Walkie Talkie Sets (Licensed)	10
7	IP CCTV Testing Device (HD Input)	1
8	Wi-Fi Analyzer (Field Tester Tablet)	1
9	UPS & Battery Tester	1
10	Cable Splicing & Termination Kit	2 sets
11	Mechanical Tool Set (cutters, strippers, crimps)	2 sets

Total Cost

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TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

Workshop Tools (Common for S&T)

#	Item Description	Qty
1	Portable Generator (3–5 kVA)	1
2	Electrical Workbench (with DC/AC supply)	1
3	Rack Mounting Hardware Kit	Lump sum
4	Fire Extinguishers & Safety Gear	Lump sum
5	Work Benches with Vices & Cabinets	2 sets
	Total cost	

Transport & Lifting Tools

#	Item Description	Qty
1	Maintenance Van (equipped)	1
2	Portable Ladder & Lifting Hoist	2
3	Portable Trolley (for fiber reels/cables)	2
	Total cost	

SUMMARY OF COST

#	Section
1	Signalling Tools
2	Telecom Tools
3	Workshop Equipment
4	Transport & Lifting
	Total Cost

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TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

Station Auxiliary Power RMU ,Panels, Station Cabling , Lighting

#	Equipment	Unit	Quantity
1	Ring Main Unit (RMU)	each	6
2	Auxiliary Power Control Panels	each	4
3	Protection Relays	lump sum	1
4	Metering Equipment	lump sum	1
5	Cables and Wiring	lump sum	1
6	Auxiliary Transformers	lump sum	1
7	Installation & Commissioning	lump sum	1
8	Power Cables (MV & LV)	lump sum	1
9	Control & Communication Cables	lump sum	1
10	Lighting Fixtures	lump sum	1
11	Lighting Poles and Mountings	lump sum	1
12	Cable Trays & Conduits	lump sum	1
13	Switches, Sockets & Panels	lump sum	1
14	Installation & Commissioning	lump sum	1

Total Cost

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TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

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UPS Systems (200 kVA), DG Sets (500 kVA with auto switchgear)

#	Equipment Description	Unit	Qty
1	200 kVA Online UPS, Double Conversion (Modular, N+1)		3
2	Battery Bank (VRLA, 30 mins full-load backup)	sets	3
3	Battery Racks + DC Cables + Connectors	sets	3
4	UPS Bypass Panels (Manual + Static)		3
5	Input/Output Breakers + Panel Integration	Lump	1
6	Monitoring System + SNMP / BMS Interface		3
7	Installation, Testing & Commissioning	Lump	1
8	500 kVA Diesel Generator Set (Prime-rated)		3
9	Auto Mains Failure (AMF) Panel + Sync Panel		3
10	500 kVA Silent Acoustic Enclosure (Canopy)		3
11	Diesel Day Tank (1000L) + Level Monitoring		3
12	Battery Start System + Battery Charger		3
13	Exhaust System + Silencer + Flue Pipe		3
14	Foundations + Anti-Vibration Mounts	lump	1
15	Installation, Cabling, Earthing & Commissioning	Lump	1

Total Cost

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TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

Substation SCADA, Automation, Remote Comms ,fiber optic cabling, trenching, foundations ,Earthing , Lightning Protection

#	Equipment / System Description	Qty
1	SCADA Master Station (at OCC, Islamabad)	1
2	RTUs for TPSS & GSS (Remote Terminal Units)	6
3	PLC-based Automation Panels	6
4	MIMIC Display Panels (Depot, OCC)	2
5	Human-Machine Interface (HMI) Stations	4
6	Network Switches (Layer 2 & Layer 3)	10
7	Fiber Optic Backbone + Splicing (33 kV ring loop)	Lump sum
8	Modems, Protocol Converters (IEC 61850/101/104)	Lump sum
9	Time Synchronization (GPS Clock, NTP)	2
10	Cybersecurity + Firewalls (OT/IT Separation)	Lump sum
11	Redundant SCADA Servers + Backup Systems	2
12	Installation, Testing & Commissioning	Lump sum
13	Excavation Machinery	—
14	Cable Trenching Work	Lump sum
15	Cable Ducts & Conduits	Lump sum
16	Backfilling & Compaction	Lump sum
17	Concrete Foundations	Lump sum
18	Rebar & Steel Fabrication	Lump sum
19	Formwork & Shuttering	Lump sum
20	Waterproofing & Drainage	Lump sum
21	Labor & Supervision	Lump sum
22	Earthing Rods & Electrodes	Lump sum
23	Earthing Conductors & Connectors	Lump sum
24	Earthing Enhancement Materials	Lump sum
25	Lightning Rods & Air Terminals	Lump sum

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TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

Substation SCADA, Automation, Remote Comms ,fiber optic cabling, trenching, foundations ,Earthing , Lightning Protection

#	Equipment / System Description	Qty
26	Down Conductors	Lump sum
27	Surge Protection Devices (SPDs)	Lump sum
28	Bonding & Equipotential Connections	Lump sum
29	Installation & Testing	Lump sum
		Total Cost

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TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

Ring Main Units ,Section Boxes

#	Equipment Description	Unit	Qty
1	33kV Ring Main Unit (RMU), 3-way, extensible, SF6 insulated	each	20
2	33kV Cable End Terminations (Indoor + Outdoor kits)	sets	40
3	DC Section Boxes (1500V), Stainless Steel IP65, lockable, insulated terminals		20
4	DC Isolators / Disconnect Switches (1500V DC, 1250A)		20
5	DC Fuses / Circuit Breakers with Arc Chutes (1500V, fast blow)		20
6	Protective Relays & Sensors (OVP, Earth Fault, Temp sensors)	Lump	1
7	Installation, Cabling & Trenching for RMUs/Boxes	Lump	1
8	SCADA RTUs for RMU Monitoring (optional)		10

TOTAL

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TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

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Third Rail Equipment (insulators, brackets)

#	Equipment Description	Unit	Qty / Rate
1	Third Rail Aluminum/Stainless Steel Conductor Rail (1500V DC rated)	Km	80
2	Third Rail Insulators (Polymer, Post Type)	PCS	2,000
3	Steel/Aluminum Support Brackets & Fasteners	sets	2,000
4	Third Rail Coverboards (FRP/HDPE for Personnel Safety)	km	80
5	Thermal Expansion Joints (TEJs)	joints (2/Km)	160
6	Section Insulators (Electrical Segmentation)	sections	200
7	Trackside Earth Bonding Equipment	Lump sum	1
8	Installation Labor, Welding & Alignment Works	Lump sum	1
9	Inspection, Testing & Commissioning	Lump sum	1

Total Cost

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TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

Brief Estimate of GSS 132/33kV, TPSS (33/1.5kV DC)Wise Breakdown for 1 TPSS (33kV / 1500V DC)

#	Equipment / Item	Unit	Qty
1	Power Transformer 132/33kV, 50 MVA	Each	4
2	132kV Incoming SF6 Circuit Breaker	Each	2
3	132kV CT/PT Sets + Isolators	sets	2
4	132kV Lightning Arresters (Gapless)	Each	6
5	33kV Outgoing Vacuum CBs	Each	6
6	33kV Busbar + Isolators, CT/PTs	sets	2
7	33kV Ring Main Units (RMUs)	Each	6
8	Control & Relay Panels (SCADA)	sets	1
9	Station Aux Transformer (33/0.4kV)	Each	2
10	Battery Bank + 110V DC UPS	sets	1
11	Earthing & Grounding Grid	lump sum	1
12	Fire Detection & Suppression	sets	1
13	Power Cable (HT/LT/control)	lump sum	1
14	Civil Works (transformer base, building, fencing)	lump sum	1
15	Testing & Commissioning (GSS)	lump sum	1
16	33/1.5kV Traction Transformers	Each	2
17	12-Pulse Rectifier / Inverter	Each	2
18	1500V DC Switchgear	Feeders	4
19	33kV Incoming VCB (HT Panel)	Each	1
20	DC Feeder Cables (EPR/XLPE)	Km	5
21	DC Busbar / 3rd Rail Assembly	sets	1
22	SCADA / RTU Control Panel	Each	1
23	Battery Bank + UPS	sets	1
24	Aux Transformer (200 kVA)	Each	1
25	Earthing System (DC Grid)	lump sum	1
26	Fire Extinguishing (FM200/CO2)	sets	1
27	Cabling & Termination (Power + Control)	lump sum	1
28	Civil + RCC Trench Foundations	lump sum	1
29	Final Testing & Commissioning	lump sum	1

Total Cost

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TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

Detail of 33kV XLPE Underground Cable (Ring Loop),DC Feeder Cable (1500V)

#	Item Description	Unit	Quantity / Length
1	33kV XLPE Cable (3C x 185 mm²)	Km	50
2	Cable Joint Kits (Heat Shrink)	Joints	60
3	Termination Kits (Indoor + Outdoor)	sets	24
4	HDPE Ducts (110 mm OD) – optional	meter	80000
5	Cable Warning Tape + Marker Poles	meter	50000
6	RCC Trenches / Cable Tray / Pull Boxes	Lumpsum	1
7	Laying, Pulling, Termination Works	Lumpsum	1
8	Earthing, Bonding & Shielding Kits	sets	50
9	Testing & Commissioning (IR, VLF)	Lumpsum	1
10	1500V DC Feeder Cable (1C x 240 mm² XLPE)	Km	80
11	DC Return Feeder Cable (1C x 185 mm² XLPE)	Km	80
12	DC Joint Kits (Heat Shrink Rated)	Joints	100
13	DC Termination Kits (Indoor + Outdoor)	sets	50
14	DC Cable Laying + Pulling	Lumpsum	1
15	Urban Raceways (Protective Tray/Conduit)	meter	40000
16	DC Earthing & Bonding Kits	sets	40
17	Testing & Commissioning (HVDC, IR)	Lumpsum	1

Total Cost

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TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

December - 2025

BIDDING DOCUMENTS – VOLUME III

– Employer's Requirement

National Engineering Services Pakistan (Pvt.) Limited
Construction Manamgement Division, NESPAK House,
1-C, Block N, Model Town Extension, Lahore

Clearance Code	4768/13/BD/1225	Doc. No.	4768 – 03	Rev No.	00

TOURIST GLASS TRAIN

FROM ISLAMABAD TO MURREE



STRADDLE MONORAIL

MANUAL OF SPECIFICATIONS & STANDARDS

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ABBREVIATIONS

The following abbreviations are used in this Manual of Specifications and Standards:

Abbreviation	Full Name
AAR	Association of American Railroads
AASHTO	American Association of State Highway and Transportation Officials
AC	Alternating Current
AFC	Automatic Fare Collection
AIS	Association for Information Systems
ANSI	American National Standards Institute
AREMA	American Railway Engineering and Maintenance-of-way Association
ARS	Automatic Route Setting
ASP	Audio and Selection Panel
ASS	Auxiliary Sub-Station
ASTM	American Society for Testing and Materials
ATC	Automatic Train Control
ATO	Automatic Train Operation
ATP	Automatic Train Protection
ATR	Automatic Train Regulation
ATS	Automatic Train Supervision
BS	British Standards
CEB/FIP	Comité Euro-International du Béton (CEB) – Euro-International du Béton Committee) – and Federation International de la Pre-constraint (International Federation of Pre-stressed Concrete)
CBI	Computer Based Interlocking
CC	Central Computer
CCH	Central Clearing House
CCTV	Closed Circuit Television
CEB/FIB	Model Code for Concrete structures. "CEB Bulletin".
CENELEC	European Committee for Electro technical Standardization
CER	Communications Equipment Room

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CIBSE	Chartered Institution of Building Services Engineers
CIE	International Commission on Illumination
CPU	Central Processing Unit
CSC	Contactless Smart Card
CVMS	Central Voice Mail System
CVRS	Central Voice Recording System
DC	Direct Current
DCC	Depot Control Center
DG	Diesel Generator
DLT	Direct Line Telephone
DOD	Direct Outward Dialing
DPR	Detailed Project Report
DSO	Depot Security Office
DTS	Data Transmission System
DVAS	Digital Voice Announcement System
DVR	Digital Video Recorder
E & M	Electrical and Mechanical
EC	Engineering Controller
ECMS	Equipment Control and Monitoring System
EMC	Electro-magnetic Compatibility
EMI	Electro-magnetic Interference
EN	Euro Norm (European) Standard
EP	Electro-Pneumatic
ETP	Effluent Treatment Plant
FAT	Factory Acceptance Tests
FFT	Fast Fourier Transform (method)
FIDS	A Flat-Panel Interactive Display System
FRLS	Flame Retardance Low Smoke Emission
FRLSOH	Fire Retardant Low Smoke Zero Halogen
GPS	Global Positioning System
GUI	Graphical User Interface

HDPE	High Density Poly Ethylene
IABSE	International Association for Bridge and Structural Engineering
TE	The Engineer
IEC	International Electro technical Commission
IEEE	Institution of Electrical and Electronic Engineers
IES	Illumination Engineering Society
IGBT	Insulated Gate Bipolar Transistor
ISA	Independent Safety Assessor
ISO	International Standards Organization
IT	Information Technology
ITU-T	International Telecommunications Union-Telecommunication Standardization Sector
JIS	Japanese Industrial Standards
Kmph	Kilometers per hour
LAN	Local Area Network
LCD	Liquid Crystal Display
LCP	Local Control Panel
LCX	Leaky Coaxial
LED	Light Emitting Diode
LOMA	Limit Of Movement Authority
LV	Low Voltage
LWR	Long Welded Rail
MCB	Miniature Circuit Breaker
MCBF	Mean Cycle Between Failures
MCC	Mains Circuit Control
MDB	Main Distribution Board
MIS	Management Information System
MMI	Man-Machine Interface
MMIS	Maintenance Management Information System
MMS	Maintenance Management System
MSS	Maximum Safe Speed
MTBF	Mean Time Between Failures

MTTR	Mean Time to Restore
BCP	Building Code of Pakistan
NEPRA	National Electric Power Regulatory Authority
PSQCA	Pakistan Standards and Quality Control Authority
NMS	Network Management System
O & M	Operation and Maintenance
OA	Officer Accommodation
OCC	Operations Control Center
OOG	Out of Gauge
PABX	Private Automatic Branch Exchange
PAS	Public Address System
PC	Personal Computer
PCM	Pulse Code Modulation
PIC	Passenger Inter Communication
PIDS	Passenger Information Display System
PIS	Passenger Information System
PSB	Platform Supervisor Booth
PSTN	Public Switched Telephone Network
PTCL	Pakistan Telecommunication Company Limited
PTFE	Poly Tetra Fluoro Ethylene
PTZ	Pan/Tilt/Zoom
RAM	Reliability, Availability and Maintainability
RASTI	Rapid Speech Transmission Index
RCC	Reinforced Cement Concrete
RCP	Radio Control Panel
RDW	Radio Dispatch Workstation
RF	Radio Frequency
RI	Ride Index
RJT	Return Journey Ticket
RMDT	Reliability, Maintainability Demonstration Testing
ROW	Right of Way

RSS	Rectifier Sub Station
RTU	Remote Terminal Unit
S & T	Signalling and Telecommunications
SAT	Site Acceptance Tests
SC	Station Controller
SCADA	Supervisory Control and Data Acquisition
SCIL	Safety Critical Items List
SCR	Station Control Room
SDH	Synchronous Digital Hierarchy
SEJ	Switch Expansion Joint
SER	Signalling Equipment Room
SIL	Safety Integrity Level
SINAD	Signal plus Noise plus Distortion (ratio)
SJT	Single Journey Ticket
SMS	Station Management System
SOD	Schedule of Dimensions
SPL	Sound Pressure Level
SS	Sub Station
STM	Standard Telecom Mode
SV	Stored Value
TC	Traffic Controller
TCCP	Train Cab Communication Panel
TDR	Train Data Recorder
TEP	Track Earthing Panels
TER	Telecommunications Equipment Room
TETRA	Terrestrial Trunk Radio
TNS	Three phase and Neutral system
TO	Train Operator
TOM	Ticket Office Machine
TPS	Traction Power Substation
TSR	Train Service Regulator

TSS	Traction Sub-station
TVM	Ticket Vending Machine
UD	Usage Data
UIC	Union Internationale des Chemins de Fer (International Union of Railways)
UPS	Uninterrupted Power Supply
VAC	Ventilation and Air Conditioning
VCC	Vehicle Communication Controller
VDU	Visual Display Unit
VVVF	Variable Voltage Variable Frequency
WAN	Wide Area Network
XLPE	Cross Linked Poly Ethylene

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CHAPTER – 1
GENERAL TECHNICAL REQUIREMENTS

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CHAPTER – 1

GENERAL TECHNICAL REQUIREMENTS

1.1 Introduction

1.1.1 The Scope of Work shall be as defined in the bidding document. The Monorail System shall be designed, constructed, tested & commissioned, complete in all respect as explained in bidding documents as per the Specifications and Standards set forth herein.

1.1.2 The Monorail System shall conform to the design requirements set out in this Manual which are the minimum prescribed.

1.1.3 The Contractor shall be solely responsible for undertaking all the surveys, investigations and detailed designs in accordance with Good Industry Practice and shall have no claim against the Employer for any loss, damage, risks, costs, liabilities or obligations arising out of or in relation to such surveys, investigations and designs.

1.2 Codes and Standards

1.2.1 General Standards Associations are detailed below. Specific Codes and Standards are also identified in the respective Chapters of this Manual.

1.2.2 The latest version of the aforesaid codes, standards and specifications, which have been published at least 60 (sixty) days before the last date of bid submission shall be considered applicable.

1.2.3 In case of any conflict or inconsistency with the provisions of the applicable codes listed in above and the provisions contained in this Manual, the provisions contained in this Manual shall apply.

1.3 Monorail System

1.3.1 The codes, standards and specifications applicable for design of the components of the Monorail System and for its operation and maintenance

are:

(i) NFPA-130 - 'Standard for Fixed Guideway - Transit and Passenger Rail System'; European Norm (EN);

(ii) International Electro Technical Commission Standards (IEC);

(iii) International Standards Organization (ISO);

(iv) Japanese Industrial Standards (JIS);

(v) United States of America, AIS, AAR;

(vi) British Standards (BS);

(vii) German Standards (DIN); and

(viii) Any other standards referred to in this Manual.

In the event of conflict between standards and specifications prescribed in two or more of the aforesaid codes, the Contractor shall be at liberty to rely on one of the aforesaid codes and on Good Industry Practice, provided however, that in the event of any such conflict, the following codes shall have overridden priority in the order listed:

(i) Specifications and Standards set out in this Manual;
(ii) NFPA 130;
(iii) EN; and
(iv) British Standards.

1.3.2 The design of the Monorail System shall also conform to:

(i) Local building bye-laws;
(ii) relevant published standards of UIC;
(iii) all statutory requirements, guidelines and directives; and
(iv) Stipulations of fire service department.

1.4 Civil / Building Works

1.4.1 For this purpose, building works shall be deemed to include station buildings, Guideway structures, Depot and workshop, OCC, buildings housing Project Facilities, traffic integration works, landscape elements and/or any other works incidental to the building works.

1.4.2 All items of building works shall conform to the standards specified in the Building Code of Pakistan 2021 (BCP).

1.4.3 To the extent specific provisions for building works are made in this Manual, the same shall prevail over the BCP 2021.

1.4.4 **Alternative standards and specifications**

The requirements listed in this Manual are the minimum. The Contractor may adopt alternative internationally recognized codes, standards and specifications if it is demonstrated to the TE that such alternative is superior or more pertinent to the Project than the standards specified in this Manual.

1.5 System performance requirements

From the point of view of system performance, the major requirements of the Monorail System are that it shall be:

(i) Safe;

(ii) integrated to its environment;

(iii) made of proven technologies and/or processes;

(iv) adapted to local climate;

(v) inclusive of protective measures against storms and other local climatic conditions;

(vi) earthquake resistant;

(vii) reliable;

(viii) efficient;

(ix) comfortable;

(x) aesthetic; and

(xi) Accessible to general public including the physically challenged.

Notwithstanding the generality of the foregoing, where specific standards or specifications are prescribed in relation to any of the foregoing, the Contractor shall comply, at the minimum with such standards and/or specifications.

1.6 General technical requirements of the monorail system

1.6.1. The Monorail System shall be designed to:

(i) Handle the passenger demand efficiently;

(ii) minimize impact on road users including pedestrians and cyclists;

(iii) minimize visual intrusion and noise pollution;

(iv) provide adequate interchange facilities including parking and pedestrian facilities; and

(v) Meet the performance requirements and the Key Performance Indicators laid down in the Contract Agreement.

1.6.2. All parts of the Monorail System, particularly the Stations, Guideway gradients in Stations, Electric Traction & power supply system, Signalling & Telecommunication system, Depot, control and information facilities shall be designed to cater the demand and capacity including number of Train Cars, as indicated in the provisions of the Bidding Document.

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1.7 Engineering and system design

1.7.1. The Contractor shall submit its engineering design for review and comments to the TE.

1.7.2. In addition to the engineering designs, the Contractor shall submit all drawings, specifications, simulation reports, calculations and assumptions, which represent the final constructed works.

1.7.3. The as-built drawings shall be dimensioned and sufficiently detailed to support any modifications to the constructed works and extensions to the Monorail System.

1.7.4. All systems and equipment to be used for the Monorail System shall be designed taking into account the local climatic conditions.

1.8 Engineering philosophy and requirements

1.8.1. System designs and equipment shall have been proven in service.

1.8.2. The Contractor shall develop the engineering based on the Specifications and Standards and in accordance with Good Industry Practice.

1.8.3. The engineering with all technical data and calculations relating to equipment shall be submitted to the TE for its review and comments on the quality and reliability of the equipment to be procured.

1.8.4. The sub-systems and equipment except rolling stock proposed to be procured by the Contractor shall have been in revenue service with at least two Mono rail systems internationally and shall have established performance reliability over a minimum period of two years, within the last ten years.

In the case of rolling stock, the technology proposed to be utilized shall have been in revenue service with at least one urban rail transport system suitable to Murree Glass Train Monorail System for a minimum length of five km and shall have established performance reliability of a minimum of two years in the last ten years and such a technology should have been certified by the Competent Authority for Safety and Commercial use.

1.8.5. Adequate margin shall be built into the engineering to protect against high ambient temperatures, seasonal humidity, corrosive conditions, and the effects of lightning strikes, etc. Prevailing at the project corridor.

1.9 Design, Drawings and Documents

Submissions

The Contractor shall submit his engineering systems design for review and comments by the TE, as follows:

(i) The initial engineering submission shall include the outline design and equipment specifications for each system.

(ii) The submission shall also include standards, interface management plan, quality assurance plans, systems assurance plans, EMC management plan, RAMS management plan, calculations and assumptions, software programs and third-party co-ordination arrangements, to enable the TE to have a complete understanding of the equipment and system arrangements.

(iii) Detailed engineering submission shall include the detailed design, drawings and software programs for each sub system, to enable the TE to have a complete understanding of the detailed design of the system arrangements.

Software

(i) With the exception of commercial, "off the shelf" software, full access to application software(s) and any other software/hardware tools including source code which may be specifically required for the intended purpose indicated in these specifications shall be provided. This provision shall be through an ESCROW arrangement wherein the latest version on the software will be made available.

(ii) For commercial software the Contractor shall provide the software, including all available documentation for the application and maintenance of that software.

(iii) Complete documentation along with the software shall comprise of signal flow diagrams, flow charts, functional blocks, details of signals and interpretations, so as to enable debugging and system level modifications, if required.

(iv) The latest version of software and documentation for use during operation and maintenance training shall be provided.

(v) The documentation of software shall be supplied at the time of Commercial Operation Date (COD).

(vi) All software shall be compatible with latest version of operating software and shall also have upward compatibility.

(vii) Diagnostic tools to be provided shall include all hardware/software required for the purpose of:

a. Uploading/downloading of all software's used in the system/sub-systems; and

b. Downloading of faults and any other information required for trouble shooting and diagnostic purpose.

c. All software, as indicated above and documentation shall be provided in an additional Hard Drive in a format compatible with the computing equipment supplied.

1.10 Quality Assurance

1.10.1. The Contractor shall develop and maintain a quality assurance system for design, installation and construction procedures and the interfaces between them.

1.10.2. The quality plan shall also cover fully all quality assurance and quality management aspects of the operation and maintenance of the Monorail System.

1.10.3. The quality assurance programs and plan shall be implemented till the expiry of the defect liability Period, and shall conform to EN ISO 9001: latest version Model for quality assurance in design/development, installation and servicing, or to any higher standards.

1.11 Systems Assurance-Reliability, Availability Maintainability and Safety

1.11.1. The Contractor shall design the Monorail System with a high degree of Safety, Reliability, Maintainability and Availability in order to provide a dependable service for the public.

1.11.2. The optimization of the system with respect to Safety, Reliability, Maintainability and Availability must be planned and must form an integrated element of the project from the inception throughout the life of the project".

1.11.3. The Contractor shall develop a RAMS Plan and submit for approval by TE before the First Design Review (FDR).

1.11.4. The Contractor shall develop an EMC management plan and submit for approval by TE before the First Design Review. The

Plan shall conform to the following standards

(i) CENELEC EN 50126: Railway application – The specification and demonstration of Reliability, Availability, Maintainability and Safety (RAMS);

(ii) CENELEC EN 50128: Railway application – Software for Railway Control and Protection Systems; and

(iii) IEC 61508 Functional safety of electrical / electronic / programmable electronic safety-related systems.

1.11.5. The Contractor shall develop RAMS targets both for the complete system and for the major elements of the E&M equipment such that it will provide a high level of dependability.

1.11.6. There shall be an efficient means of recovery from all failures, which are foreseeable by an operator acting in accordance with Good Industry Practice.

1.12 Operational Safety

1.12.1. Components critical for safety shall be 'fail safe' or 'checked redundant'.

1.12.2. The system safety plan shall identify and list safety critical components, which list shall be updated periodically during the operation of the system.

1.12.3. The quality measures of hazard severity and risk acceptance shall conform to EN 50126 or higher standards.

1.13 Safety Case

1.13.1. The Contractor shall develop a Safety Case for the Monorail System for review and approval by The Engineer and Safety Consultant.

1.14 Certification

1.14.1. The Contractor shall be responsible for obtaining certification of the Monorail by the appropriate Authority.

1.14.2. The Contractor shall demonstrate that the Monorail system is designed, manufactured, constructed, installed and tested as per a detailed Systems Assurance Plan (SAP) and as per a Safety Case that shall result in Certification of the Monorail for operation.

1.14.3. The Contractor shall prepare operating, safety and maintenance manuals and shall obtain approval from The Engineer.

1.15 Site safety engineering

1.15.1. The Contractor shall prepare a system safety plan covering the engineering, fabrication, supply, construction, installation, test, commissioning and operation and maintenance of the Monorail System in consultation with the TE.

1.15.2. The safety goals shall be in accordance with the NFPA safety guidelines, local rules and regulations and stipulations of local fire authorities. All failures identified as potential hazards shall be recorded in hazard files to be maintained by the Contractor and kept updated. The quality measures of hazard severity and risk acceptance shall

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conform to EN 50126 or a higher standard

1.16 Road safety - traffic and workers

1.16.1. Before taking up any construction, traffic diversion or maintenance operations, the Contractor shall first work out a plan to ensure the following

(i) Safety of traffic during the period of construction and the reduction of potential delays to road users

(ii) Safety of the workers engaged in construction

(iii) The arrangement for traffic during construction shall conform to the requirements of the Specifications for Road and Bridge Works issued by National Highway Authority (NHA)

(iv) The Contractor shall furnish and erect the barricades, traffic signs and markings, arrangements for adequate lighting, equipment and flag men etc.

1.16.2. The Contractor shall communicate the arrangements for safety of traffic and workers during construction to the TE for review and comments, if any.

1.17 Electromagnetic compatibility (EMC) assurances

1.17.1. EMC Management plan

1.17.1.1. The Contractor shall prepare and submit for review and comments, if any, by the TE, an EMC management plan which shall define the EMC philosophy, activities, and means of control for the engineering processes and the EMC submissions (EMC management plan), shall demonstrate compliance with the Bidding Document.

1.17.2. The EMC Management Plan shall assure that:

(i) All equipment's and systems are designed to withstand power supply surges, interferences and transients caused by lighting circuits, traction and power supplies and lightning;

(ii) all equipment's and systems are designed to cater for high magnetic and electric fields likely in the vicinity of traction and power supply systems and due to high voltage power supply cables running near the track and Stations;

(iii) the E&M equipment shall have electromagnetic compatibility with each other and shall be protected by providing anti-surge devices and other protective devices to protect them against such effects;

(iv) E&M equipment shall be provided with shielding and filtering against any conducted or radiated interferences;

(v) the operating frequency of E&M equipment shall be compatible with any frequency already in use for existing operating systems in the zone of influence of the Monorail System; and

(vi) The system shall comply with relevant national and international standards with respect to electromagnetic compatibility.

(vii) Prior to commencing any Detailed Design work, documentary evidence has to be produced to TE that the appropriate EMC standards have been agreed with each of the external authorities that could be affected by the construction and operation of the system.

(viii) The noise emitted by the Cars on run shall be governed by BS EN ISO 3095 – latest version - 'Railway applications - Acoustics - Measurement of noise emitted by rail borne vehicle' or equivalent standard.

1.17.3. EMC Engineering

1.17.3.1. The Contractor shall ensure that all electrical and electronic apparatus are engineered and constructed to operate without degradation of quality, performance or loss of function and data in the electromagnetic environment of the Project.

1.17.3.2. The Contractor shall comply with the requirements of the international standards EN 50121-1/-/5 Railway Applications – Electromagnetic Compatibility, latest version and related standards and the IEC 61000 series for Electromagnetic Compatibility, or equivalent standards.

1.17.3.3. EMC considerations shall be incorporated in the Contractor's procedures for functional safety and engineering verification.

1.17.3.4. The engineering shall ensure that any electromagnetic interference emissions introduced into the environment do not exceed that determined for the EMC management plan.

1.17.3.5. The Contractor shall ensure that the electromagnetic emissions and subsector equipment requirements do not cause or suffer unsafe or unreliable interferences between equipment under normal and abnormal traffic working scenarios.

1.17.3.6. Any shortcomings in achieving EMC shall be made known to the TE immediately and recommendations for corrective action formulated and implemented.

1.17.3.7. In respect of engineering documentation, the Contractor shall demonstrate by theoretical analysis and related Tests that the engineering of the electrical and electronic systems is fully compliant with the EMC requirements identified in the EMC Plan. The Contractor shall state clearly in the documentation, all the assumptions made and parameters used in the analysis.

1.17.3.8. Where theoretical analysis is deemed necessary, the Contractor shall detail the process and methods used for verification and validation of any simulation models used in support of the analysis.

1.17.3.9. The Contractor shall prepare and submit to the TE for review and comments, if any, reports of the verification and validation of the models.

1.17.3.10. In the circuit analysis, calculations shall be made for all component tolerance effects due to manufacture, environment, ageing, and all possible component failure modes.

1.17.3.11. If any component can exist in a dormant failure mode, the analysis shall assume that the component has failed. The Contractor shall identify all component failure modes and produce evidence that any component failure shall not cause an unsafe operation.

1.17.4. EMC Testing

1.17.4.1. EMC type testing shall be carried out on all equipment identified in the engineering stage which requires attention regarding EMC.

1.17.4.2. These shall include all EMC tests to be completed.

1.17.4.3. Tests to be conducted shall include but not be limited to satisfying the requirements of the standards listed.

1.17.4.4. The Contractor shall identify all components to be tested, specify the interval between routine tests, define the test procedure and provide verification levels and pass marks which must be achieved.

1.17.4.5. The Contractor shall carry out proof testing of circuit components.

1.18 Earthing And Bonding

1.18.1. Earthing and bonding is required to address

(i) The safety of operating personnel and other persons from electrical shock.

(ii) The minimum of electrical interference between the electrical power supply and other electrical and electronic systems and the protection of electrical equipment.

1.18.2. The Contractor shall develop an Earthing and Bonding Strategy, for approval by the TE.

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1.18.3. The E&B strategy shall address:

(i) Civil Works provisions
(ii) Building Services earthing
(iii) Rail Systems earthing
(iv) Lightning protection
(v) Specific requirements for
    a. Stations
    b. Depot
    c. Viaducts if any

1.18.4. General Requirement

1.18.4.1 The earthing system provided at any location may be common to two or more categories of earthing, in which case all the earthing points on the individual items of equipment will be bonded together for any earth fault currents.

1.18.4.2 In general, earthing and bonding is required under one or more of the following categories.

a) Neutral Earthing

Connection to earth at one or more equipotential points of the current- carrying conductors of each section of the power supply system shall be arranged to ensure that the voltage at any point in the system relative to the general mass of earth will be within defined limits and will provide a low impedance path for earth fault return currents.

For low impedance earth paths to be established the ground conditions must first be measured (earth resistivity Ω/m) and the system to be designed according to the results.

Allowance shall be made for the fact that conditions may vary throughout the year due to seasonal weather.

b) Protective Earthing

Connection to earth at one or more points of the non-current-carrying parts of electrical equipment shall be arranged to ensure that, in the event of a failure of insulation or other inadvertent connection between current and non-current-carrying parts, no dangerous potential difference occurs between the non-

current-carrying parts of the equipment and the general mass of earth or adjacent equipment, and to provide a low impedance path for earth fault currents.

c) Adjacent Metallic Structures

This relates to connection to earth of metallic structures, which are not part of the electrical equipment but are in close proximity to the electrical system.

d) Mitigation of Interference Effects

This relates to the connection to earth of the screening of low current signal and control cables. The connection to earth of the screening conductors of any low current cables will, in general, be confined to one end in order to avoid circulating currents in the screen causing interference on the signal cores.

There may be exceptions to this and EMC considerations will determine the solution to be adopted in individual cases.

There will be no exceptions in the case of screened or armored cables to the DC switchgear, which will have the metallic enclosures on insulators and connected to the Traction substation earth through an earth fault detection shunt (Frame fault detection device).

e) Treatment of Unearthed Systems

This relates to unearthed systems, where the current-carrying conductors are fully insulated from earth at all points. No part of such a system need be automatically disconnected immediately on the occurrence of a single earth fault in that part. However special care needs to be taken during design and installation when considering this type of earth system.

f) Treatment of Traction Negative Return System (DC)

This relates to the negative return traction system, where the additional 'power" rails, which form the return conductor.

A significant proportion of the return current may leave the return current collector and return through the ground (earth) or other conductive paths such as low resistance structures or buildings to the vicinity of a substation before returning to the "rail" and hence to the rectifier negative pole.

Designs shall take into account the large range of humidity levels expected.

g) Earthing for Lightning Protection

This relates to the protection of buildings and structures from lightning by the provision of lightning conductors and hence connection to the earth electrode system. Care shall be taken of the locality and lightning incidence rate and applied to the protection of the Railway Systems as a whole from "Far" and "Near" strikes, individual structures and personnel protection.

h) Legislation and Standards

Earthing, bonding, lightning and corrosion protection shall to be in accordance with current standards applicable.

Requirements applicable to the Masstransit System for the purposes of this Earthing Policy shall be assumed to be no less onerous than the relevant requirements of the following:

(i) European Standard EN50122-1 - 'Railway Applications Fixed Installations - Protective provisions relating to electrical safety and earthing'.

(ii) European Standard EN50122-2 - 'Railway Applications - Protective provisions against the effects of stray currents caused by DC traction systems.

(iii) British Standard 7361, Part 1 - Cathodic Protection - Code of Practice for Land and Marine Applications.

(iv) European Standard EN 50162 - Protection against corrosion by stray currents from direct current systems.

(v) International Union of Railways Codes (UIC) 605 'Protection from Corrosion' Measures to be taken on direct current catenaries to reduce the risk on adjacent piping and cable systems.

(vi) BS 7671 – Requirements for Electrical Installations

(vii) BS 7430 – Code of Practice for Earthing.

(viii) ANSI / IEEE 80 – Earthing of Substations

Where Local Codes conflict with International Codes/Standards discussion and agreement with the local authorities will be required.

1.19 Testing and Commissioning

1.19.1. The Contractor shall set up adequately equipped field laboratories for testing of materials and finished products.

1.19.2. It shall make necessary arrangements for such Tests for which facilities at Site laboratories are not available.

1.19.3. The Contractor shall develop an Integrated Testing and Commissioning Plan for review by the TE. This should be in line with the requirements detailed in Chapter 12 of Max. Safe Speed (MSS) and shall also be included in the Design submissions to support systems assurance verification and validation.

1.20 Review and comments by The Engineer

1.20.1. Role of The Engineer and associated review process shall be as specified in the Bidding Document

1.20.2. In cases where the Contractor is required to send any drawings or documents to the TE for review and comments, and in the event such comments are received by the Contractor, it shall duly consider such comments in accordance with the Bidding Document and Good Industry Practice for taking appropriate action thereon.

1.21 Definitions and Interpretation

1.21.1. All the obligations of the Contractor arising out of the provisions of this Manual shall be discharged in a manner that conforms to the provisions of the Bidding Document.

1.21.2. The rules of interpretation as specified in Clause 1.2, 1.3 and 1.4 of the Agreement shall apply mutatis mutandis to this Manual.

1.21.3. The definitions contained in the Agreement shall apply to the provisions of this Manual unless the context otherwise requires.

1.21.4. Terms or words not defined in this Manual or the Agreement shall be governed by the definitions contained in the applicable Specifications and Standards.

1.22 Interface Provisions

The Contractor shall ensure that all interface requirements relating to the Guideway, Viaduct and Switches with rolling stock, rail systems, Depots, AFC, Traction power system and civil works are identified and the associated Interface Management Plan is reviewed by The Engineer. In particular, the following shall be addressed:

(i) Guideway with Rolling Stock bogie

(ii) Guideway interface with Power / Return Current Rail and Traction Power System

(iii) Structure reinforcement with Earthing and Bonding requirements and EMC requirements of the Signaling circuits.

(iv) Guideway with Depot circulation

(v) Guideway with emergency egress

(vi) Viaduct with Utilities and drainage

(vii) Guideway with Cables and ducting

In view of the same, a fundamental obligation of the Contractor is to co- ordinate with all the designers / consultants / sub- consultants / Sub- contractors / vendors / suppliers etc. of the System so that the designs of all components of the Monorail System are compatible.

It will have to be ensured that his design incorporates such fixing as are required in order to avoid any necessity for any of the Sub-contractors / vendors / suppliers to drill, weld, burn or cut any part of the structure for fixing / installation of their equipment / systems / sub- systems.

CHAPTER – 2
ALIGNMENT

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CHAPTER – 2
ALIGNMENT

2.1 Alignment

2.1.1. This section lays down the standards for alignment design of the Monorail System.

2.2 Alignment Requirements

2.2.1. The Contractor should refer the documents submitted by the Technical Consultant on Survey and alignment details and carry out the Detailed Project Report including the final alignment and station locations etc. and submit to TE for their approval.

2.2.2. Modifications/ other alternatives in the proposed route alignment shall be carried out by the Contractor with the prior permission of TE.

2.2.3. The Contractor shall however be required to determine final locations of stations and the locations of access landings as per the field conditions.

2.2.4. Contractor shall develop the alignment in detail, with due consideration for

(i) International standards
(ii) Particular standards to suit monorail systems
(iii) Optimized station location
(iv) Horizontal curves designed for maximum comfort and safety.
(v) Avoidance of additional land acquisition

2.2.5. The Contractor shall, within the constraints imposed by the Monorail System, and subject to maintainability, adopt:

(i) Horizontal curve radii, suitable for operation without speed restriction
(ii) Vertical curve radii suitable for operation without speed restriction
(iii) Long transition curves for rider comfort
(iv) Guideway gradients for rider comfort and energy efficiency

2.3 Clearances

2.3.1. Clearances shall conform to the UIC codes and shall be as per international practices.

2.3.2. The Contractor shall propose the Schedule of Dimension (SOD) in tune with the Rolling stock and in consultation with TE

2.3.3. The requirements for maintaining clearances between Trains and fixed infrastructure and between two Trains shall be determined by the Contractor in consultation with the TE.

2.3.4. Highway Clearances

2.3.4.1. The vertical and horizontal highway clearances required to structures shall generally be in accordance with the requirements described below.

2.3.5. Vertical Clearances

2.3.5.1. The minimum clearance between the elevated Guideway structures and highways, utility and other structures and property should be greater by a minimum of 250 mm more than the prescribed limit.

2.3.5.2. The minimum vertical clearance below the bottom of Rolling Stock and the structure for any highway/road passing below will be 5.5 meters as prevailing presently.

2.3.6. Horizontal Clearances

2.3.6.1. The clear span over the roads passing below the elevated Guideway shall be determined after evaluation of present and future needs.

2.3.6.2. Protection shall be necessary for piers against accidental impact from road vehicles on a case-by-case basis. BS 5400 Part 2 and UIC 777(1) shall be applied.

2.3.6.3. For supports located in the median or adjoining major roads where heavy goods vehicles pass at high speed and where adequate clearances are not available, the foundations and piers shall be designed for an impact force as detailed in relevant clauses of NHA code.

2.3.7. Higher permissible stresses shall be considered.

2.3.7.1. The approach to the pier shall also be protected by non-mountable kerb and sand filling.

2.3.7.2. Where clearances are available and a suitably designed safety barrier can be provided, the pier shall not be checked for 100-ton impact force.

2.3.7.3. The protection afforded should be such that when a car of 1.5 t weight strikes the barrier at 80 kph and at an angle of 20° the wheels of the car will only just reach the pier.

2.3.7.4. The clearance between the pier and safety barrier shall be 0.6 m or more, and the safety barrier shall be a guardrail or crash barrier, mounted on posts to form a free-standing barrier.

2.4 Guideway requirements

2.4.1. Contractor while designing the Guideway beam should address the parameters detailed in the Chapter no. 3 on Accommodating Structures of MSS.

2.4.2. The geometric design of the Guideway shall conform to the standards established for the Contractor Technology.

2.4.3. The Guideway beam structure selected for the Project shall:

(i) Ensure highest levels of safety, reliability, and comfort;

(ii) Have noise and vibration emitted by Rolling Stock well within the limits laid down in the international specifications

(iii) Require minimum or no maintenance and be of proven design

(iv) Be long lasting

2.4.4. The design shall be based on proven Monorail technology and the components should have been in service in other comparable systems.

2.4.5. The running surface shall be laid to high quality of line, level and surface meeting Specifications and Standards and Good Industry Practice, for similar system and operating speeds.

2.4.6. The Guideway beam shall be compatible with the Car/ Train system and the operational characteristics.

2.4.7. The Guideway shall be suitable for operation of train sets to meet the capacity and headway requirements at the end of the period and at a maximum.

2.5 Guideway Markings

2.5.1. Requirements for Guideway markings / indications and their method of fixing to the Guideway structure shall be agreed with the TE.

2.5.2. All permanent markers proposed to be used and markers proposed to be painted including the color scheme shall be in consultation with the TE.

2.5.3. Monorail Alignment Features:

Type of vehicle	Monorail with single/dual axle bogie straddle beam type
Train Consist	Proposal shall meet the PHPDT requirements with necessary enhancement for future increase
Guide beam Running Surface Width	700 to 850 mm
Train Control	The System will be CBTC GoA 3 system. ATP and upgradable to ATO.
Primary Power Nominal line voltage	750 / 1500 V DC
Power Collection	Positive / Negative dual rail supply collection system
Axle load, maximum	11-15 tons
Bogie	Single or dual axel bogie, straddle beam type
Fire Safety Design	NFPA 130 / ASTME119/BS6853
Performance, Acceleration Rate (service)	1.0 m / s^2 minimum
Rate of change of acceleration	0.7 m per $second^3$
Braking Rate –service	1.0 m / s^2 minimum
Braking Rate – Emergency	1.1 m / s^2 minimum
Maximum Design Speed	80 kmph
Maximum Operating Speed	60 kmph
Minimum commercial operating speed	25 kmph
Minimum Horizontal Radius	50 m
Minimum Vertical Radius	500 m
Maximum Gradient	6% - 6.5%
Passenger carrying capacity	350 per train set
4 car Train, minimum	Normal load = 6 pass. / sq. m Crush load = 8 pass. / sq, m
Head way, operating, minimum	5 minutes
Design Headway	ATP-5 Minutes ATO-90 Seconds

CHAPTER – 3

ACCOMMODATING STRUCTURES

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CHAPTER – 3

ACCOMMODATING STRUCTURES

3.1 General

3.1.1 All Civil Works shall be provided, as required, to support and facilitate the efficient operation of the Monorail system.

3.1.2 This Chapter lays down the standards and performance requirements for the Civil Works to be designed, executed, tested and commissioned by the Contractor for safe, efficient and reliable operation and maintenance of the systems, transmission mediums and cable routes for the Monorail System.

3.1.3 The Civil Works shall meet the requirements in the bidding documents and the Requirements as specified here within.

3.1.4 The Civil Works shall include:

(i) Viaduct and Bridge Structures
(ii) Foundations and substructure
(iii) Station Structures (separate section)
(iv) Depot Structures (separate section)
(v) Switches
(vi) Utilities and Drainage
(vii) Utility Diversions
(viii) Roadway / Footpaths

3.2 General Performance Requirements

3.2.1 The Monorail shall run on rubber tyres along the top of a Guideway beam, with a supporting frame straddling the beam. The Guideway is proposed to be supported on a single column.

3.2.2 Viaduct and Bridge Structures

3.2.2.1 Guideway shall be RCC / Pre-stressed concrete, to the extent possible.

3.2.2.2 Contractor can propose use of steel structures & composite construction if considered an economic alternative and it generally satisfies all other structural requirements.

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3.2.2.3 Spans shall typically be 30 m.

3.2.2.4 Provision for emergency evacuation for the entire System shall be provided by walkways along the Guideway.

3.2.2.5 The minimum clearance between the elevated Guideway structures and highways, railways, utility lines and other structures and property shall be greater by a minimum of 250 mm on those prescribed by the agencies involved.

3.2.2.6 The minimum vertical clearance below the bottom of Rolling Stock and the structure for any highway/road passing below will be 5.5 meters as prevailing presently.

3.2.2.7 Protection shall be necessary for piers against accidental impact from road vehicles.

3.2.3 **Foundations and substructure**

3.2.3.1 The Contractor shall undertake all necessary survey to establish ground conditions and utility locations to undertake the foundation / substructure design.

3.2.3.2 Wherever possible, foundations shall be within the road median, to avoid differential settlement of the roadway.

3.2.3.3 Top of pile cap/ open foundation shall be at least 500mm below the lowest road level/ finished ground level.

3.2.4 **Switches and Transfer Beams**

3.2.4.1 Switches shall be suitable to the monorail industry technology.

3.2.4.2 It is envisaged that switch designs for revenue service Guideway shall feature flexible sides, so that the stabilizer and guide wheels smoothly transition from guide beam to guide beam as a vehicle transvers the switch.

3.2.4.3 Operation of switches and transfer beams and the associated Guideway configuration shall be demonstrated by the Contractor as suitable to achieve 90 second system headways.

3.2.4.4 Operational limits of switches shall take due consideration to avoid single point of failure.

3.2.4.5 Switches shall be limited to five-way switches unless approved by The Engineer.

3.2.4.6 Transfer Beams/ Tables, if required may be provided in the Depot.

3.2.4.7 Guide beam switch: switches are critical to the successful operation of monorail transit system. The Switch system shall be fool-proof, highly reliable and need low maintenance

3.2.5 **Drainage**

Adequate water drainage from the structures and reinstated roadway system shall be provided.

3.2.6 **Roads / Pavements**

Footpaths and road pavements in station and other areas excavated for construction purposes shall be reinstated to the satisfaction of the concerned Authority responsible for the maintenance of the roads and to the approval of The Engineer.

3.3 Standards

3.3.1 The design of Guideway / Station Structure shall comply with applicable codes of practice and standards.

3.3.2 These shall include but not be limited to regulations made and requirements issued by the Employer and by relevant utility agencies currently applicable at the time of submission of the Bid shall be followed and specified.

3.3.3 Design and loading requirements for the structures shall be not less than the respective International Codes of Practice, together with all applicable amendments and shall conform to the practice for design of elevated structures for mass transit system.

3.3.4 The following codes shall be applicable:

(i) AASHTO

(ii) BS.

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3.3.5 International Standards

International Standards	
AASHTO, latest version	Guide specifications for Design and Construction of segmental concrete Bridges
Structural Engineering Documents no.6 of IABSE, latest version	Structural Bearings and Expansion Joints for Bridges
BS 410: latest version	Specification for test sieves
BS 812:	Testing aggregates
BS 1154: latest version	Specification for natural rubber compounds
BS 1137: latest version	Methods of test for soils for Civil Engineering purposes
BS 5400: latest version	Steel concrete and composite bridges
BS 5930: latest version	Code of Practice for Site Investigations
BS 5950: latest version	Structural use of steel work in buildings
BS 6177: latest version	Guide to selection and use of Elastomeric Bearings for Vibration Isolation in Buildings
BS 8007: latest version	Code of Practice for Design of Concrete Structures for Retaining Aqueous Liquids
BS 8110 Parts I and II	Structural use of Concrete
Part 9: Section	Code of Practice for Design of Bridge
9.1	Bearings
Note: The above list is not exhaustive.	

3.3.5 **Other Publications**

(i) CEB – FIP Model Code
(ii) UIC/772-R the International Union of Railways Publication
(iii) IEC: International Electro technical Commission
(iv) AREMA Manual

3.3.6 The design relating to fire safety and escape shall be in accordance with the requirements of NFPA 130 Standard for Fixed Guideway Systems.

3.4 Design Requirements

3.4.1. Viaduct / Guideway Structural System

3.4.1.1 The structural system may comprise of superstructure of Reinforced Cement Concrete (pre-cast / cast-in- situ, pre- stressed) or extra dose / cable stayed or structural steel, substructure of precast / cast-in- situ RCC and foundations having pile & pile cap or open foundation.

3.4.1.2 The Guideway structure should be designed for maximum Axle Load of 11-15 tons configuration based on car design and Train configuration.

3.4.1.3 Other loads and forces to be considered for design should be in accordance with the technical characteristics of the Rolling Stock.

3.4.1.4 The NHA Codes and other International Codes for good industry practice shall be followed for design for RCC sub-structure and foundations and for pre-stressed concrete girders with internal pre-stressing.

3.4.1.5 For superstructure with external pre-stressing, International Standards shall be followed.

3.4.1.6 The Guideway structure shall be supported on single columns.

3.4.1.7 At few locations it may be necessary to adopt portal frame support in lieu of single column.

3.4.1.8 Detailed topographic and geo-technical investigations along the corridor shall be carried out by the Contractor.

3.4.1.9 Ducts for laying electrical signal and communication cables shall be provided.

3.4.1.10 For construction of the Guideway structure, use of prefabricated elements to the maximum possible extent shall be adopted in view of the need for fast-track work.

3.4.1.11 The structure should be aesthetically pleasant.

3.4.1.12 Guideway superstructure shall be supported on single row of RCC piers.

3.4.1.13 The spacing of piers shall be not less than 25 m unless otherwise justified. Where field restraints dictate the use of longer/continuous spans, pier locations and superstructure may be adjusted to suit the proposed span lengths.

3.4.1.14 At some locations, it may be necessary to adopt RCC portal frames or other suitable support system, where the alignment deviates due to topographical reasons.

3.4.2. Span Arrangement

3.4.2.1 The span arrangement for the viaduct as indicated in the DPR is for general guidance only. The Contractor shall decide on the final span arrangement and structural system taking care of the ground realities and feasible fast track erection system.

3.4.2.2 The span arrangement for the Guideway shall be planned by the Contractor and shall be approved by The Engineer.

3.4.2.3 Spans may have to be adjusted based on existing utilities and other street furniture.

3.4.2.4 Special / longer spans will be required to cross existing railway tracks / roads.

3.4.2.5 Where topographical or service utility restraints dictate use of longer/continuous spans, pier locations may have to be changed to suit the proposed span lengths.

3.4.2.6 The Contractor shall provide, by suitable choice of span lengths, a sufficiently stiff Guideway and supporting sub-structure to resist loading as defined in various paras stated above. Static and dynamic live load responses, at essential movement joint locations, shall be in compliance with the design Requirements.

3.4.3. Guideway Cross Sections and Structure Gauges

3.4.3.1 Schedule of Dimensions including the Kinematic Envelope for the rolling stock of the Monorail System and Structure Gauges for straight and curved Guideways shall have to be developed by the Contractor and approved by The Engineer.

3.4.3.2 The Contractor shall ensure that the proposed size of structure is adequate to accommodate the equipment / cables, as required for the operation of the Monorail System, outside the Structure Gauge.

3.4.3.3 Structures shall not infringe the mandatory clearances as required for the safe operation of the system

3.4.1 Vertical Profile

3.4.1.1 The superstructure shall be so designed that, when subject to dead load only, the top level of the Guideway would be above the theoretical vertical profile of the system by an amount equal to permissible Live Load deflection for the structure.

3.4.1.2 The Guideway, including the soffit of any overhead structure above the Guideway, shall be designed with camber or any suitable technology/design in case of longer span with steel girder (for PSC this is not required) to compensate the combined effect

of:

(i) Vertical curvature, if any

(ii) Dead load deflection

(iii) Permissible live load plus impact deflection as accepted by The Engineer.

3.4.1.3 Span Length-to-depth ratio should as far as possible be restricted to:

(i) Reinforced concrete member: 10

(ii) Pre-stressed concrete member: 14

(iii) Composite members: 16, Desirable 12

3.4.2 Vertical Clearance below Structure

The minimum vertical clearance available below soffit of Guideway structure shall be 5.50 m and / or as per relevant codes. Minimum vertical clearance above guide beam shall not less than 5.80 m.

3.4.3 Viaduct Loading

3.4.3.1. Loads and forces to be considered for design shall be in accordance with the proposed rolling stock's technical characteristics, maximum axle load and spacing.

3.4.3.2. Loads shall be based on the train sizes and headways subject to the approval by The Engineer.

3.4.3.3. The Contractor to provide effective design including load combination and to be got approved by The Engineer.

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3.4.4 Live Loads for Guideway

3.4.4.1. The loading applied to structures for the Project shall generally be in accordance with BD 37/88 (revised version of BS 5400: Part 2) except as detailed below.
Axle Loads and spacing shall be in accordance with the Rolling Stock proposed for the System by the Contractor and approved by The Engineer.

3.4.5 Nominal Loads

3.4.5.1. For the purpose of computing stresses and deformations, the following loads and consequential effects shall be taken into account as applicable.

(i) Dead loads

(ii) Superimposed Dead Load

(iii) Live loads

(iv) Dynamic effects
(v) Forces due to curvature or eccentricity of the Guideway
(vi) Temperature effects
(vii) Frictional resistance of expansion bearings
(viii) Longitudinal forces
(ix) Lateral forces
(x) Forces on parapets / walkways including handrails (as applicable)
(xi) Wind pressure effect
(xii) Forces and effect due to earthquake
(xiii) Erection forces and effects
(xiv) Collision Force
(xv) Buffer Stop effect (as applicable)
(xvi) Buoyancy
(xvii) Differential settlement

3.4.6 Loading Combinations

3.4.6.1. Each component of the structure shall be designed/ checked for all applicable combinations of all loads and forces. They shall resist the effect of the worst combination.

3.4.6.2. The allowable unit stress in a member subjected to a particular combination loading shall not exceed the percentage indicated against the respective combination.

3.4.6.3. The loading combinations indicated are not exhaustive. Contractor shall analyze the effects of any other combination as applicable and / or deemed appropriate.

3.4.7 Design Loads

(i) Design shall include the effects of: Static Loading: These shall consist of the loads as per international good industry practices.
(ii) Fatigue Loading: The nominal loading for the design of members in accordance with the requirement with BS 5400: Part 10. The design also must take care of the fatigue loading for the Monorail system in accordance with the approved criteria.
(iii) Vehicle Loads: Vehicle Loads shall be established as per the Contractor technology and train sizes to meet the capacity requirements.

(iv) Dynamic Loading: The static and fatigue loading given in above shall be multiplied by an appropriate dynamic factor of 20/(50+L) for concrete beam and 25/(50+L) for steel beam, but not exceeding to 25% where L = Length of the span in meters. Dynamic loading shall not be applied to piles, pile caps, centrifugal loads or braking/traction loads.

(v) Longitudinal Loads: Longitudinal loads from braking and traction shall be 18% & 20% of live load per Guideway respectively.

a. When a structure carries two Guideway, both Guideway s shall be considered to be occupied simultaneously. Traction forces shall act on one Guideway and braking forces acting on the other, with both acting in the same direction to produce the worst loading condition.

b. Longitudinal forces acting on the Guideway shall be considered to be dispersed through the Guideway before being transmitted to the substructure.

c. Provision shall be made for effect of horizontal and longitudinal forces in the Guideway, especially in the girders.

d. Additional permissible stresses while considering this contingency will be proposed by the Contractor for review by The Engineer.

e. Forces shall also be calculated for temperature differential between of steel and concrete wherever applicable.

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3.4.8 Wind Loading

The Guideway shall be designed for wind loading.

Temperature Loading

Overall temperature and differential temperature effects shall be determined as applicable.

3.4.9 Seismic Loading

3.4.9.1. The projects area falls in zone-II & III of the seismic zone; hence the designs for the structures shall adhere to relevant zone-II & III seismic conditions.

3.4.9.2. Seismic effects shall be considered on all structures.

3.4.10 Erection Forces and Effects

3.4.10.1. The weight of all permanent and temporary materials together with all other forces and effects which can operate on any part of structure during erection shall be taken into account.

3.4.10.2. Allowance shall be made in the design for stresses caused in any member during erection, for extra allowance in permissible stresses when erection forces are also considered.

3.4.11 Shrinkage and Creep

Provision shall be made for the effects of shrinkage and creep of the concrete in the structure.

3.4.12 Design Surface Crack Width

For the serviceability limit state of cracking:

(i) Design surface crack width of reinforced concrete elevated Guideway structures shall not exceed the values given in Table 1 of BS 5400 Part 4: latest version or 0.2 mm whichever is the lesser.

(ii) Pre-stressed concrete elevated Guideway structures shall be designed as per provisions of BS Codes.

(iii) Design surface crack width of reinforced concrete structures exposed to weather shall not exceed the values given in Table 1 of BS 5400 Part 4: latest version or 0.2 mm whichever is the lesser. In addition, requirements of BS 8110 Part 1 and 2 shall apply.

(iv) Pre-stressed concrete structures that are exposed to the weather shall be designed as class 1 of Clauses 4.3.4.3, BS 8110 Part 1. Structural elements that are fully protected from the weather may be designed as class 2.

3.4.13 Temperature Effects

3.4.13.1. Temperature effects shall be taken into account in accordance with the requirements of BS 5400 Part 2, where applicable.

3.4.13.2. The difference between maximum and minimum effective temperature shall be taken as 45°C.

3.4.14 Sway of Elevated Guideway Column

3.4.14.1. Longitudinal sway at the top of columns due to live loads shall be restricted to a maximum of 5mm.

3.4.15 Foundations and Geotechnical Works

3.4.15.1. "Geotechnical works" shall mean foundations, earthworks, deep excavations, slopes, embankments and earth retaining structures. It shall also include dewatering and any ground related activities in soil and rock.

3.4.15.2. The Contractor shall be responsible for determining for his design purposes the Geology and the Geotechnical parameters of the sub- surface strata along the route.

3.4.15.3. The Geo- Technical investigation details/reports relevant for the Project as available will be provided to the Contractor for reference purpose only. The results can be of use for broad reference and information only.

3.4.15.4. The geo-technical investigations are to be carried out by the Contractor on which the design shall be based.

3.4.15.5. Modifications to the designs may have to be carried out based on the test pile results to be done by the Contractor as per relevant codes.

3.4.15.6. Open or pile foundations may be adopted depending on the suitability of soil strata encountered.

3.4.15.7. Circular/ Square or Rectangular pier as per design including pier cap should be cast in single lift to give good finish without joint except for very tall piers for which single lift casting may not be practicable.

3.4.15.8. For protection of the piers against collision from moving vehicles on the road, concrete crash barrier shall be provided at road level to a height of 1.0 m above road level around the piers or along the median edges.

3.4.15.9. For construction of pile foundations, rotary hydraulic drilling rigs with faster productivity shall be used.

3.4.15.10. A safety factor of not less than 2.5 should be adopted as tested load for a single pile

and a safety factor of not less than 2.0 shall be adopted when considering pile and pile group capacities.

3.4.15.11. A safety factor of at least 1.75 for a single pile and at least 1.5 for group piles shall be adopted when the negative skin friction (which results from downward movement of adjacent soil relative to the pile caused by dewatering and/or the placement of fill) is considered.

3.4.15.12. Adequate measures will have to be taken to minimize the amount of local differential settlement of road surfaces around underground works.

3.4.15.13. The type of foundation shall depend on soil and site conditions, and, where the Monorail alignment is close to the elevated roadways, railway lines and other structures, the foundation design of the adjacent structure.

3.4.16 Pile Caps

3.4.16.1. A factor of safety to be adopted when considering a single and/or pile group capacities shall be as specified in BS codes.

3.4.16.2. Adequate measures shall be taken to minimize the amount of local differential settlement of road surfaces around pile caps.

3.4.16.3. The pile cap/open foundation top shall be kept at least 500 mm below the road level so as to facilitate necessary drainage from the viaduct and crossing of utilities.

3.4.17 Differential Settlement

3.4.17.1. Consideration of the forces resulting from differential settlement shall be made where the nature of the chosen foundation system and the ground conditions indicate that such a condition may arise but not more than

(i) 10 mm Long Term Settlement
(ii) 6 mm Short Term Settlement

3.4.18 Drainage

3.4.18.1. Properly designed drainage scheme for the elevated Guideway structure, stations and concourse and Depot shall be provided.

3.4.18.2. All drains shall be of adequate size as per hydraulic calculations and shall be connected to the nearest underground drainage facilities or discharge facilities with the provision of sumps, man holes, cross drains etc.

3.4.18.3. For fast-track construction, use of pre-cast RCC standardized drain sections shall be adopted.

3.4.19 Earthing and Bonding: Structural Works Provisions

3.4.19.1. The Contractor shall incorporate into his design precautions as per EN 50122-2 or equivalent for earthing and bonding standards.

3.4.19.2. The continuous electrical path shall be provided by ensuring full and reliable electrical connection throughout the structure.

3.4.19.3. The electrically continuous path shall be provided through the steel reinforcement either by continuous welding of structural reinforcement or by the provision of additional welded mesh reinforcement.

3.4.19.4. Where welded structural reinforcement is used to form a grid, welded cross-connections shall be at a minimum spacing of:

(i) For longitudinal bars, 600 mm measured in the transverse direction

(ii) For transverse bars, 6 m measured in the longitudinal direction.

3.4.19.5. The Contractor shall make provision for the monitoring of this continuous electrical path during construction and to demonstrate achieving of the same during construction.

3.4.19.6. The continuous electrical path will be made less than 100-meter sections. At these sections the designs shall include terminals as required from the continuous electrical path through the structures to external connections.

3.4.19.7. The terminals shall be suitable for the connection of 70 mm2 copper cable.

3.4.19.8. At each connection, four such terminals shall be provided, two of which shall be kept as spares and suitably protected. Similar terminals, spare terminals and connections

shall be provided over any joint of the structure.

3.4.19.9. General requirements for earthing and bonding the structures will be required to be determined and cross bonding to be carried out for effective earthing.

3.4.20 Design Life

3.4.20.1. The design life of all civil engineering structures shall be a minimum of 120 years unless otherwise specified or agreed.

3.4.20.2. Bridge bearings and movement joints shall have a minimum design life of 30 years, except in case of Elastomeric Bearing for which the design life shall be 25 years, apart from minor components that can be replaced without complete removal and without interruption to traffic. Such components shall have a service life of 20 years.

3.4.20.3. The minimum design life for all switches shall be not less than 40 years (not applicable to electrical components).

3.4.21 Serviceability

3.4.21.1. The design shall include the effects of groundwater conditions with the following return periods:

(i) 10 years, with a factor of safety of 1.5
(ii) Worst predicted, with a factor of safety of 1.2.

3.4.21.2. Paint systems for steelwork shall ensure a minimum life of 15 years before full maintenance painting is required.

3.4.21.3. Anticorrosive treatment to steel reinforcement shall be by the approved methods/ procedures.

3.4.21.4. The corrosion protection of non-structural steel items shall be appropriate to the accessibility of the item for inspection and maintenance.

3.4.22 Drawings and Design Calculations

3.4.22.1. The Contractor shall submit, “Method Statements”, according to an agreed schedule, covering complete details and information concerning the method, materials, equipment and procedures it proposes to use at site.

3.4.22.2. In addition to the design calculation for permanent structures, design calculations shall be submitted for false work, erection devices, formwork or other temporary construction which may be required and which will be subject to calculated stress for review by the TE.

3.4.22.3. The Contractor shall provide a proposed erection scheme (Design Construction Integration) for TE approval.

3.4.23 Other Design Considerations

3.4.23.1. The amplitude and frequency of vibrations of the elevated Guideway structure shall be limited to international standards.

3.4.23.2. The overall deflection for elevated Guideway structure will be limited taking into consideration the effect of vibration in addition to other considerations.

3.4.23.3. Suitable provisions shall be provided at the ends of beams and jacking pads on pier caps shall be provided to allow for replacement of bearings and for any repairs during service.

3.4.23.4. Provision should be made for adequate fixtures of the superstructure to the substructure, if any loading or loading combination increased by 100% of live load plus impact is likely to cause uplift of any support.

3.4.23.5. Stresses in partially completed structures shall be analyzed for appropriate critical conditions at various stages of the construction.

3.4.23.6. Any restriction on the construction operations resulting from the design assumptions shall be clearly specified on the contract drawings and specifications.

3.4.24 Transportation and Erection of Pre-Cast Elements

3.4.24.1. The movement of pre-cast elements on road shall be done at night or early morning, so that the disturbance to traffic at the ground level is minimized.

3.4.24.2. Sufficient number of mobile cranes of adequate capacity and boom length shall be mobilized by the Contractor at the casting yards.

3.4.24.3. The transportation and movement of the pre-cast elements at ground level shall be affected by low-bedded trailers.

3.4.24.4. Pre-cast elements shall not be moved from the casting yard until all curing and strength requirements have been attained, and shall be supported in a manner that will minimize warping.

3.4.24.5. A full-scale load test of the gantries, cranes, lifting and temporary holding hardware shall be performed to demonstrate the adequacy of this equipment prior to beginning any erection of the pre-cast elements.

3.4.24.6. The Contractor shall propose erection schemes and submit the same for review by The Engineer.

3.4.25 Safety Precautions

3.4.25.1. Since heavy loads have to be handled over moving traffic, safety is of utmost importance. The Contractor shall enforce a strict Safety System with all necessary precautions and instructions (safety tools, nets, railings, personal protection equipment, proper training of workers, first aid, etc.).

3.4.25.2. No unskilled / untrained personnel shall be engaged at site to perform the critical activities above the flowing traffic at ground level.

3.4.26 Survey Control

3.4.26.1. The Contractor shall provide a detailed Survey Programs and Survey Control records / data sheets, during Pre-casting operations and erection, for review by the TE.

3.4.27 Height Gauges

3.4.27.1. At locations where there is a possibility of road vehicles with height above road, of 5.5m or more coming into contact with the girder of the rail system, the over dimensional road vehicles shall have to be prevented from hitting the girder of the Rail System by providing height gauges at suitable locations.

3.4.27.2. The height gauges shall be design capable of withstanding the shocks.

3.4.27.3. The Contractor shall make his proposal and design for height gauges at such locations for review by the TE.

3.4.28 Re-instatement Works, Utilities and Miscellaneous Infrastructure Works

3.4.28.1. The Contractor shall survey, design and build all re-instatement works, shifting of

public utilities and other preparatory works along the corridor.

3.4.28.2. The scope of works shall cover:

(i) Roadways and pedestrian ways
(ii) Utility protection and relocation
(iii) Miscellaneous infrastructures like new access to premises, new property walls, foot/underpass bridges

3.4.28.3. The final configuration changes planned for road ways/streets shall be designed by the Contractor for review by the TE.

3.4.28.4. Along the median on both sides of the piers, barrier or similar type of kerbs shall be laid continuously except at junctions and cross overs.

3.4.28.5. The Contractor shall modify the existing rain water drainage system to the new configuration required for the implementation of the Project.

3.4.28.6. The Contractor shall re-instate the road structure altered by any of the works resulting from the Contractor's Scope of Works.

3.4.28.7. Adequate number of regulatory, warning and information sign posts at road level shall be installed / relocated by the Contractor as per standards.

3.4.28.8. Decommissioning or dismantling of any part of the existing vehicle traffic control system and setting up temporary traffic lights at junctions to use the construction site shall be carried out by the Contractor under the supervision of the concerned traffic police and relevant Municipal Corporation.

3.4.28.9. Construction methods shall provide those adjacent structures and utilities is protected against damage due to construction of permanent infrastructure.

3.5 Equipment & Systems Requirements

3.5.1. Materials

3.5.1.1 Design Criteria for Steel / Concrete composite girder: Guiding Code BS: 5400 (Part 3 & 5) Height of structure Varying. To be decided as per site requirement.

3.5.1.2 Grade of Concrete for RCC Deck Slab M45

3.5.1.3 Grade of Reinforcement bars conforming to BS standards

3.5.1.4 Grade of structural Steel for Bottom Flange, Top Flange, Webs and Stiffeners according to BS standard

3.5.1.5 Grade of structural Steel for Deck Plate and Rolled Sections according to BS standard.

3.5.1.6 Permanent Bolts for Site Splice of Box Girder according to BS standard

3.5.1.7 Permanent Bolts for Connection to Bracings and Cross frames according to BS standard

3.5.1.8 Grade of structural Steel for Headed Stud Connector according to BS standard

3.5.1.9 Construction stage loading 1.5 kN / m^2

3.5.1.10 Any additional major parameters of design shall be proposed by the Contractor in consultation with the TE.

3.5.1.11 Non-shrink grout shall be used for grouting of post-tensioned tendon ducts.

3.5.2. Pre-stressing Anchorages

3.5.2.1 Pre-stressing anchorages shall be detailed such that they are easily accessible for inspection and maintenance.

3.5.2.2 The detailing shall also prevent the accumulation of water and dirt around the anchorage.

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3.5.3. Movement/Expansion Joints

3.5.3.1 Movement/expansion joints and other necessary measures to control shrinkage and thermal effects shall be incorporated in the structural design, if so required, so that the performance of architectural finishes or of any services are not adversely affected during normal working conditions.

3.5.3.2 Movement/expansion joints shall be designed to be easily maintained and replaceable.

3.5.4. Switches / Transfer Tables

Switches / Transfer Tables shall be suitable for the Monorail Industry Technology.

3.5.5. Bearings

3.5.5.1 In the selection of the bearing layout, consideration shall be given to their performance in relation to the supporting structures, economy as well as maintenance and replacement of the bearings.

3.5.5.2 Consideration shall be given for the easy maintenance and replacement of the bearings.

3.5.5.3 The minimum clearance between structural members separated by bearings shall be as follows:

(i) Precast Beam/Cross Head: 150 mm

(ii) In-Situ Beam/Column: 250 mm

3.5.5.4 These are absolute minimum values and the requirement for easy maintenance and replacement of bearings shall prevail.

3.5.5.5 Due care must be taken to ensure that no pair of bearings act against one another in service conditions to the detriment of the structure and to the bearings themselves.

3.5.5.6 Whenever the expected design life of the bearings is significantly less than that of the structure, provision shall be made for the removal and replacement of the whole or parts of the bearings.

3.5.5.7 Bearings for the elevated Guideway would preferably be elastomeric up to 31m span and beyond that Pot-cum-PTFE.

3.5.5.8 The type of bearings and their installations to be adopted shall be such that they satisfy the requirements for their design life as stipulated in Clause 5.3 of Part 9, Section 9.1 of BS 5400.

3.5.5.9 Unless otherwise specified, bearings shall be designed in accordance with the requirements of BS 5400 and BS 6177 Codes or any other equivalent Code.

3.5.5.10 Bearings for elevated Guideway shall be designed to allow for the following movements:

(i) Thermal expansion and contraction: An ambient range varying between -10°C to +40°C should be considered

(ii) Shrinkage of concrete

(iii) Creep in concrete

(iv) Elastic shortening under pre-stress

(v) Displacements of structure under load

(vi) Differential settlement between Guideway piers shall be considered.

(vii) Rotation and sway of columns and crossheads under the worst load combination including the effects of temporary loads during construction shall be considered.

3.5.5.11 Schedule listing the performance requirements for each type of bearings shall be incorporated in the drawings. The schedule shall indicate the following:

(i) Dead load to be supported {SLS (Serviceability Limit State) and ULS (Ultimate Limit State)}

(ii) Maximum and minimum vertical live load to be supported (SLS and ULS)

(iii) Horizontal forces to be resisted (SLS and ULS)

(iv) Rotation capacity required

(v) Translation capacity required (both reversible and irreversible). In the case of in-situ elevated Guideway, the amount of pre-setting required for the bearings should be clearly indicated.

3.5.5.12 Calculations for movements of bearings shall take into account the variability of materials and conditions that the structure is expected to encounter during its design life.

3.5.5.13 In the above ULS and SLS as defined in UIC 772R, BS 5400, BS 8110, BS 5950

3.5.5.14 Mortar bedding composing of sand and cement, polyester resin or epoxy resin shall have a crushing strength of at least twice the average contact stress.

3.5.5.15 In the choice of bedding due consideration shall be given to the future removal and replacement of the bearing without damage to bedding or to the structural elements bonded to it.

3.5.5.16 Shear studs or bolts shall be provided to secure the bearing top and bottom plates to the structure. The shear studs or bolts shall be designed in accordance with international practice.

3.5.5.17 The fixing method to be adopted shall be such that it is convenient and possible to replace the bearings at some future date.

3.5.5.18 It shall be ensured that the bearings can be produced to satisfy the design requirements; and that the space allowed for in the overall design is sufficient to accommodate the

bearings and enable them to be inspected, maintained and replaced when required.

3.6 Buffer Stops

3.6.1. On Terminal stations, Loop line, Depot at each dead end, buffer stops shall be supplied, installed, tested, commissioned and maintained.

3.6.2. The buffer stop shall be capable of withstanding impact from a Train of maximum design length running at a speed of 15 km/ Hour without any damage to Train or buffer stop and must stop the Train within the distance, as would be required in accordance with Good Industry Practice.

3.7 Testing and Commissioning requirements

Contractor should adhere to the testing and commissioning requirements as detailed in Chapter no. 1 & 12 of MSS.

3.8 Systems assurance

Contractor should adhere to the System Assurance requirements as detailed in Chapter no. 1 & 12 of MSS.

3.9 Interface provisions

Contractor should adhere to the interface provision requirements as detailed in Chapter no. 1

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CHAPTER – 4

STATION PLANNING AND DESIGN

CHAPTER – 4

STATION PLANNING AND DESIGN

4.1 General

4.1.1 This section lays down the standards for planning and design of stations.

4.1.2 The station shall enable a safe, reliable, cost-effective and customer oriented public transport system.

4.1.3 Safety of Users, the public and operating personnel shall have the first priority.

4.1.4 The Station shall be visually appealing; open, spacious, well-lit and consistent with the environment.

4.1.5 The Station planning shall permit maximum cross ventilation and natural light for the Station as well as for the roadway below the Station.

4.1.6 The space and facilities at Stations shall satisfy functional requirements in the peak hour for the target year under all operating conditions.

4.1.7 Facilities shall be provided for handicapped persons.

4.1.8 Location of Stations is indicated in the DPR. Change in location of Stations along the already finalized alignment is permitted to minimize relocation of existing features and to provide better connectivity and traffic integration.

4.1.9 The overall width of Station structure shall be limited to be within the road width including foot paths. Where Stations are located outside the road land width, the overall width shall be governed by site conditions.

4.1.10 Road clearance shall be 5.5m (min) at concourse level at Stations.

4.2 Site Access and Circulation

4.2.1 Circulation patterns for traffic within Station sites and on approaching streets shall be site specific, and shall consider:

i. Integration of Stations with the existing urban fabric, merge with the surroundings, respect for local traditions, and minimize visual intrusion into the urban landscape;

ii. Separation of traffic modes to allow convenient, safe and rapid access to and from local facilities; and passenger design loads for the Monorail System.

4.2.2 Elevated stations shall serve the monorail. These shall accommodate:

i. Platforms
ii. Concourse
iii. Circulation
iv. Access; (stairs, lifts and escalators)
v. Entrances to street level
vi. Ticket / AFC facilities
vii. All necessary technical rooms for systems
viii. Station control, operating and support rooms
ix. Bulk, Traction and Auxiliary substations
x. Emergency power supply equipment
xi. Pump and tank rooms
xii. Kiosks and commercial facilities
xiii. Staff facilities (Only staff toilets are required)

4.2.3 Systems within the station include:

i. Building services (separate Chapter)
ii. Communications system (separate Chapter)
iii. Signaling and train control (separate Chapter)
iv. Station control system
v. Platform screen doors
vi. Elevators
vii. Escalators
viii. Passenger information systems

4.3 General Performance Requirements

4.3.1 Overall length will be dictated by the platform length. This shall be of the order of 65 m to 70 m based on four car trains of 15m cars of 6 car trains of cars of about 10m.

4.3.2 Stations may be typically 3 levels viz., road level, concourse level and platform level.

4.3.3 Stations shall be constructed on central piers in the road.

4.3.4 Contractor may elect to combine concourse and platform level, with a defined paid area. In this case a track overpass /underpass would be required.

4.3.5 Stations shall be covered for rain protection.

4.3.6 Stations shall be user friendly and barrier free for handicapped

4.3.7 At nominated stations park and ride facilities shall be provided.

4.3.8 Monorail passengers will arrive at and depart from the stations via multiple modes including: pedestrian, two-wheeler car taxi, bus.

4.3.9 Access to concourse and platform shall be from pavement, stairs, escalators and lifts for handicapped.

4.3.10 Direct access from concourse via walkways to commercial developments may also be provided.

4.3.11 Where practical within the ROW a vehicle drops off area shall be provided.

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4.3.12 Emergency Vehicle access shall be provided

4.3.13 The Monorail stations shall be tastefully designed for local culture and flavor, functional aesthetics, architecturally pleasing, user friendly, energy efficient and with station architecture that is site specific and environmentally compatible. Clear signage and way finding shall be provided.

4.3.14 Wherever space permits, stations can be designed to undertake commercial kiosks in the unpaid and paid areas of the concourse respectively.

4.3.15 Facilities for staff shall be provided. It is envisaged that each station is likely to have a Station Manager, who shall be responsible for all facets of operation and commercial activities, 2 to 3 ticketing staff, security / platform staff, plus cleaning staff.

4.3.16 Station Control Room (SCR) and ticket office shall be provided in each station.

4.3.17 A bilingual Passenger Information System shall be provided.

4.4 Specifications and Standards

4.4.1 Access Modes

4.4.2 The Stations shall be designed in a manner that enables Users to arrive at and depart from the Stations via the following modes:

i. Pedestrian walk-in;
ii. Scooter, Motorcycle, Cycle and Car with parking facilities.
iii. wherever feasible;
iv. Bus; and
v. Taxi, Auto-rickshaw, Motorcycle-rickshaw and Car drop-off.

4.4.3 Site Circulation Parameters

4.4.3.1 Site circulation and Station circulation shall be separated vertically, in most cases, with the Station above the site circulation.

4.4.3.2 An entrance shall be visible from the bus-loading area, if possible and at a minimum shall be easily accessible from the passenger loading area. Covered access from the vehicle drop-off areas to the Station entrance shall be provided.

4.4.3.3 Station and property development circulation shall be separated as far as possible.

4.4.3.4 Site circulation layouts shall be simple and direct, allowing easy orientation for drivers and facilitating movement of pedestrians.

4.4.3.5 Station parking areas, shall be laid out so that queuing for parking will not obstruct bus circulation or automobile and taxi drop-off areas.

4.4.3.6 Where conditions permit, roadways shall be one-way circulation, with turning loops eliminating intersections and conflict movements within the site.

4.4.3.7 Sightlines at merges or intersections shall be left clear.

4.4.4 Station Architecture

The Stations being windows to the service, shall be visually appealing, tastefully

designed reflecting local culture and flavor, functional aesthetics, user friendly, energy efficient and with a Station architecture that is site specific and environmentally compatible. The design should identify significant architectural features which should be taken into account.

4.4.5 Station Quality

The considerations in a quality design are:

i. Aesthetic and functional qualities are to be incorporated;
ii. appropriate roof and ceiling heights should be provided;
iii. unobstructed large span structural systems should be adopted;
iv. facades and other structural systems should provide adequate weather protection and natural light;
v. The design should make efficient use of space which aesthetically integrates lighting, communications, ventilation; and electrical and mechanical systems; and Provision for free and safe flow of Users, with adequate queuing space at all passenger service areas without disrupting normal User flow.

4.4.6 Spatial Vertical Clearances

i. All public spaces including stairs and Ramps shall have a minimum ceiling height or vertical clearance of 3 m.
ii. All non-public spaces including stairs and Ramps shall have a minimum ceiling height or vertical clearance of 2.4 m.

4.4.7 Pedestrian Access

4.4.7.1 Direct and safe approaches for pedestrians shall be provided into the Station.

4.4.7.2 Pedestrians shall have the right-of way over vehicle at crossings of internal roadways.

4.4.7.3 Pedestrian crossings shall have good visibility for both pedestrians and road vehicle drivers.

4.4.7.4 Pedestrian crossings at streets wider than four traffic lanes shall have a refuge area in the median.

4.4.7.5 At all pedestrian crossings, kerb cuts shall be provided for persons with special needs. All kerb cuts shall be marked with signs.

4.4.7.6 Pedestrian crossings shall be emphasized with textured pavement of crosswalk marking. Where major pedestrian paths cross roadways, the paving material, or a material of similar colour, shall be carried across the roadway to emphasize the pedestrian right-of-way.

4.4.7.7 The parking pattern shall allow pedestrians to walk toward the Station with a minimum of traffic crossings.

4.4.7.8 Dimensions of pedestrian walkways and crosswalks shall comply with The International codes and standards.

4.4.8 Vehicular Access

4.4.8.1 Vehicular entrances shall be located to distribute traffic loads evenly over the site.

4.4.8.2 Vehicles shall enter from secondary roads, wherever possible, with provision of space for short waiting periods.

4.4.8.3 Entrance and exit from Station parking shall be separated, where possible, from those of bus and auto drop-offs.

4.4.8.4 Emergency vehicle access shall be provided to all building structures, especially the Station entrances. Station access roads and parking lot perimeter roads shall accommodate emergency vehicles including fire trucks.

4.4.9 Station Parking

4.4.9.1 Where Station parking is at-grade, landscaping shall be used to sub-divide the parking area and to provide shade.

4.4.9.2 Entrance in the parking area shall be on a pay per entry basis. Entrance and exit gates shall be operated by means of a card validated at the parking check points. Drop off lanes can be without charge.

4.4.9.3 Parking designated for persons with special needs shall be located as close to the Station entrances as possible. Roadway crossings from these spaces to the Station

entrance shall be kept to a minimum.

4.4.9.4 All public parking places shall be numbered.

4.4.9.5 Bus lay-bys shall be provided at Stations to facilitate User transfers to bus transport in the event of Emergency or Train failure. Additional bus lay-bys shall be provided as per site specific requirements and demand forecasts.

4.4.9.6 Subways, stair and escalator space requirements shall conform to NFPA 130.

4.5 Design Requirements

Station Configurations

4.5.1 Stations shall be designed for peak flow of User traffic and the requirements of future Train services and shall follow NFPA 130.

4.5.2 The station building shall be as far as possible should be designed for Green Building rating by International good industry practice.

4.5.3 The following elements are to be designed and provided for:

i. Adequate ventilation and lighting for the road users below;
ii. Ticket counters/Automatic ticket vending machines (should be provided before access to gates/validators);
iii. User amenities to help in decentralizing customer volume and to facilitate easy maintenance;
iv. Space for passenger operated machines (Automatic Ticket Dispensing Machines) for future;
v. Passenger kiosks and commercial kiosks;
vi. Customer service center;
vii. Emergency evacuation exits;
viii. AFC system and AFC gates;
ix. Parking and circulation area for traffic integration;
x. Station entrances and exits to allow for entry/exit of Users under normal and emergency conditions, with doors opening both ways;
xi. Escalators, lifts and stairs;
xii. On line Passenger Information System including digital clocks and PA (Public Address) system;
xiii. Signage's, name boards and route maps;

xiv. Requirements for physically challenged Users and senior citizens;

xv. Landscaping works;

xvi. Security alarm and fire protection system to be located in Station manager's room complete with fire- fighting equipment as per requirement of concerned authorities;

xvii. Lightning protection and primary surge protection system for incoming power supply to the building and for sensitive relays and electronic equipment.

4.5.4 Design Features for General Station Security

4.5.5 The Station design should be such as to promote real and perceived security for the Users.

4.5.6 The following features shall be incorporated in Station design to maximize safety and security of the system and its users.

4.5.7 Stations shall be open, spacious and well-lit so as to maximize visibility of people, platform, other building/structure areas, and parking areas.

4.5.8 Hiding areas shall be minimized.

4.5.9 Access points to parking area shall be minimized.

4.5.10 Adequate lighting shall be provided, minimizing shadows and avoiding dark areas.

4.5.11 Shatter guard protection shall be provided for glass windows/doors. Transparent material for door of the cabin of stair wells and elevators shall be provided.

4.5.12 Planning shall provide for open lines of sight to as much area as possible.

4.5.13 All passenger routes of travel shall be clearly defined, and shall be direct, well-lit and with good visibility.

4.5.14 The Station design shall conform to the following standards:

i. The Persons with Disabilities Act;

ii. Building Code of Pakistan;

iii. NFPA 70-National Electrical Code;

iv. NFPA 72-National Fire Alarm Code; and

v. NFPA 130-Standard for Fixed Guideway Transit and Passenger Rail Systems.

4.5.15 Handicap Accessibility

The Railway System design shall conform to the following reference standards and regulations

i. The Persons with Disabilities Act.
ii. Americans with Disabilities Act (ADA).
iii. ADA Accessibility Guidelines for Buildings and Facilities (ADAAG).
iv. International Building Code.as applicable to Planning and Design Principles;
v. safety and security;
vi. Station layout;
vii. access to Station and circulation;
viii. waiting area and ticketing;
ix. toilets – public toilets to be provided in paid areas;
x. commercial areas;
xi. lighting;
xii. signage and graphics; and
xiii. Furniture fixtures and equipment.

4.5.16 Information Displays

4.5.16.1. Signage's shall be user-friendly and shall provide information essential to Users, engendering a sense of reassurance, security and orientation when entering, exiting or transferring. It shall Guide Users to various Station areas, provide information of the Station and its services and provide information on Train services.

4.5.16.2. Essential public information signage's shall be of retro-reflective high intensity prismatic boards or equivalent.

4.5.16.3. User information shall cover the following as the minimum: Static signage's such as Station name, destination of services, platform number, position of doors of Coaches, way finding signs, direction, entry, and exit;

i. Variable signage's such as real time travel information to customers;
ii. maps and long-term changeable information on scheduled services;
iii. information on the use or operation of a place or system;
iv. intermodal connections;
v. emergency exits; and
vi. Rules of conduct to Users.

4.5.16.4. Major information to Users such as platform number, direction, entry, exit etc. shall be in letters of size not less than 300mm. For other information, size and color code shall be decided in consultation with the TE.

4.5.16.5. All signage's shall have alternate pictorial signage's of same size as the letters.

4.5.16.6. The technical fabrication details for the fixed hardware system shall be in accordance with security requirements.

4.5.16.7. The following principles shall be followed for placement of signage's: User information displays should be so located that Users seeking information have ready access without obstructing free flow of Users; signs shall be placed at decision points, and perpendicular to the line of sight; and signage's shall be placed on the left side of passages including stairs, lifts and escalators.

4.5.16.8. Lighting levels shall be so designed that general lighting does not overpower the light emitted by signage's.

4.5.17 Advertisement

4.5.17.1. Advertisement installations may be installed in public areas and at Station site areas including at inter-modal transfer facilities.

4.5.17.2. Advertisement installations shall not adversely impact operations, station circulation pathways or create safety hazard and shall be compatible with Station design including signage and art installations.

4.5.17.3. The installations shall be of standard sizes with fire resistant/ non-combustible materials.

4.5.18 Platform

4.5.18.1. Platform length must allow safe access to all doors of Trains including door to the driver's cab and shall accommodate the longest Train plus allowance for inaccurate stopping.

4.5.18.2. Minimum 4.0 m wide, side platforms built approximately to the height of the Coach floor and designed to give free visual access along its length shall be provided.

4.5.18.3. Ramps to assist wheel chair users to board/alight Trains shall be provided with step-free access.

4.5.18.4. Platform floor shall have durable, non-slip and visually pleasing finish using heavy duty homogeneous tiles.

4.5.18.5. Roof shall be provided over the entire platform.

4.5.18.6. Platforms shall have a clear head room of at least 3000 mm to structures and platform signs to a width of at least 2000 mm from the platform edge over their entire length. Suspended signs, fittings, and fixtures shall have a minimum clearance of 2.1 m above finished floor.

4.5.18.7. Platform should have clearances as per Schedule of Dimensions.

4.5.19 Emergency Egress

4.5.19.1. Station design should allow safe evacuation of occupants in an Emergency.

4.5.19.2. For egress/fire evacuation measures, the Station design shall meet the requirements for Stations as provided in NFPA 130- latest version Edition, Section-5, Item 5.5 - Means of Egress. Fire detection and suppression shall be generally as per PBC (Pakistan Building Code) latest version.

4.5.19.3. For calculation of occupant load, projected ridership figures or maximum Train load capacities, whichever is more shall be used. Occupancy at the time of evacuation should be based on peak usage with 5 minutes delay to the scheduled Train service in the busiest direction only. Users waiting to board and those normally alighting from the next Train in each direction should be evacuated.

4.5.19.4. Each Station shall have a minimum of two main access/egress points remotely located from one another. There shall be sufficient exit to evacuate the Station occupant load from the Station platform within the time period prescribed as per NFPA 130 standard. The maximum travel distance to an exit from any point on the platform shall not exceed 100 m.

4.5.20 Fire Precautions

4.5.20.1. The choice of materials in public areas of Stations should be such as to keep the fire load and the smoke and toxic gas generation in the event of a fire to the minimum practicable level.

4.5.20.2. An electrical fire alarm should be provided for manual operation by Users/staff, and installed in accordance with International good practices: Code of Practice for Fire detection and Alarm Systems. Public Address System should be protected as per provisions of International good practices:

4.5.20.3. The non-public areas should be provided with a warning cum address system to alert staff inside plant and machine rooms.

4.5.20.4. Firefighting equipment should be provided as per Applicable Law.

4.5.21 Performance Requirements

4.5.21.1. Centralized control of the Station E & Ms.

4.5.21.2. All Stations shall have a dedicated central management unit of all major E&M equipment so that the maintenance staff can have control over them.

4.5.21.3. The equipment under local central command shall include the following as a minimum:

(i) The entrance closing gates of the Station;
(ii) lighting; and
(iii) Escalators and lifts.

4.5.21.4. The local central management unit shall be the relay to the OCC.

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4.5.21.5. For dealing with Emergency, the control should also have the following:

(i) An emergency procedure information system;
(ii) a means of monitoring fire detection systems;
(iii) a means of summoning Emergency services;
(iv) communication system;
(v) public address system;
(vi) a means of monitoring operation of lifts, escalators, ticket barriers and other equipment; and
(vii) CCTV monitoring of all Station areas.

4.6 Elevators, Escalators and Stairs

General

4.6.1. The positioning of escalators, elevators and stairs should be integrated with User flows throughout the Station. These shall be positioned to encourage left hand circulation and minimize conflicting User movements.

4.6.2. Adequate space for queuing shall be provided for all escalators and elevators.

4.6.3. Elevators

4.6.3.1. Elevators with a carrying capacity of not less than 10 Users and designed to accommodate wheel chairs shall be provided. They shall be suitable for service as public service/goods elevators and shall be rated for a minimum of 180 starts/hour.

4.6.3.2. Elevators shall comply with BS-EN 81 and other appropriate international codes and standards and relevant statutory requirements. Elevators shall be type Class A for passenger loading and shall comply with NFPA 101 Fire Life Safety requirements.

4.6.3.3. The elevators shall comply fully with the National Policy for Persons with Disabilities.

4.6.3.4. During a fire situation, the use of elevators shall be prohibited.

4.6.3.5. Elevators shall be electric traction type and machine-room less, gear less arrangement with the traction drive motor and controls mounted within the hoist way of the Elevator at the top landing.

4.6.3.6. Elevators shall comply with BS 7255 – "Code of Practice for safe working of lifts", or equivalent to allow for the emergency release of users at nearest landing. This shall include:

(i) an alarm button at low level in elevator and two-way speech communication with Station control both being controlled from a supply independent of elevator main supply; and

(ii) Emergency lighting and intercom for duration of 3 hours.

a. Elevators shall have Variable Voltage and Variable Frequency (VVVF) drive system.

b. Elevators shall be provided with Lift safety instructions announcement system to facilitate use of elevators by "visually – impaired" Commuters.

c. Elevators shall be equipped with Automatic Rescue Device and electrically operated proximity detector device(s) installed on the leading edge of the car doors to create a three-dimensional zone of protection for the entire height of the door opening.

d. Elevators shall have minimum opening dimensions of 900 mm x 2100 mm and shall be rated for a minimum 1000 kg load. Elevator doors shall be heavy duty and all accessories shall be of the "anti-vandal" type. An intercom system shall be provided

between the Elevator and the Station Control Room (SCR) for emergency communication.

e. Elevators with single access shall include a laminated framed safety mirror in the rear panel of at least half of the elevator height, for ease of reversing of wheel chairs from the elevators.

f. The control system shall be microprocessor based to control the Elevator position and operating sequence logic and have the facility for transmitting function and fault data. Monitoring and control of the Elevator operation shall be through the system of Station Management Systems (SMS).

g. Operating panel buttons shall be a minimum of 50 mm diameter and shall also have the operation of the button superimposed on it in Braille. A ventilation opening or duct to open air of area 0.3 m² or, 3.5 % of the ross-section of the elevator shaft, whichever is greater shall be provided at the top of each elevator shaft.

h. The ventilation openings shall have a minimum free area of 0.3 m², or 3.5% of the cross section of the elevator shaft, whichever is more.

i. "Guidelines and space standard for Barrier free Built Environment for Disabled and Elderly Persons".

j. Guidelines for safety of elevator as per International best practices.

4.6.4. Escalators shall be provided at all to assist vertical User traffic flow between street level, concourse and platforms to meet the requirement of the Key Performance Indicators and NFPA-130.

(i) Capacity and travel speed of escalators shall be computed as under:

a. Capacity – 3000 persons per hour (minimum)

b. Travel Speed – 14.63 m/min (vertical component of travel speed)

(ii) Escalators shall be used as stairways in stationary position during an Emergency for Station evacuation. All escalators shall be of a standard pattern, two lanes

wide, having a minimum width of 1000 mm with a width at hip height of 1200 mm. They shall have four (4) flat treads at entry and exit and be equipped with double safety brushes on either side.

(iii) Escalators shall be reversible, monitoring and control of the operation being through the system of SMS.

(iv) Escalators shall be designed for continuous operation in either direction for a period of not less than 20 hours per day, seven days per week, at temperatures varying between -10 and +45°C.

(v) Materials of construction for escalators exposed to high ambient temperatures and dusty and dirty conditions shall be suitable for these aggressive conditions.

(vi) Escalators shall comply with BS-EN 115. They shall be suitable for service as public service escalators /passenger conveyors. The angle inclination of the escalators shall be not more than 30° to the horizontal with two tread band speeds of 0.5 and 0.65 m/s. During periods of no occupancy, the speed shall automatically reduce to 0.2 m/s and come to halt if not occupied for 5 minutes.

(vii) Access shall be provided to the escalator underside for cleaning purposes.

(viii) Operation of escalators (starting and stopping) shall be controlled from upper or lower level and from the Station Control Room.

(ix) Escalators shall be located along the normal and direct path of User circulation and be easily identifiable.

(x) Escalators shall be so designed that routine operation and maintenance can be performed with minimum disruption to station functioning.

(xi) Escalators shall conform to BS-EN 115: Safety rules for the construction and installation of escalators and passenger conveyors.

4.6.5. Stairs

(i) All steps in a flight of stairs should have the same dimensions.
(ii) Tread of steps should be minimum 300 mm.
(iii) Riser shall not be more than 150 mm.
(iv) Hand rails shall be provided at a height of about 900 mm.
(v) Step noses shall be rounded and color contrasted.

(vi) Minimum width of stairs shall be 1500 mm.

(vii) Minimum head room over a stair shall be 3.0 m.

(viii) The stairway must be well lit. When a stair runs along-side of an escalator, the angle of stair nosing's shall be aligned with those of the escalator and should be below the line of the escalator treads.

(ix) For fire escape stairs, relevant provision of NFPA 130 shall apply.

4.7 Basic Requirements

Safety

4.7.1. Fire Resistance and Smoke Generation

Use materials with minimum burning rates, smoke generation, and toxicity characteristics for Station finishes, consistent with requirements of Fire/Life Safety requirements.

4.7.2. Attachment

Eliminate hazard from dislodgment due to temperature change, vibration, wind, seismic forces, aging, or other causes, by using proper attachments of adequate bond strength.

4.7.3. Skid-resistant (for walking surfaces)

Use floor materials with skid-resistant qualities. Entrances, stairways, platform edge strips, and areas around equipment should have flooring having high skid-resistant properties.

The following static coefficients of friction shall be provided as a minimum: Coefficient of Friction

(i) Public horizontal surfaces-0.6;

(ii) non-public horizontal surfaces, interior-0.5;

(iii) non-public horizontal surfaces, exterior-0.6;

(iv) stairs, Ramps, sloping sidewalks-0.8; and

(v) Area around equipment-0.6.

4.7.4. Contrast

Platform edge strips shall be of visually-contrasting material.

4.7.5. **Durability**

Use materials with wear resistance, strength, and weathering qualities consistent with their initial and replacement costs, and their location in the Station. The materials must maintain good appearance throughout their useful life. Materials shall be colorfast.

4.7.6. **Ease of Maintenance**

(a) Cleaning

Use materials which do not soil or stain easily, which have surfaces that are easy to clean in a single operation, and on which minor soiling is not apparent. Materials shall be cleanable with standard equipment and cleansing agents.

(b) Repair or Replacement

Use materials which, if damaged, are easily repaired or replaced without undue interference with the operation of the System. Spare materials shall be available for tile and other unit materials. (Say quantity of approximately two percent of the total used.).

4.7.7. **Resistance to Vandalism**

Materials and features that do not encourage vandalism and are difficult to deface, damage or remove shall be provided.

All surfaces exposed to the public are to be finished in such a manner that the results of casual vandalism can be readily removed with normal maintenance techniques. The Contractor is required to describe procedures for removal of more serious defacement for each finish in public areas and within 3 m of the floor surface.

4.7.8. **Aesthetic Qualities**

Create feeling of warmth, attractiveness, quality, and civic pride in the facility.

4.7.8.1. **General Criteria**

Certain general criteria for finish materials are indicated below to achieve the goals

outlined above as well as those, which would result in a high level of illumination, good cleanliness levels, and the appearance of high cleanliness.

4.7.8.2. Surface

Applied materials shall be hard, dense, non-porous, non-staining, acid and alkali resistant, of long life and low maintenance. Surfaces within reach of the public, up to 3 m above the floor level may be finished with applied materials.

4.7.8.3. Color

Colors shall aid maintaining high illumination levels, with sufficient contrasts and accents to provide visual interest and warmth and to conceal minor soiling to provide uniform contrast ratio in all Stations, a 100 mm wide yellow warning strip shall be placed adjacent to the 500 mm paver at platform edge.

4.7.8.4. Texture

Smooth surfaces should be preferred over rough ones for ease in cleaning and being less prone to catch settling dust. Rough surfaces are desirable where a skid resistant feature is important, and are acceptable where surfaces are difficult to reach.

A distinctive texture shall be provided at the platform edge when open or operable to the tracking to enable the blind to sense the platform edge.

4.7.8.5. Unit Size

Unit should be large enough to reduce the number of joints yet small enough to conceal minor soiling and scratches and to facilitate replacement if damaged. Monolithic materials may be used if they have inherent soil hiding characteristics that can be easily repaired without the repair being noticeable.

4.7.8.6. Joints

Joints should be small, flush, limited in number and using the best possible materials. Horizontal joints should not be raked but should be flush or tooled concave. Monolithic materials should have adequate control joints and expansion joints at the proper spacing in order to prevent surface cracking.

4.7.8.7. **Cost**

Materials shall be selected for long life, low maintenance, easy to replace and overall aesthetic and functional qualities.

4.7.8.8. **Availability**

Materials selected should be readily available.

4.7.8.9. **Proprietary Materials**

Proprietary items shall only be used where it is established that no other materials would meet the particular design requirements.

4.7.8.10. **Installation Standards**

Materials shall be detailed and specified to be installed in accordance with industry standards and manufacturer's printed directions.

4.7.8.11. **Flammability**

Interior finishes including doors/ windows shall meet requirements of the code and the fire/life safety requirement:

(i) Finishes for all protected exit ways shall be Class A as defined by NFPA 101. Platforms, mezzanines, corridors, stairways, and vestibules shall be considered exit ways;

(ii) Finishes in all other areas shall be Class B as defined by NFPA 101; and

(iii) Combustible adhesives and sealants may be used when they meet the requirements stated above.

4.7.8.12. **Reference codes and standards**

The following codes and standards shall be adopted:

(i) Building Code of Pakistan;

(ii) National Fire Protection Association;

(iii) ASTM Standards in Building Codes;

(iv) International Standards Organization (ISO);

(v) American Society of Civil Engineers (ASCE);

(vi) American National Standards Institute (ANSI);

(vii) British Standards (BS);

(viii) American Architectural Manufacturers Association (AAMA); and

(ix) NFPA Codes.

4.8 Landscaping at Elevated Station Complex and Guideway Alignment

Landscaping of all areas within the stations as well as corridor shall be undertaken in consultation with the TE if required.

4.8.1 Rail System Alignment

Suitable landscaping and appropriate vegetation along the route of the viaduct shall be provided to improve the aesthetic appearance if required. Shrubs, trees and ground cover suitable to their location and the city environment shall be provided to improve and soften the impact of the structure on the city scene after completion of construction.

4.8.2 Station Areas

Appropriate planting should be provided to enhance and soften the appearance of the Station box, the approach structures and the inter change areas.

4.8.3 Depot Areas

Appropriate planting should be provided in the Depot area.

4.8.4 Rain Water Harvesting

The rain water harvesting of the runoff water within the Station areas shall be planned as per the policy, rules, norms, requirements and methods of the Federal and Punjab government.

4.8.5 Fencing

The Contractor shall provide appropriate vandal-proof perimeter fencing at suitable locations, determined in consultation with the TE, along the entire reserve boundaries at both sides of the Rail System including Depots, Stations, installations, buildings etc.

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4.9 Environmental Protection Requirements

4.9.1 General

The Contractor shall implement the environmental protection requirements applicable to the Works.

4.9.2 Noise

4.9.2.1 The design of the permanent works shall comply fully with the following requirements:

(i) All parts, including non-structural parts, of the structures shall minimize as far as practicable the radiation of noise due to vibration caused by the passage of Trains. Particular attention shall be paid to the minimization of noise at the low end of the acoustic frequency spectrum; and

(ii) Walls and slabs intended to contain airborne noise from the Trains shall be of concrete of 200 mm minimum thickness and shall be purpose-made, non-combustible and vibration absorbing / dampening, and shall utilize GRC panels (Glass fiber Reinforced Concrete) or similar construction.

4.9.2.2 Allowable Range of Noise levels:

The allowable range of noise levels for different land uses are:

(i)	Residential:	50 – 70 dbA
(ii)	Business and Commercial:	75 dbA
(iii)	Hospitals:	60 dbA
(iv)	Rural:	45 – 50 dbA

The point for measurement of the noise level shall be as per relevant standards.

4.9.2.3 Provision of Noise barriers:

Noise barriers shall be provided in lengths of monorail alignment passing through sensitive residential or hospital zones

Noise barriers shall be installed where the predicted increase in noise level from the system is detectable i.e. it generates noise at least 3 dBA higher than the measured ambient prior to project implementation and the predicted Community noise level (CNEL) increase over a 24-hour period is more than 1dBA. The choice of barrier type

and their disposition along the alignment shall be closely related to aesthetics of the structures

4.10 Platform Screen Doors (PSD)

4.10.1 General

4.10.1.1 All materials and equipment to be provided for the platform screen door system shall be of proven design and shall be provided by a manufacturer who has accomplished platform screen door system projects for a period of at least ten (10) years unless otherwise approved by The Engineer.

4.10.1.2 The PSD system shall include structural frame, sliding screen door, fixed screen, hinged screen, emergency end walkway door, sensors, control system, power supply and other necessary facilities.

4.10.1.3 In elevated stations, the PSD system shall comprise transparent half height barriers with structural frames extending for the full length of the station platform sufficient for the final monorail train set and from platform floor level up to a height of 1.3m It shall be floor mounted and entirely self-supporting.

4.10.1.4 Pairs of sliding screen doors (door sets) shall be installed in the structural frames and located opposite each set of train passenger doors.

4.10.1.5 A series of fixed screens shall be installed between each pair of sliding screen doors with the exception of the areas located alongside the front half of the leading Vehicle and the rear half of the last Vehicle

4.10.1.6 Hinged screens (swinging inwards towards the platform) shall be provided alongside the front half of the leading Vehicle and the last Vehicle. These shall be capable of being opened from the trackside by means of a panic bar to facilitate detrainment in the event of emergency condition.

4.10.1.7 At each end of the platform, a platform screen return shall be provided and within this an emergency end walkway door shall be provided giving access between the public area of the platform and the Restricted Area.

4.10.1.8 The PSD system shall include all the associated control and operation mechanisms for the safe operation of the platform screen doors.

4.10.1.9 The PSD system shall be designed in conjunction with the Signalling system such that the number and location of platform screen doors being opened in a fail-safe manner to correspond to the number and location of the Train doors regardless of Train length.

4.10.1.10 The PSD system shall comply with the appropriate requirements of NFPA 130, latest version, and in particular the requirement that emergency egress

from the train to the platform shall be possible regardless of the stopping position of the train.

4.10.1.11 The structural design of the PSDs shall take into account the following air pressure effects:

i) When Trains enter into and depart from or pass through any station, also taking into consideration the most onerous operation speed and the physical characteristics of the Train and the Civil Infrastructure.

ii) Wind loadings for elevated stations.

4.10.1.12 The PSD system shall prevent unauthorized person access from the station platforms to the Guideway.

4.10.1.13 Each fully equipped door set shall consist of bi-parting, power operated sliding screen doors.

4.10.1.14 The sliding screen doors shall be synchronously controlled throughout the length of the platform.

4.10.1.15 The sliding screen doors shall provide a clear opening width of not less than 600mm wider than the clear opening width of the Vehicle doors and a clear opening height of 1.3 meters above finished floor level.

4.10.1.16 Each door mechanism shall incorporate a mechanical latch, which shall automatically engage when the door is fully closed, preventing the doors from being opened by the passengers on the platform.

4.10.1.17 The mechanical latch shall release automatically when the door opening mechanism is operated.

4.10.1.18 The PSD system shall be designed to prevent any corrosion resulting from any stray current.

4.10.1.19 With the exception of the structural frame and glass panels, replacement or rectification of faults of all components, sub-assemblies, or major assemblies shall be accessible entirely from the platform side and shall be capable of maintenance or replacement within a maximum time period of three (3) hours.

4.10.1.20 If glass panels cannot be replaced from the platform side, it shall be possible to install a temporary safety screen from the platform side and such temporary safety screens shall be provided at every station.

4.10.1.21 All electrical equipment interconnections shall be made with mechanically retained plugs and sockets, and all terminations shall be clearly marked.

4.10.1.22 When similar plugs are situated adjacent to each other they shall be constructed to prevent a plug being inserted into the incorrect socket.

4.10.2 PSD Safety

4.10.2.1 The Contractor shall as a minimum prepare a hazard analysis and design safety study report for System Assurance.

4.10.2.2 No part of any sliding screen door or its control system or any other component used in the PSD system shall be capable of causing injury to passengers or personnel as a result of door operation.

4.10.2.3 Particular attention shall be paid to detecting trapped obstacles in the sliding screen doors.

4.10.2.4 No single defect or failure of any part of the PSD system shall produce a situation capable of causing injury to personnel.

4.10.2.5 No spurious electrical signals shall cause any sliding screen door to be activated accidentally.

4.10.2.6 The PSD system shall incorporate sliding screen door monitoring devices for proving that all the sliding screen doors and hinged screens are closed and latched.

4.10.2.7 The mechanism to check the status of the sliding screen doors and hinged doors shall be designed to be Safety Critical.

4.10.2.8 Once all the sliding screen doors and hinged screens have proved to be closed and

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latched, a corresponding signal shall be transmitted to the Train, via the Signalling system, to enable train movement.

4.10.2.9 An additional closed and latched signal shall also be used to illuminate a corresponding platform indicator.

4.10.2.10 The position of the platform indicator shall be located to ensure that it can be clearly observed by the train drivers from their seated position.

4.10.2.11 The closed and latched status of all sliding screen doors shall be continuously monitored by the PSD system.

4.10.2.12 In the event of a failure causing the loss of the 'closed' or 'latched' signal, even though it has been ascertained that the sliding screen doors and hinged screens are physically closed, a mechanism shall be provided to enable authorized staff to temporarily override the door status.

4.10.2.13 A manual facility shall be provided on the platform, accessible only by the authorized staff and adjacent to of the door controls, to transmit a pseudo 'closed' and 'latched' signal to the Train, via the Signalling system.

4.10.2.14 The pseudo signal shall be identical to the genuine 'closed' or 'latched' signal, to enable the Train to depart from the station.

4.10.2.15 Use of the pseudo facility shall be recorded.

4.10.2.16 Once the Train has completely left the station zone, following an activation of the pseudo signal, the PSD system shall immediately cancel/reset the pseudo signal, to ensure that the monitoring circuit reverts to the normal condition, including the fault condition if any.

4.10.2.17 Each time the pseudo signal is activated a corresponding signal shall trigger an alarm at the SCR.

4.10.2.18 Sliding screen door and hinged screen monitoring alarms shall be implemented through the SCADA system, with alarm presentation as detailed in the Particular Specification for SCADA.

4.10.2.19 The hinged screens shall be a hinged door that opens inwards towards the platform.

4.10.2.20 The lock assembly shall be fitted with an approved emergency handle or push bar on

the track side, to enable quick passenger access to platform in the event of emergency condition.

4.10.2.21 It shall be possible for authorized persons on the platform side to manually unlock, by means of a key, and open the hinged screens without activating the emergency handle or push bar.

4.10.2.22 The emergency end walkway door shall be a hinged door that opens in both directions and shall be locked when closed.

4.10.2.23 The lock assembly shall be fitted with an approved emergency handle or push bar on the emergency walkway side, to enable passengers being evacuated from the track to gain access to the platform from the emergency walkway.

4.10.2.24 Once the emergency handle or push bar has been activated it shall remain in the activated position until reset by means of a key.

4.10.2.25 It shall be possible for authorized persons on the platform side to manually unlock, by means of a key, and open the emergency walkway door, without activating the emergency handle or push bar.

4.10.2.26 The PSD system shall maintain all metallic parts exposed to passengers or station personnel at an equal electrical potential to the body of the Train.

4.10.2.27 To prevent possible electric shock due to a potential difference between the train body and the PSDs, all metallic parts of the PSDs shall be electrically bonded to the proper earthing system.

4.10.2.28 The PSD system shall be insulated from system earth.

4.10.2.29 The Contractor shall provide a specification and type test results to demonstrate that the glass to be provided meets the requirements of the hazard analysis.

4.10.3 PSD Passenger Interface

4.10.3.1 The sliding screen doors shall not exert a combined closing force greater than 140 Newton's and/or a closing kinetic energy greater than 9.5 Joules.

4.10.3.2 The limiting value of sliding screen door movement kinetic energy for the last 150mm of door travel shall be less than 2 Joules per door.

4.10.3.3 The time for unlatching and opening shall be no longer than 3.5seconds including response time.

4.10.3.4 The time for closing and latching shall be no longer than 3.5 seconds including response time.

4.10.3.5 Each door opening or closing speed shall not vary by more than +/-10% when compared with the speed of adjacent doors on the same platform. The opening/closing speeds of each sliding screen door shall be capable of individual adjustment.

4.10.3.6 During all operating modes and under all power supply conditions, sliding screen door movements shall be smooth, controlled and devoid of jerks or any violent motion.

4.10.3.7 The sliding screen doors shall include an obstruction detection system, which shall be capable of detecting any obstruction causing a gap of more than 20 mm between a pair of sliding screen doors.

4.10.3.8 In the event of an obstruction causing a gap of less than 20 mm becoming trapped, and the sliding screen doors closing, the compression of the sliding screen door seals shall be such as to allow the obstruction to be removed.

4.10.3.9 If a door set whilst closing detects an obstruction prior to achieving locked status according to the door monitoring device, then the door set shall reopen to 0.5 meters to enable removal of the obstruction.

4.10.3.10 Following a short delay, the door set shall attempt to close again. In the event that the door set fails to close following 3 consecutive attempts, further door set movement shall cease on the offending door.

4.10.3.11 In the event that a door has stopped movement following this condition, further door set closure shall require another activation of the door close command.

4.10.3.12 The sliding screen doors shall not slam after removal of an obstruction or on loss of power supply.

4.10.3.13 The number of attempts that door sets make to close in the event of an obstruction shall be adjustable from 1 to 20.

4.10.3.14 The minimum reopening distance shall be adjustable from 0.3 meters to full width.

4.10.3.15 A means shall be provided on the trackside of each door set, whether fully equipped or not, for the passengers to easily release the latch and open a door set so as to gain access to the platform in an emergency.

4.10.3.16 The manual release of the latch shall be achieved without the use of any tools or key or the need to break any seal.

4.10.3.17 It shall be possible for authorized persons on the platform side to manually release the latch and open any door set using an approved key.

4.10.3.18 No component failure shall inhibit manual opening of any sliding screen door when the release mechanism is operated.

4.10.3.19 The gap between the sliding screen doors and the Train shall be sized to prevent any person passing between the sliding screen doors and the Train.

4.10.4 Power Failure to PSD

4.10.4.1 In the event of failure of the normal power supply to the PSD system, the PSD system shall continue to operate from the central uninterruptible power supply provided at each station for a period of not less than one (1) hour.

4.10.4.2 In the event of loss of all power supply, the sliding screen doors shall remain in their same status (i.e., if the sliding screen doors were open, they shall remain open, and similarly if they were closed, they shall remain closed.

4.10.4.3 In the event of failure of the normal power supply and/or the UPS supply to the PSD system, the mechanism to manually unlatch the sliding screen doors, either by an authorized person on the platform side or from the trackside, shall not be affected.

4.10.5 PSD Opening and Closing Operation

4.10.5.1 When a Train is correctly positioned at a platform, the PSD system shall receive door command signals, which originate from the Train via the Signalling system, to either open or close the sliding screen doors.

4.10.5.2 The open and close command signals will correspond with the operation of the train passenger doors, ensuring that the train passenger doors are synchronized with the

sliding screen doors.

4.10.5.3 The opening operation of the sliding screen doors shall be synchronized with the train passenger doors following a short delay, provided by the Train, ensuring that the train passenger doors open first.

4.10.5.4 Similarly, the closing operation shall also be synchronized with the train passenger doors to ensure that the train passenger doors close first, again following a short delay provided by the Train.

4.10.5.5 The time difference of both opening and closing of the sliding screen doors, compared with the operation of the train passenger doors, shall be identical on every station.

4.10.5.6 In the event of a signal transmission failure, preventing the Train from transmitting door control commands, local means shall be provided on the platform, accessible only to the authorized staff, to manually activate either an open or close command of the sliding screen doors. In the event that a local door command is activated, a corresponding message shall be transmitted to the OCR.

4.10.6 PSD Door Monitoring

4.10.6.1 Each door set shall be assigned and marked with an individual door number. In the event of a door set failure, a corresponding message shall be triggered in the OCR identifying a failure with the door number and the relative platform location.

4.10.6.2 The number sequence allocated for each door set shall be identical on each platform and at each station.

4.10.7 PSD Sliding Screen Door Open Indicator Light

4.10.7.1 Each sliding screen door shall include an associated ‘door open’ indicator light, which shall be amber in colour, that shall be illuminated when the sliding screen door is open and extinguished when the sliding screen door is proved closed and latched and flashing when the sliding screen door is moving.

4.10.7.2 The indicator shall be placed in a position above the associated sliding screen door and shall be clearly visible to the station personnel when standing at the emergency walkway doorway.

4.10.8 PSD Sliding Screen Door Monitoring Devices

4.10.8.1 Sliding screen door monitoring devices shall be positioned to ensure that they are not affected by displacement of the sliding screen door, or by normal wear of any part of the sliding screen doors in service.

4.10.8.2 The sliding screen door monitoring device shall detect and prove that the sliding screen doors are fully closed.

4.10.8.3 Such devices shall be capable of detecting any obstruction causing a gap of 10 mm or greater and so preventing the sliding screen door closed and latched status from being achieved.

4.10.8.4 The indication of all doors closed and locked shall be repeated in the SCR for the fully equipped and controlled door sets on each platform face.

4.10.8.5 A separate indication shall be provided in the OCR for door open status for the remaining door sets that are not fully equipped and controlled together with an alarm to indicate that one or more of these sliding screen doors has been manually released and opened either from the trackside or the platform side by station staff.

4.10.9 PSD Out of Service Indicator Light

4.10.9.1 Each sliding screen door shall also incorporate an additional red status indicator light to identify either an 'out of service' condition or malfunction on that sliding screen door e.g. failure to open or close when instructed.

4.10.9.2 The 'out of service' indicator light shall be located so as not to be confused with the 'door open' indicator.

4.10.9.3 In the event that a sliding screen door is 'out of service', a remote indication of the 'out of service' condition shall be transmitted to the SOR.

4.10.10 PSD Hinged Screens

4.10.10.1 Each hinged screen shall be fitted with a monitoring sensor that shall trigger an alarm at the OCR, in the event that any hinged screen is opened.

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4.10.10.2 Each hinged screen shall also incorporate an additional red status indicator light to facilitate its rapid identification in the event that it is detected as being opened or its monitoring sensor has become faulty.

4.10.10.3 The sensors shall also be interfaced to the CCTV system to cue the relevant camera, in the event of a trigger, to facilitate rapid visual evaluation from the OCR.

4.10.11 PSD Emergency End Walkway Door

4.10.11.1 Each emergency end walkway door shall be fitted with a monitoring sensor that shall trigger an alarm at the OCR, in the event that any emergency walkway door is opened or its monitoring sensor has become faulty.

4.10.11.2 The sensors shall also be interfaced to the CCTV system to cue the nearest camera, in the event of a trigger, to facilitate rapid visual evaluation from the OCR.

4.10.12 PSD Status Monitoring and Alarms in OCR

4.10.12.1 The Contractor shall provide a means of monitoring PSD status in the OCR at each station.

4.10.12.2 It shall incorporate an audible alarm to draw the attention of the operator when an unexpected event occurs.

4.10.12.3 It shall also incorporate a simple means of alarm acknowledgement for the operator to silence an incoming alarm.

4.10.12.4 The use of a SCADA workstation located in the OCR for this purpose is preferred.

4.10.13 PSD Door set Isolation

4.10.13.1 Each door set shall be provided with a manual isolation device, which shall be used to mechanically lock the door set 'out of service', isolate the power supply and bypass the system monitoring for closed and latched status.

4.10.13.2 The manual isolation device shall also prevent the respective door set from being opened by normal means, including the trackside release mechanism.

4.10.13.3 The manual isolation device shall be capable of locking a door set in either the closed or open position, with no effect on the operation of any other door set.

4.10.13.4 Access to the manual isolation device shall be achieved by means of a lockable cover requiring the use of an approved key.

4.10.13.5 The key shall not be capable of being removed when in the 'unlock' position.

4.10.14 PSD Structural Integrity and Durability

4.10.14.1 The structural works shall include all the elements required to support, house or frame the PSD installation.

4.10.14.2 The structural frame shall be designed to resist torsion, lateral and vertical loading to prevent excessive deflection in any direction.

4.10.14.3 In the case of an elevated station with half height barriers, the structural frame shall be connected only to the platform floor and shall be entirely self- supporting.

4.10.14.4 Sliding screen doors shall be adjustable in the event of any long-term vertical loading on support elements causing vertical downward deflections of up to 2 mm maximum.

4.10.14.5 The door weight shall be kept to a practical minimum and shall not exceed 100 kg including the running gear and ancillaries.

4.10.14.6 The installation of the PSD (Platform Screen Door) system shall accommodate the constructional and movement tolerances of the supporting and surrounding structures.

4.10.14.7 The design of the PSD system shall be such that the system as installed will resist all expected combinations of loading conditions, throughout the Service Life of the installation.

4.10.14.8 As a minimum the PSD system shall provide a satisfactory door operation when subjected to any combination of the following design loads:

i) Crowd loading pressure of 500 Newton's/ metre² at a height of 1.125 m without any deformation or reduction in operating performance, and a pressure of 1500 Newton's/ metre² without rupture or permanent damage

ii) Train generated air pressure loading when Trains enter into and depart from or pass through any station.

4.10.14.9 The Contractor shall carry out an analysis of the design value to be adopted taking into consideration the most onerous operation speed and the physical characteristics of the Train and the Civil Infrastructure.

4.10.14.10 At least 300,000 operations per year, associated with the entry and departure or passing through of a Train at a station shall be considered.

4.10.14.11 The design of the PSD system shall also ensure that no permanent deformation is caused from the effects of cyclic and repetitive loading associated with crowd load, impact, wind and/or train movements over the Service Life of the PSD installation.

4.10.15 PSD Architectural Treatment

4.10.15.1 The PSD system shall be constructed of robust, maintenance-free and easily cleaned materials.

4.10.15.2 The materials used in the PSD system shall:

i) Not introduce a significant fire load into the station

ii) Not be a cause of flame spread

iii) Be constructed of materials, which minimize smoke and heat emission and shall not generate toxic gases during fires.

4.10.15.3 The fire resistance shall be achieved by the use of material of limited combustibility as defined in NFPA 130 and shall be acceptable to the fire services department.

4.10.15.4 The sliding screen doors and structural frame shall be equipped with glazed panels which may be stiffened horizontally with a middle rail, not more than 100 mm wide, located approximately 1050 mm above the finished floor level.

4.10.15.5 The glazing shall be secured by a removable beading to facilitate replacement from the platform side.

4.10.15.6 The design of the header box shall not preclude its use for displaying route maps and advertisements.

4.10.15.7 Where control equipment is located in separate equipment cubicles, this equipment shall be easily accessible from the platform for operation and maintenance purposes without requiring a track possession but secured against unauthorized access by means of lockable doors.

4.10.15.8 The door thresholds shall be flush with the platform floor finished surfaces.

4.10.15.9 The thresholds shall be wear resistant, non-skid and readily cleaned.

4.10.15.10 All doors shall be constructed of toughened glass and be compliant with relevant International Standards Practices.

4.10.16 PSD Signage

4.10.16.1 The Contractor shall provide all platform screen doors with appropriate signs relating to key features and the information requirements of passengers associated with the platform screen doors.

4.10.16.2 All signs shall be provided with appropriate symbol and both Urdu and English text.

4.10.16.3 As a minimum, the following warning signage shall be provided:

i) "Do Not Lean Against the Door" on all sliding screens

ii) "Keep Fingers Away from Gap Between Sliding Screen and Fixed Screen" on all sliding screens

iii) "Warning that door may be opened inwards during an emergency" on all emergency hinged screens and the end walkway doors.

4.10.16.4 As a minimum, the following instructions for use signage shall be provided:

i) "Push bar to open" on the panic bars on the trackside of the end walkway doors and the emergency hinged screens

ii) "Pull Handles to open" adjacent to the opening handles on the trackside of the sliding screens.

4.11 Testing and Commissioning Requirements

Contractor should adhere to the testing and commissioning requirements as detailed in Chapter no. 1 & 12 of MSS.

4.12 Systems Assurance

Contractor should adhere to the System Assurance requirements as detailed in Chapter no. 1 & 12 of MSS.

4.13 Interface Provisions

Contractor should adhere to the interface provision requirements as detailed in Chapter no. 1.

CHAPTER – 5

ROLLING STOCK

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CHAPTER – 5
ROLLING STOCK

5.1. General

5.1.1. This section lays down the technical and performance requirements of the monorail Rolling Stock (cars) covering its design, manufacture, testing, commissioning.

5.1.2. The basic architecture of the Train shall be determined to meet the operational requirements.

5.1.3. The monorail rolling stock shall be straddle beam type, of proven technology and suitable for operation in Islamabad/Murree weather condition to meet the traffic demands.

5.1.4. The Train design shall be:

i). Safe, efficient and reliable for operation;
ii). lightweight and elegant;
iii). of high technological standard; and
iv). of modular design.

5.1.5. The design features of the monorail Rolling Stock shall be compatible with all supporting systems utilized in the Mono-Rail Systems and Project.

5.1.6. The monorail Rolling Stock shall be safe to operate under all climatic conditions in the operating environment in Islamabad/Murree without damage, and also under all operating conditions.

5.1.7. The monorail Rolling Stock shall be compatible with the traction supply system and shall be designed to operate safely in the range of voltage of the power supply.

5.1.8. The speed control system should meet operational safety in normal operation and should behave satisfactorily in abnormal/degraded situations.

5.1.9. Trains should have adequate access and egress doors for dealing with the heaviest passenger demand.

5.1.10. The interiors of monorail rolling stock should be designed to provide a safe and

convenient environment for passengers and should minimize harm in case of an Emergency or accident.

5.1.11. The Rolling Stock should be designed for minimum risk of fire and with adequate Emergency egress in case of fire.

5.1.12. The Car/Train shall have the latest microprocessor based integrated diagnostic system. All-important diagnostic information with fault correction instruction shall be displayed on the TO's (Train Operator) VDU (Visual Display Unit).

5.1.13. The diagnostic system shall provide for carrying out other diagnostic investigations by connecting a portable PC to the system;

5.1.14. The noise emitted by the Cars on run shall be governed by BS-EN ISO 3095:2005 – 'Railway applications Acoustics Measurement of noise emitted by rail-borne vehicle' or equivalent standard.

5.1.15. The safety of the Rolling Stock shall be verified by Tests before commencement of commercial service. The Tests and demonstration methodology shall be defined by the Contractor in consultation with the TE.

5.1.16. The Rolling Stock must be able to operate irrespective of weather conditions and the temperature inside the Train parked in the sun.

5.1.17. Monorail Rolling Stock safety systems shall conform to IEC 62278 and IEC 61508.

5.2. General Performance Requirements

5.2.1. General Criteria

5.2.1.1 Design axle load shall be based on Coach Design. Mechanical design of Coaches shall provide for dense crush load standing User density of 10 per square meter with all fixed seats occupied, (occasional overload). 8 per square meter for other designs.

5.2.1.2 The passenger capacity of Coach for all normal and degraded performance requirements shall be based on all seats full, with standing capacity in the free-standing space of:

i). 4 persons per square meter for normal load;

ii). 6 persons per square meter for maximum load; and

iii). 8 persons per square meter for crush load.

5.2.1.3 Static profile:

i). The width of coach shall not exceed 3.2 m

ii). The height of a coach, shall not exceed 5.5 m

5.2.2. Performance Requirements of Train Service

The train shall be compliant with the operational requirements at a crush load of 8 passengers per sqm, when operating at Traction Supply voltages from minimum to maximum working voltages. The indicated performance requirements are:

Performance, Acceleration Rate (service)	1.0 m / s^2 minimum
Rate of change of acceleration	0.7 m per $second^3$
Braking Rate –service	1.0 m / s^2 minimum
Braking Rate – Emergency	1.1 m / s^2 minimum

5.2.2.1 Rescue Mode Performance:

i). A fully loaded (dense crush) train, in normal working condition, without any damage regarding hour rating of traction motor and other equipment, shall be capable to start and to push or haul a defective train with the same composition in dense crush load, with brakes released on the defective train, on routes including sections of all gradients and curves up to the next station, with a speed of 20 kmph minimum.

ii). Thereafter, all the passengers have detrained from the defective train at the station; continue to push the defective train up to the terminal station. There shall be no equipment damage or degradation, while maintaining safe operation.

5.2.2.2 Degraded Conditions:

i). In the event of failure of one motor car, the train shall be able to complete its journey up to a station having berthing facility or to the depot to permit normal train operation on the route.

ii). For both the above-mentioned conditions i.e., 5.2.2.1(i) & 5.2.2.2 (i) the capacity

of traction motors on any car combinations, shall be so designed that in the event of failure of motor on one Bogie, the defective bogie shall be isolated electrically and the Train shall be able to complete its journey to destination without incurring a delay of more than five minutes.

5.3. Train Operating Modes

5.3.1. The trains shall be equipped with ATC equipment and train operator controls to operate the train in the following modes:

i). Manual (coded) mode,
ii). ATO mode
iii). Restricted mode,
iv). yard mode,
v). wash mode and
vi). Reverse mode.

The mode selector switch and master controller shall be housed in a driver's control console. The master controller shall incorporate a driver's safety device "dead man" control. The master controller and the mode selector switch shall be interlocked in the manner to be agreed at the design stage and approved by the TE.

5.3.2. **Manual mode:** The train shall be capable of being driven manually in the forward direction up to the permitted speed by ATP, indicated visually in the cab-on-cab display.

5.3.3. **Restricted mode:** The train shall be capable of being driven manually in the forward direction but shall be limited to a permitted speed up to 25 kmph by the on-board ATP.

5.3.4. **Yard mode:** The train shall be capable of being driven manually in the forward direction for parking the train in the yards, but shall be limited to a speed of 15 kmph maximum.

5.3.5. **Wash mode:** In wash / coupling mode, the train shall move forward at 5 kmph maximum for coupling and or washing purposes.

5.3.6. **Reverse mode**: In this mode the train shall be driven manually in the reverse direction at a speed of 3 kmph maximum for a limited distance. This shall be possible only when train is proved to be stationary by the ATP or the traction equipment in the event of an

ATP failure. Attempts to change direction when the train is in motion shall activate the emergency brake.

5.4. Ride and Stability:

5.4.1. All cars in the Train shall be dynamically stable throughout the speed range up to 80 km/h, design speed.

5.4.2. The Sperling Ride Index (RI) of the Car under all loading conditions, when travelling throughout the range of operating speeds and curves prevailing in normal passenger service for the service life of all suspension components shall not exceed 2.75 in both vertical and horizontal directions in inflated condition and 3.0 in deflated condition. The ride quality of the Car shall conform to EN 2631-Part 4.

5.4.3. The RI calculations shall be done as per para 2.1 of ORE (Operational Research Establishment by UK) Report C 116 using FFT method (Fast Fourier Transform method) and UK 513 E-Guidelines for evaluating passenger comfort in relation to vibration in railway vehicles. In case of pneumatic traction tyre, the oscillation trial shall be conducted with tare and fully loaded Cars in both inflated and deflated conditions up to maximum design speed plus 10 kmph starting from 40 kmph in the incremental order of 10 kmph for inflated conditions and up to 80 kmph for deflated condition.

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5.5. Platform Stops

5.5.1. The train control equipment in interface with ATC equipment should ensure that trains stop within 500 mm of the designed stopping position.

5.5.2. The train equipment shall ensure that doors of cars on the platform side only open. Manual over ride provision shall be made to correct the door opening in case doors on the non-platform side are to be opened.

5.5.3. An emergency stop facility shall be provided on the Train Operator's Console in a prominent position.

5.6. Passenger Emergency Evacuation

5.6.1. The evacuation of passengers during emergencies shall be laterally to a rescue train using a bridge plate (with hand rails) between the side doors of the two trains.

5.6.2. Provision for construction of Central walk way between guide beams shall be provided if required with the consultation of TE.

5.6.3. The Contractor shall indicate the proposed arrangement for the evacuation during emergencies and make suitable provision in the cab or cars as the case may be.

5.7. Train Requirement

5.7.1 The monorail train shall be Straddle beam type, bi-directional running on elevated concrete guide-way structure. Guide wheels shall be fitted on sides enveloping beam for stability and guidance.

5.7.2 All train units shall be designed for:

(i) Negotiating sharpest curves of the alignment.

(ii) Ascending and descending all maximum gradients and sharpest curve radii fully loaded, in regular service in all weather conditions, including stopping and starting

(iii) Capable of running coupled together in multiple-unit trains for rescue purposes.

(iv) Fully loaded itself, and coupling up to, an empty failed train and starting, moving and braking at the maximum gradient of the alignment

(v) Fully loaded itself, and coupling up to, a fully loaded failed train and starting, moving and braking at the next station

(vi) Minimize noise vibration.

(vii) Provided with emergency facilities for disconnecting the train from the traction current supply

(viii) Comply with all relevant fire specifications

(ix) Fitted with destination indicators

Such a design and specification as can reasonably be expected to have a routine service life of not less than 30 years. Typical major refurbishment after 15 years

5.7.3 Minimum performance requirements are given below:

Type of vehicle	Monorail with single / dual axle bogie- straddle beam type
Train Consist	Proposal shall meet the PHPDT requirements with necessary enhancement for future increase
Overall Width including Doors	3.2 m, max.
Overall Height, from bottom of skirt to top of roof	Up to 5.5 m.
Passenger Doors	2 per side per car, bi-parting
Doorway Width- clear	1250 to 1500 mm
Doorway Height clear	1900mm
Floor to Ceiling Height	2100 mm
Guide beam Running Surface Width	700 to 850 mm
Train Control	The System will be CBTC GoA-3 system with driver + ATP upgradable to ATO
Primary Power Nominal line voltage	750 / 1500 V DC

Power Collection	Positive / Negative dual rail supply collection system
Axle load, maximum	11-15 ton per axel
Auxiliary Power Supply	415 / 240 V AC.
Low-voltage Power Supply:	24 V DC or 110 V DC"
Propulsion	AC Electrical motors with VVVF& gear reducers
Brake: Regenerative Braking:	Electro-dynamic regenerative brakes
Parking Brakes	Spring applied brakes
Emergency Brakes	Pneumatic brakes
Service Brakes	Hydraulic / pneumatic
Bogie	single or dual axle bogie, straddle beam type
Main load Tyres	Metro type nitrogen filled with internal run flat and pressure monitoring sensor
Guidance Tyres	Metro type nitrogen filled with Internal run-flat support
Fire Safety Design	NFPA 130 / ASTMA119/BS6853
Performance, Acceleration Rate (service)	1.0 m / s^2 minimum
Rate of change of acceleration	0.7 m per $second^3$
Braking Rate –service	1.0 m / s^2 minimum
Braking Rate – Emergency	1.1 m / s^2 minimum
Maximum Design Speed	90 kmph
Maximum Operating Speed	80 kmph
Minimum commercial operating speed	30 kmph
Minimum Horizontal Radius	50 m (alternative proposal shall meet the alignments of CMR)
Minimum Vertical Radius	500 m
Maximum Gradient	6.5%
Passenger carrying capacity	350
car Train, minimum	Normal load = 6 pass. / sq. m Crush load = 8 pass. / sq., m Shall propose car train to meet traffic demand.
Head way, operating, minimum	5 minutes
Design Headway	ATP-2 Minutes, ATO-90 Seconds.
Air Conditioning	passenger & driver (cab)

5.8. Monorail Coach Design Requirements

5.8.1 Car Body

5.8.1.1 The Car structure shall be monologue, light weight fabricated out of Austenitic stainless steel or corrosion resistant steel or aluminum consistent with safety and strength requirement. The body paneling should have resistance to the traction and braking effort as well as impact and accidental damage. The car body shall conform to Railway applications. Structural requirement of railway vehicle bodies or other standard applicable to coaches of monorail transport system

The front nose structure shall be out of composite material or steel. Where dissimilar

materials are used, measures shall be provided to mitigate corrosion in the body due to electrolytic action.

5.8.1.2 Design Criteria

The structures of shell and bogie shall withstand the crush load standing passenger density of 10 per sq m with all fixed seats occupied (occasional overload). 8 per square meter for other designs. The structure shall provide enhanced strength and durability up to 30 years. The train's crashworthiness capability shall be up to 8 km/h without any permanent structural deformations

5.8.1.3 The Car shall be aesthetically pleasant and functionally sound. The outer profile of the vehicle shall be of such that the entire surface can be fully cleaned by an automatic car wash plant.

5.8.1.4 The outer most ends of the end Coaches shall be provided with automatic couplers with simultaneous automatic connection of pneumatic pipes and electrical connection and the Inter-coach coupler shall be semi-permanent type. All couplers shall have crash worthiness features.

5.8.2 Doors

5.8.2.1 The doors shall be vibration free and insulated against heat and sound transmission. The doors shall be sealed against draughts and water The doors shall be as rigid and lightweight Aluminum construction

5.8.2.2 Each Coach shall have minimum of four electrically powered, bi parting doors, with two doors on each body side. The passenger, sliding doors shall be as per EN 14752 and shall be able to resist the loads without deformation or damage.

5.8.2.3 The doors shall have correct side door enabling provision which detects if the Train is correctly located in the platform halting position and thereafter allows door actuation on the platform side of the Train.

5.8.2.4 The door mechanism shall have safety provision whereby the Train cannot start unless all doors have been closed and electrically locked.

5.8.2.5 The exterior doors shall be designed so as to retain the passengers during all service

conditions and shall minimize risk in the event of an accident.

5.8.2.6 The doors shall have following additional safety features:

(i) Obstacle detection and preventing the Train from starting in case of obstruction;
(ii) internal and external release;
(iii) door closing warning by audible and flashing light indication;
(iv) visual door open indication;
(v) monitoring from the driver's cab; and
(vi) Door status indication on TO's VDU.

5.8.2.7 Provision shall be made for passengers to open Train doors to permit evacuation from a stopped Train in an Emergency.

5.8.3 Windows

All windows shall be sealed, flush with the exterior of the Coach and shall be provided with double-glazed, toughened and laminated glass of appropriate standard. The glazing should have resistance to breakage and should minimize danger on breakage, especially from objects hitting it, taking into account the speed of the Train. The exterior glazing should withstand aero dynamic forces.

5.8.4 Gangway

The monorail car shall have a wide gangway connecting to the adjoining cars excluding the TO cab side. The gangways shall be completely weather proof, draught proof and vandalism proof.

5.8.5 Car Interior

5.8.5.1 Nominal clear height inside the Coach shall be 2100 mm.

5.8.5.2 Flooring material shall be, the one that meets or exceeds the skid resistance requirements with a coefficient of friction of at least 0.4, and shall be skid resistant when wet and shall be easy for cleaning surface. The floor construction shall comply NFPA 130 / BS 6853. The floor shall be designed for a minimum trouble-free life of 15 years under all passenger loadings. Hatches in the floor of passenger areas shall be avoided.

5.8.5.3 The seat should be designed ergonomically.

5.8.5.4 Width of seats shall be 450 mm. 30% of the seats, an isolated area shall be earmarked for

"Ladies only", senior citizens & disabled persons

5.8.5.5 Two spaces for wheelchair, one on each Driver car, near the TO cabin shall be provided in each car with necessary arrangements. Foldable tip-up seat shall also be fitted at these locations.

5.8.5.6 For lighting the interior of the car, fluorescent lamps or compact fluorescent lamps or LED shall be used. During night, the illumination shall be not less than 200 lux at the floor of the car and not less than 350 lux at seating positions.

5.8.5.7 Headlight and side marker lights in Driving Motor Car shall conform to latest International Standards. In the event of failure of main power supply, these also shall be powered from standby batteries of sufficient capacity to maintain the emergency lights (50 percent of the lights) and all exterior lights for 90 minutes. Electric lighting shall be of similar or equivalent performance to EN 13272: Latest version – 'Railway application – Electrical lighting as applicable to urban rail transport systems.

5.8.5.8 Material used for interior of a car shall be resistant to scratching, graffiti, and detergents.

5.8.5.9 Interior shall have colour design to have maximum visibility. Contrasting colour shall be used for improved visibility for visually impaired persons.

5.8.5.10 Grab pillars/rails and grab handle shall have bright colour.

5.8.5.11 In each car, four numbers (two on each side) single sided electronic route maps, with electronic flash light shall be provided above the seats, facing towards the center line of the car. These shall show direction of travel, current location

5.8.5.12 Environmental conditions for the equipment on board the Coach shall conform to EN 50125-1.

5.9. Fire & Safety Provisions:

5.9.1 All the car interior materials shall comply with NFPA 130 / BS 6853.

5.9.2 Materials selected especially for internal fixtures, fittings, furniture and decorations shall be such as to minimize the risk of fire and the spread and effects of fire.

5.9.3 All electrical circuits should be fused or otherwise protected to avoid danger from overheating or arcing.

5.9.4 Passenger and train crew compartments shall be provided with two dry powder type or other appropriate approved type fire extinguishers located near the gangways. These shall be in a niche so as not to cause injury to people.

5.9.5 Materials with known hazardous properties should not be used. Where it is unavoidable to use such materials, passengers should be shielded from the effects of such materials.

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5.10. Ventilation and Air Conditioning

5.10.1 The car, including the TO's cab, shall be air-conditioned with an air- conditioning units in each Coach. Air-conditioning in Coaches shall conform to EN 14750 or equivalent and to internationally accepted standards and practices. The capacity of air conditioning systems shall be suitable for Chennai tropical conditions.

5.10.2 The cab temperature should be maintained at comfortable 25° C $\pm$ 2 with the relative humidity of 60 %

5.10.3 In the event of failure of air-conditioning unit/units, harmful quantities of the refrigerant should not be released inside the compartment and there shall be an arrangement for forced ventilation of the cars.

5.10.4 The air-conditioning system shall provide a high rate of renewed air, maintenance of constant temperature and take into account, frequent door opening and high User density. The units shall be compact; roof mounted and of low power consumption.

5.11. Train Operators Cab

5.11.1 Either ends of the train shall have TO Cabs for forward driving and ease of reversals at the terminals. The cab ends shall be designed to give the TO and others inside the cab, protection in the event of an accident and impact with objects.

5.11.2 The TO cab shall have full front view.

5.11.3 TO's seat should be fully adjustable to allow him to take a comfortable position in relation to the controls and view of the signals. A folding seat shall be fitted in the cab for co-driver or inspecting official.

5.11.4 The cab shall be spacious and the layout shall be ergonomically designed with all controls within the reach of the TO sitting on his seat.

5.11.5 There shall be provision for cab Signaling.

5.11.6 The TO's cab shall be provided with continuous communication with Operation Control Centre.

5.11.7 The train shall be fitted with Automatic Train control and traction current collection equipment so that train shall be capable of being driven manually under ATP supervision. The TO's cab shall have space for all equipment needed.

5.11.8 Train Data Recorder: The train data Recorder (TDR) shall be fitted in the TO cab. The TDR shall continuously gather vital operational data so that the information is available in the event of an accident. It should be enclosed in a sealed and tamper resistant case.

5.11.9 The TDR shall be capable of withstanding a temperature of 55°C maximum.

5.11.10 The TDR equipment and its installation shall be to BS EN 60529 and shall meet the crash protection requirements of RGS GM/RT/2472

5.11.11 The TDR shall be capable of recording speed of Train, Location of Train, Direction of

travel, Power controller position, Brake controller position and brake equipment response, Driver's safety operator position, Status of line power, Status of head lights and Tyre pressure / Flat tyre in case of Nitrogen inflated.

5.12. Train Management System

5.12.1 The Contractor shall propose microprocessor-based Train Diagnostic Equipment.

5.12.2 The TMS provides supervisory control, monitoring and diagnostic systems. Train status information is graphically displayed during operation via the HMI (Human Machine Interface) panel. Its user-friendly interface display allows the operator to quickly respond and understand all train system status.

5.12.3 The annunciation of train system status and abnormal conditions are categorized and displayed in real time and prioritized in order of critical system hierarchy. All data is logged for further analysis.

5.12.4 This equipment shall monitor all operationally critical equipment and notify disturbance to its normal working and record failures. Operating events shall be recorded to enable unplanned events to be analyzed. The Train management information shall be displayed on the Train Operator's Human Machine Interface (HMI).

5.13. Bogie

5.13.1 The Bogie shall be a proven design for Straddle Monorail in a high hilly terrain and suspension shall provide a smooth & safe passenger ride comforts for all service conditions. The bogie shall consist of suspension, Main and balancing tyres, traction equipment, current collection devices, and brakes. The bogie shall permit the minimum curve being negotiated safely with least strain on the guide beams. The main / load tyres shall be heavy duty type nitrogen filled with internal run flat and pressure monitoring. In the event of deflated tyres, the monorail car shall ensure safe operation.

5.13.2 All cars in the Train shall be dynamically stable throughout the speed range up to 80 km/h, design speed.

5.13.3 The bogie structure shall be steel fabricated and designed to support static and fatigue loads for as long as 30 years. The structures of bogie shall withstand the crush load standing passenger density of 10 per sq m with all fixed seats occupied (occasional overload). 8 per square meter for other designs.

5.14. Brake System

5.14.1 Braking should be provided on all Coaches and must be continuous and automatic throughout the Train. Continuous automatic brakes should inhibit traction power when applied.

5.14.2 The brake system shall comprise the following types of brakes:

(i) Electric regenerative service brakes;
(ii) electro-pneumatic (EP) / Hydraulic service friction(mechanical) brakes (drum)
(iii) fail safe emergency pneumatic brakes; and
(iv) Spring applied, pneumatic release parking brakes.

5.14.3

a). It should be possible to apply Emergency Brake from the TO's control position.
b). If a door opens when a Train is in motion, the driver should get visual and audible alarm and driver shall attempt to close manually. In case of not possible to close, suitable remedial action shall be taken to safe guard the passengers.
c). Train shall be proven to be complete in all respects before Emergency Brake can be released.

5.14.4 For the service brake, the electro dynamic brake (regenerative) is preferred, the use of pneumatic brake being limited to the lower speed range when the electro dynamic brake effort is insufficient. There shall be smooth blending of electro-pneumatic brakes and regenerative brakes.

5.14.5 The parking brake shall be automatic and shall be designed to hold a fully loaded Train (8 Users per sq m) on the steepest gradient of the Rail System in the worst anticipated wind condition at that location, for an unlimited time on main line.

5.14.6 ATP equipment shall interface with the braking system. In the event of loss of ATP, the speed of the Train shall be controlled by the TO.

5.14.7 The Train braking system shall be compatible with the Signalling system.

5.15. Electric Propulsion System

5.15.1 The propulsion equipment shall be Insulated Gate Bipolar Transistor (IGBT) based variable voltage variable frequency (VVVF) traction system. It shall have total traction and regenerative braking control. The system shall also provide high reliability and

safety integrity featuring safe-off state interlock with the braking system. It shall be also equipped with a dual media redundant network interfaced to the TMS.

5.15.2 Traction motor, other electrical and electronic equipment shall be provided with cooling arrangement, considering Reliability and Maintenance in service and the same shall be approved by TE."

5.15.3 The entire electric propulsion system shall be provided with microprocessor based diagnostic system and the same shall be integrated with similar diagnostic system of entire Coach/Train.

5.15.4 Traction motors shall be asynchronous three phase AC motors: suitable for IGBT based VVVF traction system.

5.15.5 Means shall be provided to isolate locally each traction equipment in the Train.

5.15.6 The electric propulsion system shall allow movement of Train in reverse at limited speed.

5.15.7 Means shall be provided to isolate locally each traction equipment in the train

5.16. Energy Measurement

5.16.1 Separate quote for the following shall be submitted as an optional requirement:
The electric propulsion system shall have arrangement for measurement of energy consumed on each Train, in accordance with the Standards prescribed in this Manual. The measurement shall be in three parts namely, total energy consumption, energy consumption for traction and energy regenerated

5.17. Current Collection System:

5.17.1 Each bogie shall be fitted with the current collection equipment and shall be compatible with traction system.

5.17.2 The shoe gear shall operate with thermal rating of power with traction supply, both in normal and Emergency operation, maintain good electrical contact,

and provide for a mechanism whereby the shoe is allowed to break off without causing damage to it or to any other Train borne equipment.

5.17.3 A system of retracting and securing of current collection shoe gear shall be provided to enable full electrical and mechanical isolation between shoe gear and conductor rails. A suitable arrangement can be provided as an alternative.

5.18. Auxiliary Power Supply

5.18.1 The auxiliary power supply shall be natural or forced air cooled static inverter-converter based system with back-up batteries and battery charger.

5.18.2 Back-up and stand-by batteries shall be of latest design.

a) All Trains shall be equipped with a stand-by battery power source consisting of Nickel cadmium cells having a nominal voltage of 110V. The battery shall be rated and tested as per IEC 60623 and IEC 60993. It should supply Emergency load for at least 90 minutes in case of failure of power supply from battery charger and the voltage level at any device shall not fall below 77V DC. Non-essential load shall be shed after 30 seconds of failure of battery charge supply. NFPA 130 is acceptable as an Alternative.

b) The stand by batteries shall be protected against undermanned discharge and over charge

c) Emergency loads shall include, but not limited to:

(i) Emergency lighting;
(ii) all exterior lights;
(iii) ventilation fans but not air conditioners;
(iv) communication systems including public address, emergency alarm, surveillance system and Train radio;
(v) propulsion and brake controls;
(vi) door controls;
(vii) electric horn;
(viii) cab console indicators, lighting and interlocking; and
(ix) ATO/ATP Train-borne equipment.

d) In the event of loss of traction or auxiliary supply, battery supply should automatically get connected to supply essential loads.

5.19. Vehicle Coupler & Drawbar Assembly:

5.19.1 The coupler & Drawbar assemblies shall be capable of negotiating the curves and gradients on glass train alignments and depots. The couplers at either ends of the train shall be capable of emergency mechanical connection and shall absorb impact energy in worst service.

5.20. Communication System:

5.20.1 Train borne communication equipment shall be provided on the train which shall be an integrated system of audio and data communication between the passenger and train driver.

5.20.2 The following on-train communications requirements shall be provided:

(i) Two-way communication between passengers and the TO in an Emergency. Emergency buttons and talk back phones, one on each side near the doors shall be located.

(ii) Also Two-way communication between the Operations Control Centre (OCC) and train driver via train radio equipment.

(iii) Cab to Cab communication

(iv) Emergency passenger announcements on the train by OCC

(v) Telephone communication between TOs of driving cab & non-driving cab.

(vi) Public Address System for various announcements to passengers by TO, like station names, emergencies, etc. shall be suitably located.

(vii) Facilities for simple conversation between drivers of driving cabs in two coupled trains.

(viii) An automatic voice announcement system, pre-recorded or synthesized voice recorded system to announce next arriving station or any other general announcements in local language Tamil and English.

(ix) A passenger information display system.

(x) Chime when doors are closing and opening.

(xi) Passenger saloon surveillance system using CCTV camera, covering 90% of saloon area, in each car. This shall be viewed by TO on his VDU. A record of the video image of each camera in the car shall be maintained for half an hour cycle.

(xii) Complete tools for configuring route / station data announcements, messages and fonts and interface of the system with other sub systems, etc. shall be

supplied. It shall be possible for the engineer to configure the PIS/ PSSS software for implementing operational & maintenance related modifications.

(xiii) Full access to the software for the above said purpose shall be provided. Any hardware / software tool required for this purpose shall also be provided.

(xiv) Network Video Recording system (NVRS)- Video Analytics software enabled

5.21. Passenger Safety at Platforms

Passenger safety at platform will have to be ensured by providing suitable arrangements (as acceptable by The Engineer) to cover the gap between platform edge to the car, against fall protection and protection from electrocution.

5.22. Electromagnetic Compatibility (EMC) / Electromagnetic Interference (EMI) Conditions

5.22.1 Monorail cars shall comply with Electromagnetic Compatibility standards EN 50121-1: latest version – part 1 to 3;

5.22.2 All equipment and systems shall be electromagnetically compatible with each other and shall also be electromagnetically compatible with all existing external systems which may affect or be affected by the equipment or systems including radio system, television systems, the telephone network, medical installations (fixed and mobile units such as heart pacemakers), and the power distribution network. Electromagnetic compatibility with external systems shall be achieved.

5.22.3 The Contractor shall liaise with the appropriate authorities and agree which standards shall be adopted and, if necessary, produce custom specifications to supplement these standards should they be insufficient on their own. In such cases, the Contractor shall, prior to commencing any detailed design work, produce documentary evidence to The Engineer that the appropriate EMC standards have been agreed with each of the external authorities that could be affected by the construction and operation of the System.

5.22.4 All equipment shall be adequately designed to be immune to all electromagnetic interference that could arise. Failure of any electromagnetic suppression components fitted to safety critical systems shall not cause that equipment to fail and cause an unsafe condition on the System, when it is subjected to interference that is within the bounds of the adopted standards.

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5.22.5 The Contractor shall propose details of system protection from electromagnetic interference from both elements of the system and external elements that might affect it, for review by the TE.

5.23. Environmental Conditions and Noise Standards

5.23.1 Monorail cars shall comply with environmental standards EN 50125.

5.23.2 EN 50125-1: latest version – Railway applications – Environmental Conditions for equipment – Part 1: Equipment on board Rolling Stock.

5.23.3 The monorail cars shall comply the following noise standards as applicable to rubber-tired vehicles.

5.23.4 **Stationary Trains**

a) The noise level inside the car and the cab, when running at the scheduled maximum speed shall not exceed 72 dB (A). The noise level shall be measured in the car along the center line between 1200 mm and 1600 mm above the floor and at a distance over 600 mm from the end of the car. The measurement shall be done as per ISO 3381.

b) Noise level outside the Train

The noise level outside the Train shall not exceed 68 dB (A) with all Auxiliary Equipment operating. The noise level shall be measured at a point 7.5 m from the Train centerline at a point between 1200 mm and 1500 mm above the rail level. The measurement shall be done as per ISO 3095.

5.23.5 **Moving Trains**

a) The noise level when running at the scheduled maximum speed shall not exceed 72 dB (A). The noise level shall be measured in the car along the center line between 1200 mm and 1600 mm above the floor and at a distance over 600 mm from the end of the car. The measurement shall be done as per ISO 3381.

b) Noise level outside the Train when the train is moving at the scheduled maximum speed shall not exceed 85 dB (A) with all auxiliary systems operating. The noise level shall be measured at a point 7.5 m from the Train centerline at a point between 1200 mm and 1500 mm above the rail level. The measurement shall be done as per ISO 3095.

5.23.6 All noise levels listed above are in decibels referred to 20 micro-Pascal's as measured with "A" weighting network of standard Type 1 sound level meter with time weighting F.

5.24. Testing and Certification of Rolling Stock

5.24.1 A static test on the car shall be carried out to validate the design.

5.24.2 Before monorail car is deployed in actual service, the first train shall be subjected to oscillation trials on actual track Alignment.

5.24.3 The Contractor shall approach the nominated authority, along with details of the test result, and shall obtain his approval, before commencement of monorail services.

5.25. Maintenance Plan

5.25.1 A comprehensive maintenance plan shall be prepared for systematic maintenance of cars, and shall be designed to achieve:

i). RAMS requirement;
ii). Design life of equipment;
iii). Safety requirement
iv). Maintenance of good passenger environment; and
v). Maintenance of good external conditions of cars.

5.25.2 The trains need a thorough washing from outside and cleaning from inside in the shortest possible time and in a planned manner. The Contractor shall plan for automated coach washing plant apart from washing equipment for washing components of the monorail car.

5.25.3 The maintenance plan shall define the intervals, activities, and contents, the system for measurement between maintenance, the tolerance for safety in service and for withdrawal from service, and the facilities needed for the maintenance.

5.25.4 The maintenance facilities shall include, but not limited to:

a) Bogie
b) re-furbishing of monorail car; and
c) Periodical overhaul of monorail car.

5.25.5 Minimum life requirement of all monorail car components that affect safety shall be specified considering their criticality and maintenance regime and timely replacement arranged.

5.25.6 The Depot shall provide accommodation for stabling of cars, electric substation and power distribution systems, flood lighting, fire-fighting, and other ancillary structures for effective maintenance of all facilities provided as part of the Depot.

5.26. Car Requirement Calculations

Car requirement calculations shall satisfy the requirements the requirements of traffic demand, and shall include traffic reserve, maintenance reserve, and Emergency reserve, make up time, Station stops, turn-around time etc.

5.27. Computer Simulation Results

5.27.1 A computer simulation run of the designed Train composition (in crush loading condition) under the specified voltage and wheel conditions with the use of a Train schedule software program shall be carried out and simulation results with the following details shall be provided:

a) Inter-station running time;
b) actual schedule speed with the specified dwell time at each Station; and

5.27.2 In addition, a complete computer-generated master chart showing Trains possible to be run with the prescribed headway shall be generated. The Contractor shall hand over to IE with a copy of the software package and any hard ware/software tool required for the software.

5.28. Training of Operation and Maintenance Personnel

The Contractor shall engage persons with the requisite qualifications and training, as prescribed by rules, to undertake O&M functions of the Monorail System. Such persons shall be provided with in-service training as may be necessary

CHAPTER – 6

MAINTENANCE DEPOT

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CHAPTER – 6

MAINTENANCE DEPOT

6.1 General Introduction

6.1.1 This section lays down the facilities and standards to meet the performance requirements for maintenance facilities, to be designed, constructed, commissioned and operated for the Monorail System as per system requirement.

6.1.2 In this context the general term "Depot" shall apply for the general facility that include

(i) Daily inspection facilities
(ii) Rolling Stock cleaning facilities
(iii) Main workshop maintenance and overhaul facilities
(iv) Infrastructure maintenance facilities
(v) Road vehicle facilities
(vi) Stabling areas
(vii) General stores
(viii) Other associated facilities and support services

6.1.3 Depot maintenance includes repair and maintenance of Civil Works and System including the following to the Technology Provider's documented processes, including:

(i) Rolling Stock
(ii) Civil engineering provisions
(iii) Guideway, Switches etc.
(iv) Signaling and train control systems
(v) High Voltage (HV) power supply, traction (including power rails) and auxiliary power supply system
(vi) Communication and control systems
(vii) Fare Collection systems and Ticket Vending system
(viii) Fixed and movable M&E equipment
(ix) Depot Utilities
(x) Emergency Rescue and Relief vehicles
(xi) Road and Material movement vehicles
(xii) Engineering Train Vehicles (if any)

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6.1.4 The Contractor may propose the combining of depot if technically feasible, subject to the approval of The Engineer.

6.1.5 A single main Workshop / Overhaul facility may be provided, if the Contractor can demonstrate safe transfer of rolling stock to the facility to the approval of The Engineer.

6.1.6 Land provisions for the Depots are as indicated in the documents.

6.2 General Performance Requirements

6.2.1 The Depot shall be designed and constructed such that all maintenance plant, tools, and equipment required for the stabling of Rolling Stock and the performance of all levels of maintenance activities are provided.

6.2.2 The works to be constructed shall include all structures and civil works, architectural finishes, landscaping, fixed E&M and Rolling Stock equipment and Depot plant, tools and equipment. The fixed E&M equipment includes, but not limited to the Signaling, communications, traction, and auxiliary power, building services and office equipment.

6.2.3 A speed of 25 Km/h shall be possible for at least 300 meters from the mainline.

6.2.4 All Guideway shall be capable of Monorail running at 15kmph in the Depot area and speed to be restricted 10 km/h across switch decks

6.2.5 Routes in and out of the depot shall not be impeded from normal shunting operations for maintenance.

6.2.6 Facilities in the Depot shall be ergonomically designed and arranged in a logical manner in order to optimize the routine workflow and the capability for coping with abnormal situations.

6.2.7 The Depot Guideway layout shall be designed to achieve a minimum of shunting movements. Alternative routes shall be provided to the largest (reasonable) extent, to relieve congestion and ensure availability of the Depot.

6.2.8 All stabling, servicing, and light maintenance facilities shall accommodate the maximum revenue service train configurations permitted, without the need for separation of train sets.

6.2.9 The Emergency shed, stabling Guideway, power rail maintenance vehicle, Guideway maintenance vehicles shall connect directly to Main Line without shunting movements.

6.2.10 If the length of test track which can be accommodated in the available land is a constraint the Test track facilities shall be provided on the revenue line, with the capability of permitting operation under all revenue line conditions. Vehicle testing shall be undertaken during non-revenue periods.

6.2.11 Depot facilities shall allow access by road vehicles and mechanical handling equipment, including emergency service vehicles and equipment, and delivery of Monorail System vehicles. As far as possible, access shall avoid conflicts with train movements.

6.2.12 Lightening conductor shall be provided to protect the Depot and equipment.

6.2.13 Earthing and Bonding shall provide to for the E&M and Rail System equipment.

6.2.14 The Depot design shall be based on operational requirements and maintenance required for Train, other E&M equipment and infrastructure.

6.2.15 The Depot layout shall facilitate security considerations for pedestrian and vehicular access and perimeter protection.

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6.2.16 The Depot minimum ground level (except, drains/pits/sunken floor etc.) elevation shall not be less than the 100-year flood plain level.

6.2.17 The Contractor shall provide the Electric High Voltage substation located in the Depot, providing Traction and Auxiliary Systems power for the revenue line and Depot.

6.2.18 Electric high voltage substation of adequate capacity shall be located in the Depot, providing traction and auxiliary systems power for the Depot by connecting to the 33 kV 3-phase Auxiliary power and 750V DC or 1500V DC for the Traction System.

6.2.19 The switching station for Depot & Main line shall be separate.

6.2.20 The Contractor shall coordinate with Civil Authorities, Electricity Authorities for taking power for these sub-stations.

6.2.21 The Depot Plant and Machinery equipment shall be designed and supplied for a Design

Life of 30 years.

6.2.22 Civil and Structures shall be designed for a Design Life of 120 years and fabricated buildings for a Design Life of 60 years.

6.2.23 Depot E&M equipment shall be designed and supplied for similar Design Life as the revenue line similar equipment.

6.2.24 The Depot site shall be laid-out for Guideway geometry, load bearing capacities and building dimensions, sized for maintenance of the Monorail System equipment for 30 years.

6.2.25 The Contractor shall demonstrate to The Engineer that his design optimizes the Depot Operations.

6.2.26 Under normal operating conditions, the Depot shall be able to operate as an independent entity, without affecting the revenue line operations.

6.2.27 Abnormal operating conditions in the Depot, which have the potential to interfere with main line operations, shall be identified in the O&M plan, and mitigation measures provided.

6.2.28 All Train movements between main line and Depot and within the Depot shall be controlled by the Depot Controller.

6.2.29 The Depot must have adequate provision for future expansion to cater to the maintenance needs for the planned life of Monorail system.

6.3 Standards

6.3.1 All facilities shall be provided as per rules and regulations and Acts of Central and State Governments as applicable for the maintenance Depot.

6.3.2 The Depot infrastructure shall be designed and built-in compliance with applicable local building byelaws/codes and services provided to proven international standards.

6.3.3 **Building Code and Regulations**

(i) Equipment, materials, and systems shall be designed, in accordance with the

latest issue of codes and standards.

(ii) Unless otherwise stated, the design shall be governed by all applicable local codes, statutory regulations and standards issued by the local agencies.

(iii) Such regulations include:

(iv) NEPRA

(v) Pakistan Electric Rules 2023

(vi) Building Code of Pakistan

(vii) Building Bye Laws

6.3.4 Guideway and Structural Standards

6.3.4.1 AASHTO, latest version Guide specifications for Design and Construction of segmental concrete Bridges

6.3.4.2 structural Engineering Documents no.6 of IABSE, latest version

6.3.4.3 Structural Bearings and Expansion Joints for Bridges

British standards

(i) BS 410: latest version Specification for test sieves

(ii) BS 812: Testing aggregates

(iii) BS 1154: latest version Specification for natural rubber compounds

(iv) BS 1137: latest version Methods of test for soils for Civil Engineering purposes

(v) BS 5400: latest version Steel concrete and composite bridges

(vi) BS 5930: latest version Code of Practice for Site Investigations

(vii) BS 5950: Structural use of steel work in buildings

(viii) BS 6177 latest version Guide to selection and use of Elastomeric

(ix) Bearings for Vibration Isolation in Buildings

(x) BS 8007 latest version Code of Practice for Design of Concrete Structures for Retaining Aqueous Liquids

(xi) BS 8110 Parts I and II Structural use of Concrete Part 9 Section 9.1 Code of Practice for Design of Bridge Bearings

6.3.5 Rail Systems Codes and Standards

6.3.5.1 The following codes shall be applicable:

(i) NHA (National Highway Authority

(ii) AASHTO

(iii) BS.

6.3.5.2 International Standards (IS)

6.4 Design Requirements

6.4.1 Planning of Depot

The Depot lay out shall be planned to optimize the Rolling Stock maintenance facilities through proper integration with optimization of land requirement and providing adequate stabling, inspection and washing plant facilities.

6.4.2 Depot Facilities

The Depot facilities shall be designed to accommodate but not be limited to the following:

(i) Stabling of Trains
(ii) Daily routine inspection of Cars
(iii) Exterior and interior cleaning of Trains and works Trains
(iv) Light maintenance of Cars
(v) Recovery facilities for Cars, from all areas of the Rail System
(vi) Fuel storage and fueling facilities
(vii) Heavy maintenance of Trains and works Trains
(viii) Tyre replacement facilities
(ix) Lifting of Cars
(x) Repainting, repairs and modifications of Trains and works Trains
(xi) Other E&M equipment maintenance
(xii) Traction sub-station and Auxiliary sub-station
(xiii) Back-up power / diesel generator
(xiv) Effluent treatment facility
(xv) Test track
(xvi) Infrastructure Maintenance Depot
(xvii) Staff facilities
(xviii) Depot control center,
(xix) Service buildings and other offices
(xx) Training facilities
(xxi) Fire services
(xxii) Security
(xxiii) Spares and storage facilities
(xxiv) All other works required to be carried out in the Depot as per

maintenance program.

(xxv) The Operational Control Centre (OCC) shall be located at one of the Depot sites.

6.4.3 Depot Operating and Maintenance Plan

6.4.3.1 The Contractor shall submit a Monorail Operating and Maintenance Plan (O&M Plan) for review by The Engineer during Initial Design Submission.

6.4.3.2 The Monorail O&M Plan shall include the Depot Operations and Maintenance Plan and detail all functions to be provided by the Depot, how the requirements will be satisfied and those engineering facilities required for the operations and maintenance of the Monorail

6.4.3.3 The maintenance schedule covering annual program of preventive, urgent and other scheduled maintenance and Maintenance Manual for the regular and preventive maintenance of the Rail System shall be prepared. The facility requirement for the Depot should be clearly brought out along with phasing plan.

6.4.3.4 **Depot Design**

(i) The Design of the Depot and stabling shall include:
(ii) Depot Master Site Plan
(iii) Depot Civil Works
(iv) Depot Approach Structures
(v) Depot Guideway
(vi) Depot Building Structures
(vii) Depot Architecture
(viii) Depot Building Services
(ix) Electrical distribution
(x) Lighting
(xi) Low Voltage Systems
(xii) Heating Ventilation and air-conditioning Systems
(xiii) Fire Services
(xiv) Water supply and water treatment
(xv) Sewage system and sewage treatment
(xvi) Storm water drainage system
(xvii) Waste Water Treatment

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(xviii) Mechanical systems

(xix) Depot Traction Power

(xx) Depot Signalling

(xxi) Depot Communications

(xxii) Cranes and Materials handling

(xxiii) Depot Equipment

6.4.3.5 **Exterior Washing**

Facilities shall be provided for exterior washing using automatic car washing plant.
Water shall be recycled to the maximum possible extent and effluents shall go to effluent treatment plant (ETP).

6.4.3.6 **Light Interior Cleaning**

Routine cleaning may be undertaken in stabling sidings.
Elevated pathways between Guideway s shall be utilized for access to the vehicles.
Pathways shall be connected to the interior circulation roads in order to access trash removal and cleaning supplies as well as providing safe and rapid staff access.
Cleaning personnel shall be adequately protected against inclement weather.
Cleaning facilities shall enable the use of mobile cleaning equipment and disposal of residue.

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6.4.3.7 **Heavy Interior Cleaning**

Monthly cleaning of the interiors shall be accommodated through a dedicated Guideway for an entire ultimate car train length.
The Guideway shall have train door level covered platforms on both sides along the full length of the train and shall have water supply, drains, and lighting.

6.4.3.8 **Under Body Cleaning**

(i) Under body cleaning shall be provided for cleaning under frame equipment and bogies prior the major inspections and overhauls, as suitable for a monorail rolling stock.

(ii) Under body cleaning shall: Utilize air pressure / vacuum in a pit arrangement.

(iii) Incorporate features for dust extraction for safe working conditions.

(iv) Be located near the entrance to the inspection berth and workshop in order to

minimize reversing moves and time.

(v) Intervals of use shall be in accordance with the maintenance intervals as discussed below.

6.4.4.1 Inspection

Facilities shall be provided to inspect the Monorails to the Technology Provider's standards, envisaged as follows:

(i) Daily inspections of the train-consist on the stabling Guideway upon receipt or departure. Only exterior inspections and on-board tests will be performed.

(ii) The depot shall be provided with overhead stringers for electrical power suppliers, above all guider beams side mounted electrical power receptacles fitted on the rolling stocks shall be used for electrical power requirements on rolling stock inspections in depot

(iii) Day to 3-week inspections of the car, roof mounted equipment and interior fittings.3-month inspections of the Monorail Cars similar to the 3-day/3-week programs but to accommodate a greater depth and extent of inspection.

(iv) The daily and 3 weekly inspections shall be accomplished in a Servicing Shed on Guideway, suitable to be expanded to meet the final capacity train sets.

(v) Provisions shall be incorporated for access to the roof of the cars.

(vi) Sufficient number of Guideway shall be provided in the depot layout to accommodate the 3-day inspection interval for the ultimate fleet size. The rolling stock manufacturer will determine final inspection intervals.

(vii) Centre lines of the Guideway s shall be about 6.25 meter apart and shall be with Ramps and steps to the Access Platform and roof access platform from the adjacent shop floor surface.

(viii) In the Inspection area adequate lighting, compressed air and floor drains shall be provided.

(ix) Facilities for 3-month inspection shall be equal to that above but shall also include overhead lifting functions for the heavy roof mounted equipment as well as replacement of unit spares.

6.4.4.2 Servicing and Light Maintenance

6.4.4.2.1 The light maintenance facility shall be provided to the Technology Provider's standards to enable:

(i) Routine servicing

(ii) Testing and investigation

(iii) Routine preventative maintenance;

(iv) Corrective maintenance; and

(v) Quality assurance testing.

(vi) The light maintenance facility shall be protected against inclement weather and shall be arranged to optimize work flow.

(vii) In recognition of the short duration and high throughput nature of servicing and light maintenance activities, a one-way flow for vehicles through the facility and a queuing space for vehicles awaiting attention shall be considered.

(viii) Safe access to vehicle mounted equipment shall be provided.

(ix) Access to vehicle current collectors shall be restricted.

(x) Supplies and services necessary such as electricity, and compressed air, special test equipment and interfaces to the maintenance management system shall be provided at suitable locations.

6.4.4.3 Heavy Maintenance

(i) The heavy maintenance facility shall be provided to the Technology Provider's standards to enable:

(ii) Periodic overhaul

(iii) Modification and replacement of major components

(iv) Collision damage and major breakdown repair

(v) Quality assurance testing

(vi) Mechanical, electrical and electronic workshops shall be provided for the overhaul and quality assurance testing of monorail equipment.

(vii) The heavy maintenance facility shall be protected against inclement weather and shall be arranged to optimize work flow.

(viii) Plant and machinery provided shall be capable of fully supporting the entire workload of the workshop.

(ix) Safe access to all vehicle mounted equipment shall be provided.

(x) Guideway shall be arranged to enable access to undercarriage equipment

(xi) The traction supply equipment shall be interlocked with potentially hazardous activities and shall be retractable where necessary.

(xii) Testing and movement of vehicles shall be possible without connection to the continuous traction system, power rails etc., where necessary with the help of stingers etc.

(xiii) Bogie disassembly & assembly arrangements for bogie maintenance shall be provided.

(xiv) Supplies and services necessary, special test equipment and interfaces to the maintenance management system shall be provided at suitable locations.

6.4.4.4 Overhaul

6.4.4.4.1 Specialized repair and overhaul facilities shall be provided for all components and subassemblies such as:

(i) Bogies
(ii) Wheel / tyre sets
(iii) Traction motors
(iv) Brake equipment
(v) Suspension gear
(vi) Door panels and operating devices
(vii) Air Conditioning units
(viii) Current Collectors
(ix) Couplers
(x) Electrical and electronic equipment
(xi) Others as required

6.4.4.4.2 Overhaul-Facilities (Workshops) shall be provided for the overhaul of the cars at intervals of approximately 3 years and 6 years. Actual intervals will be based on Technology Provider's recommendations and may be based on distance rather than time.

6.4.4.4.3 The facilities shall be provided for bogie removal, and the rapid removal of specified components and assemblies, the overhaul or disposal of removed items and the reinstallation on the vehicle.

6.4.4.4.4 Guideway in the Workshop shall have a minimum distance from the center of Guideway to the nearest structure of 5.8 m to 6.0m. Distances between adjacent Guideway shall be 6.25 m. They shall be un-powered i.e., without power rail.

6.4.4.4.5 Adequate space shall be provided for removal and transportation of equipment from and to the vehicle including bogies.

6.4.4.4.6 Use of fork lift vehicles can be planned for removal of certain components from the sides of cars/Bogies.

6.4.4.4.7 Guideway shall be arranged to enable access to undercarriage equipment.

6.4.4.4.8 Cranes shall be provided along with body stands.

6.4.4.5 Unscheduled Maintenance

(i) Corrective maintenance may be performed in the Servicing Shed or the Workshop or at other facilities depending on the nature of the repair or inspection.

(ii) Vehicle stands shall be provided to enable access to undercarriage equipment.

(iii) One train berth space in the Servicing shed shall be dedicated for unscheduled maintenance.

6.4.4.6 Tyre Change

Facilities shall be provided for tyre replacement.

6.4.4.7 Systems Maintenance

Maintenance facility for all systems-Guideway including switches / Guideway, traction, Signalling, communication and fare collection shall be provided.

6.4.4.8 Test Track

A dedicated separate line or a section of the Revenue Line in proximity to the Depot shall be designated for the test track for the testing of trains during non-revenue periods.

The section of Guideway selected shall have minimum impact to the adjacent urban area.

The Test track shall be provided to allow testing of Monorail vehicles. The

test track shall have the following features:

(i) Length of about 1.2 km. The objective should be 1.5 km

(ii) Straight and tangent track or with a maximum curve of 1000 M

(iii) Grade not to exceed 0.1%

(iv) Have no crossings

(v) Be completely fenced / gated with clearly definable access points

(vi) Paved walkway on both sides of the test track with desirable clearance of 2 m (fence 3.6 from center of the test track)

(vii) Isolation devices at connections to the remainder of the depot Guideway s

In case a separate test track is not possible a dedicated separate line or a section of the Revenue Line in proximity to the Depot shall be designated for the test track for the testing of trains during non-revenue periods.

The section of Guideway selected shall have minimum impact to the adjacent urban area.

The Test track area shall be equipped with revenue line Continuous Automatic Train Control System facilities, similar to those of the revenue line, for testing train and train borne equipment.

6.4.4.9 Stores

Centralized storage shall be provided for the System with appropriate facilities for Corridor maintenance and operation requirements for material and supplies, spare parts and overhauled components waiting to be put back in service and associated handling equipment.

Capacity provided shall consider the following:

(i) Planned maintenance activities and contingencies for unplanned repair.

(ii) Storage of consumable, capital spares and spares parts for maintenance of Rolling Stock.

(iii) Storage of tools, consumable, capital spares and spares parts for maintenance of other assets such as Guide way, Signalling, communication, etc.

(iv) Design of these facilities will fully account for security and climatic considerations.

(v) Facilities shall include all racking, shelving, bins and material handling equipment.

(vi) The main storage area will be located close to the workshop area.

6.4.4.10 Stabling

The following factors shall be incorporated into the depot in relation to related to Monorail stabling:

(i) The stabling Guideway shall connect directly to the mainline without any shunting moves necessary

(ii) The number and arrangement of stabling sidings shall be such that when all the Monorail serviceable trains are berthed, adequate spare Guideway shall still be available in the Depot for shunting movements' necessary, and contingencies.

(iii) Operation and maintenance staff shall have safe access to all stabled trains through, underpasses and walkways without many reverse movements.

(iv) Routing of trains from the mainline shall be through a path that connects directly to the stabling areas via the car wash. That is, trains shall be washed on entrance into the depot and then be stabled on assigned Guideway without shunting movements. This requirement shall be applicable to a minimum of 75% of the total stabling capacity.

(v) A minimum of a Train Length clear of fouling mark shall be provided before the automatic coach washing plant so that the full train is clear of the main depot entry line when washing is in progress.

(vi) Trains arriving at or departing from the stabling areas shall have a capability to bypass a train on either end of the car wash when the train is within 5 meters of the car wash.

(vii) Trains shall also have direct access to the shops from the mainline without reversing moves being required.

(viii) Movement of trains from stabling areas to the shops shall not interfere with trains entering or leaving the depot.

(ix) Stabling areas shall be provided for rakes of cars length to meet the train consists required at the end of the concession period.

(x) The required length is the coupler-to-coupler length plus 2 Metre between trains or fouling points and Buffer Emergency stop length.

(xi) Stabling Guideway shall be on level formation or on a grade not exceeding 0.1%.

(xii) For the stub end Guideway, no more than two trains are permitted in line.

(xiii) Spacing of adjacent stabling Guideway s shall be such as walkways and trolleys movement in stabling is unhindered.

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(xiv) A minimum of 50% of the total stabling capacity shall be provided with a sun shade cover to reduce heat load on the trains. The cover shall prevent direct sunlight on all cars.

(xv) No single failure of equipment or a System / sub-system shall prevent or delay more than 50% of the stabled fleet from entering revenue service in accordance with the planned time table.

6.4.4.11 Offices and Amenities

Suitable office and staff amenities shall be provided for personnel based and I or working in the Depot, such as:

(i) Management and administration;

(ii) Engineering

(iii) Operations (drivers and control);

(iv) Maintenance;

(v) Training

(vi) Security.

6.4.4.12 Depot Guiderail Layout

The Guideway structures within the Depot will include:

(i) Transition structure to the main line. Precautionary measures shall be provided to prevent accidents from an out-of-control car running down the slope.

(ii) General Guideway s. May run at higher levels, on columns / elevated platforms as per the Concessionaires design

(iii) Guideway s within buildings. Depending upon the entry level and function these may be at various building levels

(iv) Guideway for test track

(v) Facilities in the Depot shall be ergonomically designed and arranged in a logical manner in order to optimize the routine workflow and the capability for coping with abnormal situations.

(vi) The Depot track layout shall be designed to achieve a minimum of shunting movements.

(vii) Alternative routes for movement shall be provided to the largest reasonable extent, to relieve congestion and ensure availability of the Depot.

(viii) Double Guideway access shall be provided to permit simultaneous movement

of Trains leaving and arriving at the Depot.

(ix) The layout shall permit Cars to pass through the Train washing plant on arrival in the Depot without conflicting movements.

(x) All stabling, servicing and light maintenance facilities shall accommodate the maximum revenue service Train configurations permitted, without the need for separation of Cars of Train consists.

(xi) Depot facilities shall allow access by road vehicles and mechanical handling equipment, including Emergency service vehicles and equipment, and delivery of Monorail Cars.

(xii) As far as possible, access shall avoid conflicts with Train movements.

(xiii) The Depot layout shall facilitate security and smooth flow for pedestrian and vehicular access and perimeter protection, with least interference to normal maintenance and operation activities.

6.4.4.13 Building Structures

(i) Building structural form may be proposed by the Contractor for the approval of The Engineer.

(ii) For heavier structures like depot, workshop etc., particularly those with crane loading, and above stabling lines, pile foundations shall be such that no cracks or settlement is noticed.

(iii) Super structure may be of reinforced concrete cement framed structure or steel column, supplemented by brick work in shed structures and of brickwork in other buildings and ancillary works.

(iv) Pre-fabricated steel structures are acceptable for workshops.

(v) Shed structures such as Main Workshop, Inspection bays, workshop etc. may have steel truss roof and may have pre-engineered structures with steel cladding.

(vi) The office & other structures may have normal flat reinforced concrete roofing.

6.4.4.14 Buried Services

(i) All buried services shall be protected underneath the Depot tracks and shall enable future replacement of services.

(ii) Protection provided shall be capable of supporting the loads of the Guideway structures.

(iii) As far as reasonably practicable, under-track crossings shall be aligned so as to

pass under the track at right angles to the Guideway, and shall enable safe separation of electric cable ducts and the track work.

6.4.4.15 Walkways

(i) Walkways shall be positioned to provide personnel circulation across Guideway s.

(ii) Personnel moving about the Depot always shall have a clear view of moving rail vehicles.

(iii) Walkways shall provide safe surfaces under all weather conditions, adequate electrical insulation properties where necessary, and enable Guideway maintenance.

(iv) Appropriate lighting, ventilation and drainage shall be provided.

6.4.4.16 Yard Landscaping

(i) Yard landscaping provisions shall include planting of trees and shrubs and suitable pavement and lighting features.

(ii) Trees, shrubs and ground covers shall be used all around the perimeter green strip surrounding the outside of the Depot, where possible.

(iii) Trees and shrubs shall also be used around the administrative building, parking areas, traffic islands, Depot entrances, etc. Low shrubs and ground covers shall be used along the fences on both sides.

(iv) Internal Depot vehicular roads shall be suitably paved and to IRC standards, with appropriate road furniture, lighting and markings.

(v) Main entrance, parking areas and access to administration building shall also be paved.

6.4.4.17 Earthing and Bonding

Earthing and bonding system provided shall comply with EN 50122-1 and all other relevant international standards. Refer Chapter 1 on General Technical Requirements. Particular attention shall be provided for earthing / lightning / stray current protection requirements for:

(i) Workshops

(ii) Rail systems electronic systems

(iii) Building services equipment

(iv) High mast lighting
(v) Fences
(vi) Test track
(vii) Guideway transition structure with main line
(viii) Utility connections into the Depot
(ix) Control Rooms
(x) Substations
(xi) Car Wash
(xii) General buildings

6.5 Equipment, Finishes & Systems Requirements

6.5.1 Materials and Finishes

6.5.1.1 All materials shall be selected with the highest regard for safety and security.

6.5.1.2 They shall be non-combustible and non-toxic, and conform to all applicable Pakistani codes and standards.

6.5.1.3 Materials shall be selected for their wear, strength and weathering qualities that resist abrasion, impact, humidity, temperature changes and sunlight.

6.5.1.4 Colour and appearance shall be retained throughout the design life of the material.

6.5.1.5 Materials shall be stained resistant and non-water absorbent, easy to clean, repair and replace.

6.5.2 Doors and Windows

6.5.2.1 Workshop doors shall be motorized collapsible steel shutters.

6.5.2.2 Doors and windows in all the other structures shall be of steel, with glazed panels.

6.5.2.3 All windows shall be provided with iron grilles and in all external windows wire glazed shutters shall be provided.

6.5.2.4 Door shutters in offices and other buildings shall be of flush panel and glazed type.

6.5.3 Flooring

6.5.3.1 Heavy-duty flooring (Cement, concrete reinforced with short steel bars or iron casting) shall be provided in heavy repair and lifting bays for Monorail.

6.5.3.2 Other buildings such as sub- station shall also be provided with heavy-duty floorings. Generally, plinth level should be 460 mm (minimum) above the natural ground level or center of road whichever is higher.

6.5.3.3 Acid storeroom shall have acid and alkali resistant tiled floors.

6.5.3.4 In the rest of the workshop buildings cement concrete floorings shall be provided.

6.5.4 Signage

6.5.4.1 Signage shall be consistent with and comply with the requirements for signage in the Chapter 4 on Station Planning and Design.

6.5.4.2 Depot signage shall include the following signs and graphics:

(i) Safety
(ii) Directional
(iii) Information
(iv) Identification
(v) Accessibility
(vi) Emergency
(vii) Regulatory
(viii) Operational.

6.5.4.3 As agreed with The Engineer Signage shall be in Urdu and English.

6.5.5 Depot Signalling

6.5.5.1 The Depot Signalling system shall enable control of movements of the Trains within the Depot limits and shall provide route setting and holding with indications of Train locations displayed on a mimic panel/VDC and shall be controlled from a Depot Control Centre (DCC).

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6.5.5.2 Signaled routes shall be interlocked against conflicting Train movements without compromising operational requirements.

6.5.5.3 Facility shall be provided on the transfer berth(s) for Trains entering the revenue line from the Depot, to establish the correct mode of driving and Train run data.

6.5.5.4 Facility shall be provided for Trains leaving revenue service at the Depot entry transfer berth(s) to change to Depot operation mode and to download Train identification and condition data. This shall not require the vehicle to be stationary.

6.5.5.5 A warning system shall alert staff working in depot areas of approaching vehicles.

6.5.6 Electric Power Supply and Traction System

6.5.6.1 The Auxiliary Supply System and Traction System shall be designed for full redundancy.

6.5.6.2 The essential services in the Depot shall be provided with stand by generator

6.5.6.3 Two diverse supplies shall be provided for a 33kV 3-phase Supply ring main supplying each station and the Depot, and traction power supply at 750V DC or 1500V DC.

6.5.6.4 The traction System in the Depot shall include the provisions outlined below:

a. Depot High Voltage and Low Voltage Electric Power Supply

(i) The Depot Sub-Station shall have suitable protection equipment.

(ii) The HV switching and protection equipment shall be of similar design and equipment to that of the revenue line

(iii) Power supply switching and metering shall be controlled by a power SCADA System from the OCC.

b. Depot Traction System

(i) Separate Traction Sub-station (TSS) shall be provided for Depot.

(ii) The Traction System switching and protection equipment and equipment in TSS shall comply with the relevant standards specified in the Chapter

9 for Electrical Power System

(iii) With the exception of certain maintenance tracks, stabling tracks and works sidings, where appropriate, all tracks in the Depot workshops shall be fitted with stringer type traction supply; sectionalizing shall enable the isolation of areas for O&M purposes.

(iv) Energizing of the traction supply shall be interlocked with material handling equipment to achieve complete safety of personnel and equipment.

c. Segregation from the Link Line

(i) Traction supplies (shall be arranged such that the Depot traction system shall be normally segregated from the Link Line connecting to the revenue system.

(ii) The TSS should have arrangement to couple the Depot to the Link Line during Depot supply outage conditions.

d. Electrical Sectioning

(i) The Depot traction power supply system shall be suitably sectionalized to support maintenance and to mitigate system failures.

(ii) Remote controlled switches shall be provided in the OCC for isolating elementary sections of the Depot.

e. Depot Traction Supplies

(i) Traction supplies provided in the Depot shall be fed through separate feeder from TSS.

(ii) Local Control Panels shall be conveniently located in/around depot and equipped with status indication and safety interlocking.

f. Washing line

(i) Traction power supply for washing lines shall allow unimpeded operation without compromising safety.

6.5.7 Lighting

6.5.7.1 Lighting for the Depot shall comply with the Chapter 10 on Building services and the particular requirements below.

6.5.7.2 General Depot lighting shall provide safe and efficient levels of lighting in order to maintain 24-hour operations.

6.5.7.3 Only administration area and Depot entrances shall have public street quality lighting standards. All other areas of Depot shall have industrial type lighting with uniform lighting level.

6.5.7.4 Ultimate care to be taken to avoid glare or light pollution from inside the Depot boundaries to outlying areas, other than what is necessary for perimeter security.

6.5.7.5 The entire Depot site shall be illuminated to provide for secure and safe operation, 24 hours a day and during inclement weather.

6.5.7.6 Where used, high lighting masts shall allow for lowering of hoisted light rings for ease of maintenance.

6.5.7.7 Heavy-duty, protected fixtures shall be used to light pits, tunnels, bridges and gangways.

6.5.7.8 Movable lighting, on motorized or tracking rigs may be used in order to provide flexible and movable high intensity illumination to accompany night work crews along stabling, and other outdoor maintenance tasks.

6.5.8 Depot Control and Communication Systems

6.5.8.1 The control and communications facilities in the depots shall be integral with the overall Communication Systems of the monorail System.

6.5.8.2 All control and communication systems provided for the Depot shall comply with the requirements the Chapter 8 on Communication Systems including the following:

(i) Design criteria
(ii) Spare capacity and expansion
(iii) Performances
(iv) Environment
(v) EMC
(vi) Power and Telecommunications Consultative Committee (PTCC)
(vii) Control and communication systems performance specification.

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6.5.9 Specific requirements for the Depot are outlined in the following sections.

6.5.9.1 CCTV

CCTV cameras shall be located to monitor roads and access to the Depot.

Monitors shall be provided in the DSO and OCC. Refer Chapter 8 on Communication Systems.

6.5.9.2 Communication Network

The system-wide communications backbone network shall provide a node within the Depot. This system shall carry voice, data and video communications between the

OCC, revenue line and the Depot. Refer Chapter 8 on Communication System.

6.5.9.3 Fire Detection System

Fire detection and fighting system shall be provided in the Depot for the automatic control of fire. Refer Chapter 10 on Building Services.

Automatic and manual fire detectors shall be provided in buildings and supervised from a fire alarm control panel located in the Depot Security Office (DSO).

Alarms shall also be routed to the OCC via a DMS for the Depot.

An interface between the fire detection and prevention system and the CCTV equipment shall automatically enable viewing of the incident area from the DSO and OCC;

6.5.9.4 Clock System

Slave clocks shall interface with the Signalling system, communication systems, security systems, DMS and Power SCADA Systems to provide a common time reference and shall include display units at least in the DCC and DSO. Refer Chapter 8 on Communication System.

6.5.9.5 Intercom

An intercom system shall be provided between the DCC and Depot areas. Refer Chapter 8 on Communication System.

6.5.9.6 Radio System

The Operator Radio System shall include a base station and antenna for providing radio communications within the Depot for communications between the DCC, DSO, Train and mobile operation and maintenance staff, and the OCC. Refer Chapter 8 on Communication System.

6.5.9.7 SCADA System

A SCADA System shall be provided for the automatic control of the Depot power supply and traction system and its remote control from the OCC. Refer Chapter 9 on Electrical Power Supply.

6.5.9.8 SMS System

An SMS System shall be provided for controlling and indicating of fixed E&M equipment of the Depot

6.5.9.9 Telephone System

A telephone sub-exchange of the PABX System shall be provided in the Depot.
The PABX shall provide the O&M requirements for voice connection with the revenue line facilities and public telephone system, as specified in the control and communications specification. Refer Chapter 8 on Communications

6.5.9.10 Waste Water Treatment Plant

A waste-water treatment and recycling plant shall be provided for storm water and water from Train washing and cleaning, and shall be located within the Depot.

6.5.9.11 Security System

An automated security system shall be provided for the following:

(i) Vehicular and pedestrian access control and recording entrance and exit with the Depot
(ii) Fire alarm control panel
(iii) CCTV covering the Depot site, buildings and perimeter fencing
(iv) Access control to offices, technical rooms, stores.
(v) The supervisory equipment shall be located in a Depot Security Office (DSO) provided at the Depot main entrance.

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6.5.9.12 Drainage System

An internal depot site and building storm water drain system shall be developed.

6.5.9.13 Sewerage System

The Contractor shall establish if Sewerage water can be discharged into the municipal sewerage system or if on-site sewerage treatment plant is required.

6.5.9.14 Maintenance Management System

A Maintenance Management System (MMS) shall be provided.
Access to the MMS shall be possible from appropriate locations in the Depot, revenue line and the central control facilities of the integrated electronic control center and stand-by control centers.

The system shall address, but not be limited to, the following items:

(i) Data exchange with Train borne systems
(ii) Failure recording and analysis
(iii) Maintenance Manual and diagnostic
(iv) Maintenance planning and recording
(v) Staff schedules
(vi) Stock control
(vii) Interface to the asset database.

6.5.9.15 Depot Equipment and Machinery

Equipment and machinery shall be provided to undertake the work identified in the Depot operations and maintenance plan.
It is recognized that designs and specifications of depot equipment shall be dependent on the Contractor's technology.

The Contractor shall prepare details of the required equipment and machinery, for approval of The Engineer.

Equipment shall be proven in service for the application.

6.5.9.16 Train Recovery Equipment

Equipment shall be provided for recovery of damaged or otherwise disabled rail vehicles from all areas of the Rail System.
Rescue vehicles are also required for fire- fighting, medical facilities and emergency rescue operations.
Movement for these facilities may be planned by road or by Guideway or by both.

6.5.9.17 Switches and Guideway

Switches and Guideway shall be same as those used on the revenue line.

6.6 Testing and Commissioning Requirements

Contractor should adhere to the testing and commissioning requirements as detailed in Chapter no. 1 & 12 of MSS.

6.7 Systems Assurance

Contractor should adhere to the System Assurance requirements as detailed in Chapter no. 1 & 12 of MSS.

6.8 Interface Provisions

Contractor should adhere to the interface provision requirements as detailed in Chapter no. 1

6.8.1 The Contractor shall ensure that all interface requirements relating to the Depot with rolling stock, rail systems and civil works are identified and the associated Interface Management Plan which shall be reviewed by The Engineer. In particular the following shall be addressed:

(i) Depot interface with Rolling Stock
(ii) Depot with Signaling Systems technical rooms and cable containment
(iii) Depot with Communications Systems technical rooms and cable containment
(iv) Depot with OCC
(v) Depot with Building Services Systems
(vi) Depot with Civil Interfaces, approach viaducts, utilities, roadway
(vii) Depot with Earthing and Bonding System Systems

CHAPTER – 7

SIGNALLING AND TRAIN CONTROL

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CHAPTER – 7
SIGNALLING AND TRAIN CONTROL

7.1 General

7.1.1 This section lays down the standards and performance requirements for the Signaling and Train control (S & TC) system to be designed, constructed, tested and commissioned by the Contractor for the monorail system. The Contractor shall build a system of Signaling to proven standards so as to ensure the safe movement of trains over all running lines. The system shall be designed to operate at 90 seconds interval during services.

7.1.2 The Signaling system shall support operation of train. The Signaling shall enable the configuration of onboard and wayside Signaling equipment so as to enable operation of all trains.

7.1.3 All the trains shall utilize 750 /1500 V DC supply for traction power

7.1.4 The Signaling and Train Control System for the revenue lines shall be controlled from centralized Operation control Centre (OCC).

7.1.5 Only one Depot to be located Near Lake View Station Islamabad at prescribed locations. The Signaling and Train Control system of the depot shall be controlled from the Command & Control Center (DCC). The Depot shall be provided with simple form of Signaling.

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7.2 Overriding Considerations

7.2.1 There are four overriding considerations which are of the highest importance in the development of the Signaling and Train Control System for the monorail:

a. The Signaling and Train Control System shall be designed by the Contractor to smoothly support a close headway operation.

b. The attainment of the reliability, availability, and maintainability and safety requirements of the System shall be verified by analysis, simulation, testing and commissioning, and system demonstrations as required in this Specification.

c. The attainment of the operating performance requirements, e.g. design headway and throughput.

d. Minimize the trackside equipment. The complete system is planned to be tested & commissioned in phased manner.

7.3 Performance Requirements

7.3.1 The Signaling and Train Control (S&TC) System shall achieve all performance requirements specified in this chapter.

7.3.2 The S & TC System including all sub-systems and equipment shall be of proven design. All the systems/sub-system equipment, hardware and software proposed by the Contractor shall have been in use and have established their satisfactory performance. (Ref clause 1.8.4)

7.3.3 Built-in diagnostics and remote monitoring functions for each microprocessor- based equipment module of the Signaling and Train Control System shall be provided such that the performance requirements can be demonstrated.

7.3.4 The system shall be according to CENELEC Standards (EN50126-1, EN50126-2 EN50128, and EN50129) or equivalent for Reliability, Availability, Maintainability and Safety of electronic Signaling equipment.

7.3.5 The Reliability, Availability, Maintainability and Safety requirements shall be fully demonstrated by the Contractor

7.3.6 **Service Life**

i. All components, materials, software and other support required to repair and service all Signaling and Train Control System shall be available for at least 25 years.

ii. The Contractor shall conduct operating simulations for normal, congested and abnormal working service patterns.

7.3.7 **Safety Requirements**

7.3.7.1 The Signaling and Train Control System shall provide for the safe routing, spacing, movement and control of trains.

7.3.7.2 The Contractor shall establish and maintain complete responsibility of the system safety through the application of engineering and management principles, criteria and techniques to optimize all aspects of safety throughout all phases of the system life cycle.

7.3.7.3 The Signaling and Train Control System shall not lead to an unsafe condition when the plug-in module/card/equipment is taken out.

7.3.7.4 The probability of Wrong Side Failure shall be less than 10^{-9} per operating hour of the Signaling and Train Control System for this corridor. The Contractor shall submit a safety case pertaining to the Signaling system and provide information / documentation required by the ISA appointed by the Contractor, with the approval of TE

7.3.7.5 The Contractor would engage an ISA to certify safety and fit for purpose of the S & TC system, commissioned, before seeking approval from TE.

7.3.8 **Service Capacity**

The Signaling and Train Control system design shall make provision for minimum head way of 90 seconds.

7.3.9 **Signaled Headway**

The S&TC system shall be designed with Signaling design headway such that service headway of 90 seconds shall be available.

7.3.10 **Bi-Directional Running**

The Signaling and Train Control System shall provide continuous Automatic Train Control with Automatic Train Operation, Automatic Train Protection and Automatic Train Supervision over bidirectional routes.

All PIDS & PA interfaces shall also work in auto mode in case of bi-directional working of trains.

7.3.11 **Functional Requirements**

7.3.11.1 The revenue line S & TC system shall be a continuous Automatic Train Control system (CATC) comprising Automatic Train Protection (ATP) system, Automatic Train Supervision (ATS) system and Automatic Train Operation (ATO) system and shall also provide CATC supervised working over each main line track.

7.3.11.2 The Continuous Automatic Train Control (CATC) system shall consist of the following components:

a. Automatic Train Protection (ATP): All the functions under ATP shall be vital functions and shall govern the overall functioning of CATC system. This vital

system maintains the safety of train operation including separation of trains, enforcement of speed restriction, and safe operations through interlocking.

b. Automatic Train Operation (ATO): The normal train operation is controlled by the train borne ATO system. The system drives the train and stops at the stations. The ATO system also opens the train doors to the correct side.

c. Automatic Train Supervision (ATS): This system directs train operations to provide scheduled service under normal conditions and the best service possible under adverse conditions. It exchanges messages with external subsystems such as CBI, ATC, Master Clock, PIDS, PAS and Train Radio etc.

7.3.11.3 The system shall be normally operated in ATO mode with driver onboard.

7.3.11.4 Line-side signals shall be provided at interlocking, terminal stations for protection of switches and for starting from depots.

7.3.11.5 The Signaling and Train Control System shall provide the following modes of train operation.

i. Automatic Train Operation Mode (ATO) or AM mode

ii. ATO mode shall be used as the normal method of Train control using ATO

iii. Automatic Train Protection Mode (ATP) or Coded Manual (CM) Mode

iv. The CM mode shall be used till ATO is introduced and as a fallback method of Train control using ATP when a train or Trackside equipment fault prevents ATO driving.

v. Restricted Manual Mode (RM)

vi. Restricted mode (RM) driving shall be used as a fallback method of Train control when a train or trackside equipment fault prevent ATP supervision. It is default mode of operation in Depot.

vii. Cut-Out Mode (By-pass Mode)

viii. In cut out mode train shall be operated by the Train operator in accordance with line side signals and verbal instructions by controller. It is used in case of complete failure of Signaling & train control equipment.

ix. Yard/ Depot mode: in this mode the train driving controls shall be operated within the speed limit for the Depot. This mode shall be used for all movements within the Depot and workshop.

x. Wash mode: a Sub mode of yard mode, shall limit the train speed while washing in fixed plant and for coupling of trains.

xi. Reverse mode

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7.4 Design Criterion

7.4.1 Signaling and train Control systems shall be of communication-based Control System GoA-3(Moving Block) as defined in IEEE 1474.1.

7.4.2 According to the definition of IEEE 1474.1, CBTC systems rely on the three following aspects:

i. Self-localization of the trains by on-board equipment: With CBTC technology, the detection of trains no longer requires track circuits. The train passes over a first transponder to get initial localization information. Then it computes its position on the line from the travelled distance calculated as per the displacement measurement system. Transponders along the track allow for a repositioning at specific locations. On-board equipment transmits the train's position to the wayside control system which updates the positions of all the trains in its area of responsibility. Under no circumstance any CBTC equipped train would be de-localized either on main line, siding or due to any turn back operations.

ii. In exceptional cases of delocalization of vehicle due to on board or way side equipment failure, the vehicle shall be localized automatically upon restoration of the failed equipment.

iii. Continuous and bi-directional communication between wayside and on-board equipment: With continuous communication, the on-board equipment can continuously transmit its position, speed and any other relevant information to the wayside equipment.

iv. Vital functions performed by both on-board and wayside equipment: Automatic train protection and operation functions are shared between on-board and wayside equipment and vitally performed by both to ensure high safety of the system.

7.4.3 **Basic CBTC Functions**

7.4.3.1 The following functions form the basis of CBTC's train control capabilities:

i. Localization: establishes a train's location.

ii. Sieving: establishes that the front and rear ends of a train are clear.

iii. Virtual Blocks and Train Tracking: resolves train location,

iv. Movement Authority: authorizes train movement limits.

v. Speed Management: establishes limiting speeds.

vi. Speed Enforcement: enforces speed limits.

7.5 System Description and Performance Requirements

7.5.1 The system shall be based on proven CBTC technology with secure Radio communication complying with IEEE 1474.1.

7.5.2 The CBTC based Automatic Train Control (ATC) system shall consist of Automatic Train Protection (ATP), Automatic Train Operation (ATO) and Automatic Train Supervision (ATS) systems. The ATC function shall be responsible for implementing train movements in accordance with the requirements established by the ATS function, within constrains established by the interlocking function. The design of the ATC system shall ensure safe and reliable performance under normal operation and degraded operation.

7.5.3 Line side signals shall be provided along terminal stations towards Depot End, to maintain Train services and to allow safe Train movement.

7.5.4 The System shall be fault tolerant and configured such that any single point of failure shall not result in loss of indication or control or degraded operation.

7.5.5 The Computer Based Interlocking (CBI) system shall be of proven failsafe design for the operation of Vital Signaling Interlocking. It shall interface with wayside equipment, ATP, ATC and ATS system. The system shall degrade itself to predefined safe conditions in the event of any fault occurrence.

7.5.6 The ATC system shall be a continuous bi-directional communications-based system. Wayside ATC computer shall acquire the state of Interlocking, track profile, train position and other necessary information, and then vitally transmit to train-borne ATC for the calculation of safe speed-distance curve and drive the rolling stock equipment.

7.5.7 The ATC system shall have a track data base (train borne or otherwise) with all necessary track information (profile, switch, position etc.) for calculation of safe speed-distance curve required to drive the rolling stock equipment.

7.5.8 On the revenue lines the train shall normally operate under ATO mode. These modes are to be defined under various conditions including a fallback situation.

7.5.9 The ATS system shall assist Traffic Controllers at OCC to restore service after service interruptions. To reduce the recovery time, the system shall be able to re-start automatically after power interruption and/or system crash.

7.5.10 The delivered system shall be possible to be interfaced with other systems built under this Project as per the interface specifications.

7.5.11 The CBTC system shall follow the IEEE CBTC standards along with the CENELEC standards for the safety like EN 50126, EN 50128, EN 50129 or equivalent international standard for safety.

7.5.12 **Performance Requirements**

The performance requirements are mentioned as under.

7.5.12.1 The ATC system shall be of CBTC type and shall comply to IEEE Standard 1474.1-latest version and 1474.2- latest version.

7.5.12.2 All Rolling stock, passenger trains and maintenance vehicle such as tow vehicle shall be CBTC equipped.

7.5.12.3 The ATC system shall support Plat Form Screen Door (PSD) operations. Line side signals if required shall be provided for operation under special conditions (for example at switches and depots).

7.5.12.4 The ATC system shall provide high-resolution Train location determination, it shall be based on a continuous, high capacity, bidirectional Train-to-wayside data communications using a secure radio system with fault tolerant equipment design to ensure that a high level of train service is maintained in the presence of a single point failure.

7.5.12.5 The free space propagation radio system shall be resistant to interference from other radio transmissions so as to ensure proper functioning of the CBTC system, In event of any possibility of interference during initial survey, guided propagation solution (waveguide)/leaky feeder shall be proposed to avoid / minimize interference from other radio sources such that it does not affect functioning of the CBTC system.

7.5.12.6 The Contractor shall be responsible for obtaining any license / approval required PTA

(Pakistan Telecommunication Authority) for frequency authorization / siting clearance for the Radio system of the CBTC system.

7.5.12.7 Vital functions of the ATC system consisting of ATP and ATO functionality shall be performed by Train-borne and wayside processors.

7.5.12.8 The ATC systems shall be of suitable hot standby redundant architecture.

7.5.12.9 For the train borne ATC equipment (ATP & ATO), redundant units shall be provided in each of the cabs in hot standby configuration.

7.5.13 Vehicle Position Detection

The Contractor shall provide equipment for detecting the position of trains which is fit for its purpose according to the modes in which trains may run at that location. The train detection equipment shall be fail safe. The position shall be determined with the accuracy required to meet the requirements in this specification related to:

i. Locking of switches
ii. Prevention of collisions between trains
iii. Prevention of over speeding where a speed limit applies
iv. Provision of accurate information about train service to users.
v. Event renovating: The vehicle position detection equipment shall be highly reliable and accurate

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7.6 Data Communication System (DCS)- Radio System Based

7.6.1 The track to train communication link shall be of high integrity, bi-directional data communication link suitable for transmission of safety critical information. The means of transmission and reception of the trackside ATP information shall be chosen such that there is no pickup of stray signals in the process. The transmission medium along the trackside shall have an unobstructed communication path between it and the train-borne antennae. Provision shall be made for redundancy to achieve high availability of system if required.

7.6.2 Communication shall be carried out over a high speed data link with error correction in a noisy environment. It is therefore vital that the method of data transfer employed protects the integrity of the data link. Any errors in the received data due to corruption over the links shall be detected and rejected. The data communication system shall have

sufficient capacity to accommodate the minimum needs specified and to accommodate future increase in data. The DCS shall provide the data communication functions between each Signalling subsystems including the wayside to wayside, wayside to train and intra-train data communications.

7.6.3 The DCS shall support bidirectional data transfer and shall have sufficient bandwidth and low latency to support all the ATS, ATP and ATO functions.

7.6.4 The DCS shall provide timely and secure delivery of Train control messages.

7.6.5 The DCS system shall comply with the requirement of BS EN 50159-2: latest version.

7.6.6 The DCS system shall provide authentication mechanism to ensure messages are sent from authenticated sources.

7.6.7 The entire DCS (way side) system shall be a duplicated system with multiple redundancies to provide high operation availability when equipment fails. Failure of a DCS equipment or physical link shall not affect the normal Train operation. The train borne DCS shall also be redundant architecture.

7.6.8 The DCS system shall satisfy the EMC requirements

7.6.9 The Contractor shall be aware that there shall be other radio-based communications systems in the project area and the DCS system shall be designed not to interfere and be interfered by such systems.

7.6.10 The Contractor may use 2.4 GHz or 5.8 GHz band-based radio system for CBTC based solution. The radio communication protocol used shall be rugged and immune to interference from other systems. The Contractor shall take all approvals from concerned authorities like PTA if the frequencies used, requires a WPC license.

7.6.11 Wayside radios will be sited based on a detailed study of radio propagation in the complete track alignment territory. The study shall include effect of trains themselves on radio propagation. In event of a complete failure of a wayside Radio Access Point (AP) or DCS equipment, communication shall be maintained through neighboring locations.

7.6.12 The wayside radio equipment will be compact and shall be configurable for installation even under severe space constraints. Wayside radios shall require a power source and a

data link over multimode fiber optic cable (FOC).

7.6.13 The FOC for the radio APs shall be independent of the back bone FOC specified in telecom specifications. The way side DCS equipment or AP shall be connected by multiple fibers FOC loops to provide high operation availability. Failure of one FOC shall have only limited impact to the DCS system. Various radio antennas for the Radio access points or DCS may be
required, for adequate radio coverage, as per radio propagation study in the territory.

7.6.14 In event of interference in free space radio propagation solution, the Contractor shall preferably use a guided transmission media (leaky waveguides) which shall require less maintenance and also be less prone to outside radio interference.

7.6.15 **Train borne DCS Equipment**

7.6.15.1 The Train Borne DCS equipment shall be configured in a dual redundant hot standby configuration. Failure of one train borne DCS equipment shall have no impact on operation of the train.

7.6.15.2 The Train-borne DCS shall be able to communicate with the Wayside DCS equipment seamlessly in particular when the communication link is being handover between different Wayside DCS devices or during roaming operation.

7.6.16 **Wayside DCS Equipment**

7.6.16.1 The wayside DCS equipment shall be provided in project corridor and Station areas. The Contractor shall design the DCS system taking into account all the Site constraints such as noise barrier and track alignment.

7.6.16.2 The DCS shall be able to support the ultimate train service Headway and Train fleet.

7.6.16.3 The DCS shall be designed to support the train operation during the maximum Train density resulting from degraded operational conditions such as Train jamming.

7.6.16.4 Radio survey along the project corridor and Depot areas shall be carried to ensure that the wayside-to-train radio communication signal strength is able to meet the required Train operation requirements.

7.7 Fallback Mode of Signaling

7.7.1 The Signaling System provided shall accommodate degraded and emergency operation.

7.7.2 In case of failure of the CBTC system in a particular zone or complete failure of the CBTC system, the system design shall ensure that the trains remain protected. Under failure conditions the Train IDs shall be stored and not be lost. The Controllers shall make use of these IDs to control the traffic.

7.7.3 On restoration of the system, all trains shall be localized automatically with updating of Train IDs and operation of trains under ATP protection.

7.8 Electro-Magnetic Compatibility

7.8.1 The EMC control plan shall include measures to reduce conducted, induced and radiated emissions to acceptable levels as specified by the relevant international standards. The plan shall specify measures to increase immunity of Signaling and Train Control System.

7.8.2 The plan shall analyze EMI/EMC impacts on the design of the Signaling and Train Control System including train-borne equipment and trackside equipment as well as the general environment. Particular attention should also be paid to additional requirements in grounding, bonding, and shielding, filtering and cabling arrangements.

7.8.3 The Contractor shall ensure that the fundamental frequencies, harmonics and cross-products produced by the Signaling and Train Control System shall not interfere other systems.

7.8.4 **EMC Tests**

7.8.4.1 The Contractor is required to conduct full EMC tests and the tests to be conducted shall include but not limited to satisfying standards as follows:

7.8.4.2 **Overall Compliance:**

1. EN50121-1
2. EN50121-2
3. EN50121-4

7.8.4.3 The following specific EMC requirements shall be met by the design of the Signaling and Train Control System:

i. Radiated Emissions

As a minimum requirement, the maximum levels of radiated electro- magnetic interference (EMI) of the installation shall not exceed the levels specified in EN50081-2;

ii. Conducted EMI

The maximum levels of conducted EMI of the installation shall not exceed the levels specified in EN50081-2; and

iii. Induced EMI

The Contractor shall ensure that any cables other than power cables used by the system are properly screened, earthed and terminated to prevent noise and/or electric shock from exceeding the levels defined by the International Telecommunication Union (ITU).

7.8.5 The Contractor shall ensure that all the Signaling and Train Control equipment are designed and constructed in accordance with the latest issues or versions or revisions of internationally recognized EMC standards, including but not limited to EN50081, EN50082, EN50121, EN50123, IEC571, EN50155, and IEC 61000 to ensure proper functioning.

7.9 Intra System EMC

The Contractor shall ensure that all intra system EMI are taken care of through proper design and other special measures. All major subsystems shall be tested for emissions and immunities in accordance with the appropriate international standards for equipment operating in Railway of similar industrial environment.

7.10 Degraded Operation Modes

i. The normal mode of operation for trains equipped shall be ATO Mode.

ii. In the event of failure of ATO system, ATO Mode shall degrade to ATP Mode. The driver will get an indication / alarm to this effect and may continue the journey in ATP mode without stopping of train and a conscious action of change of mode selector to ATP mode. However, In the event of failure of the ATP, EB shall be applied and the train shall come to stop, after which the driver shall be able to continue the run only in RM mode.

7.11 Roll-Back Protection

The Signaling and Train Control System shall prevent reverse movement of the train (Roll back) in all the operating modes (AM, CM and RM) by applying the emergency

brakes after having rollback for 3 meters or 5 seconds for the first time and 1 meter or 2 seconds for each subsequent rollback. The S&TC System shall prevent the train from releasing the emergency brake after detecting 5 consecutive rollbacks.

7.12 Switches

7.12.1 The switches used in monorail system shall be of industry approved type. The Contractor shall propose the type of switch machine to be used and the operating voltage. It would be preferred to have an operating voltage already in use in the system to avoid making separate arrangements for power supply for switch machines. Notwithstanding the above, the operating voltage being proposed should be in vogue for operation of switches on major monorail systems.

7.12.2 Locking detection shall be provided to detect that the switch lock is in the respective locked position before authorizing a train movement over the switch. Contractor may indicate if the switch machine proposed includes detection for external mechanical locking provided. It shall be possible to operate trains through all switches in all directions of travel. Loss of electrical power shall not cause a change of physical switch status and the switch and lock shall remain in the last operated position.

7.13 Operational Control Centre

7.13.1 The key functions of the OCC to be considered are, but not limited to, the following:

i. Monitor and operate the revenue line Signaling system,
ii. Plan and regulate train operations in order to provide consistently good service,
iii. Act as the centralized communication hub, including radio, telephone, public address, video monitoring and alarms,
iv. Monitor all and operate some of the station equipment, such as escalators, lifts, fire detection systems, station lighting etc.,
v. Monitor and control the system-wide AFC system,
vi. Manage, organize and initiate responses to failures and emergencies including communications with external Emergency Response Agencies,
vii. Supervise the security and the safety of the system,
viii. Monitor and report all anomalies including any defects affecting trains or wayside equipment
ix. Organize and monitor the maintenance and manage the operation / maintenance interface, in both traffic and non-traffic hours
x. Monitor and control
xi. Control of possessions and non-traffic hour works.

7.13.2 **DCC Functions**

i. To supervise the train movements in the Depot area

ii. Crew management.

iii. The DCC shall also authorize the train movements in the uncontrolled area.

7.14 Ergonomic Study

7.14.1 The Contractor shall undertake the Ergonomic study before designing the layout, the seating arrangement, viewing angle for the projection system, workstations etc. of all the subsystems in the OCC. Following to be ensured

1) An Operational Control Centre system is fit for purpose, from a human factors / ergonomics perspective, if it enables trained operators to carry out their designated tasks safely and reliably under normal, abnormal and emergency situations.

2) The system should not place undue demands on error-free and/or rapid human actions in response to emergency situations.

3) Operators should be able to perform their tasks in a sustained manner without excessive workload, exceptional time pressure, significantly reduced levels of alertness, or the need to use novel actions or procedures.

4) Any equipment (hardware and/or software) provided for the operators should support their tasks and is tolerant of human error. It should be designed to avoid any loss of confidence in, or frustration with, the equipment by users.

5) Equipment should be designed to minimize the need for trained operators to have frequent recourse to user instructions or other forms of help or written procedures.

6) To avoid confusion, the terminology used on any equipment should match that in normal use by operators.

7) Priority operator responses, to ensure the safety of passengers and staff, should be clearly distinguished by suitable design means. Such responses should be quick and easy to make.

8) Different items of equipment (including equipment from different suppliers) used by an operator should present information in a consistent format with compatible means of navigation and control.

9) Any long-term health effects, which may arise from the ergonomics of the workplace, should be identified and suitable controls implemented.

10) Wherever possible there should be compliance with current human factors design standards and best practice guidelines.

7.15 OCC Subsystem

7.15.1 Projection Display of appropriate used by monorail systems shall be installed in OCC.

7.15.2 The Traffic projection panel will display the following:

i. Real time train movement
ii. Display train ID of moving train
iii. Position of switches (locking & detection) & status of routes
iv. Any other important information

7.15.3 In addition, following alarms shall be displayed on the Projection display panel for traffic control:

i. Trouble (Station equipment failure)
ii. Power failure (No power supply to station equipment room)
iii. S&T-UPS failure
iv. Non-Descriptive Alarm
v. Any other alarms included after detailed design

7.16 Depot Signaling

7.16.1 The depot Signaling shall control movements of Train within the depot. As a minimum a two-aspect line side signal system shall provide route setting and holding with indications of train locations displayed on a mimic panel and shall be controlled from DCC.

7.16.2 Signals and routes shall be interlocked against conflicting Train movements without compromising train operations.

7.16.3 A facility shall be provided on the transfer berth for trains entering the revenue line from the depot to establish the correct mode of driving and train run data.

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CHAPTER – 8

COMMUNICATION SYSTEMS

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COMMUNICATION SYSTEMS

8.1 General

8.1.1 General Overview

The proposed communications systems shall consist of modern, reliable equipment based on proven technologies to provide high quality, redundancy and reliable services.

The Communication System shall consist of the following:

(i) Data Transmission System (DTS)

(ii) Clock System,

(iii) Telephone and Ancillary (TEL) System,

(iv) Intercom system, the Voice recording system,

(v) Closed Circuit Television (CCTV) System,

(vi) Public Address (PA) System,

(vii) Radio System,

(viii) Passenger Information System (PIS),

(ix) Voice recording system,

(x) Video Recorders System,

(xi) e-mail system,

Each subsystem is connected to the Data Transmission System.

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8.1.2 Performance

8.1.2.1 The Communication System shall be a highly resilient system in order to grant an availability level close to 100%. There shall be no single point of failure in the Communication System which may result in loss of essential communications such as important voice and data communications and CCTV surveillance. All essential equipment and their transmission links, including their power supplies, shall be duplicated where required.

8.1.2.2 Electromagnetic compatibility

All equipment must be able to work in a classical railway environment. Protection measures about electromagnetic compatibility will have to be taken when necessary to guarantee that systems work satisfactorily.

8.1.2.3 Design life

Unless stated otherwise, the design life shall be a minimum of 20 years.

8.1.3 Approvals and authorizations

The Contractor shall be responsible for liaising and interfacing with the Pakistan Telecommunication Authorities for applying and obtaining all approvals and authorizations required for the implementation and operation of the proposed Communication System (radio frequencies as an example). The Contractor shall provide all design data and any other information as may be required. The Contractor shall bear all fees and charges associated with the applications, obtaining the approvals, and operations of the proposed system including license fees, connection and leasing fees, etc.

8.1.4 Supervision

All communications sub-systems (PA, PIS, CCTV, Radio, Control, Clock systems) will be remote-controlled and monitored from the OCC. This will be operated on separated workstations or on workstations used for SCADA system. All failures/alarms will be directly reported and logged to a database.

Software used for the configuration and monitoring of the networked equipment shall use Simple Network Management Protocol (SNMP). English will be used for MMI software.

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8.1.5 Installation or Operation of Telecom Equipment:

8.1.5.1 Communication system will cover all areas (Trains, Stations, Tracks, Depot / Workshop / OCC). All employed materials must be adapted to the project corridor enjoyment. They must have been already used successfully in comparable systems and networks.

8.1.5.2 Telecommunication devices will be installed preferably in dedicated technical rooms of appropriate size or at least in common technical rooms with low voltage systems like Signaling, fare ticketing when it will not interfere with such system located in that room. Any equipment, whether in public areas or not, that is exposed/not exposed to the external ambient conditions shall conform to relevant industry standard. All equipment shall be readily accessible for replacement or maintenance as appropriate.

8.1.5.3 The Contractor shall describe that how proposed Communication System are provided in the proposed system. Global minimal reserve of 20 % in systems is required when no more important percentage is clearly wanted in this document. All public area equipment shall be selected, constructed and mounted in such a way as to architecturally blend in with its surroundings and be vandal proof. The Contractor shall describe how all the communication systems can be integrated into a single architectural fixture. Equipment shall be designed and installed so that they can be effectively isolated for maintenance or other purposes without affecting the performance of the rest of the system.

8.2 Data Transmission System (DTS)

The DTS shall provide the different types of data transmission facilities for voice, data and video, to support the communications services mentioned in para 8.1.1. It will principally be used for transmissions between the OCC room and distant sites (depot, stations, Radio base stations etc)

8.2.1 System Architecture

8.2.1.1 The DTS will cover the whole monorail system, i.e. stations, depot, OCC building with two rings of fiber optic links and will be fault tolerant. A Cable cut or an equipment failure must have no influence on the DTS operation and performance.

8.2.1.2 The DTS will consist of two sub-networks that must be totally separated:

8.2.1.3 A first one is used for data transmission needs of Murre Glass Train Monorail systems except the e-mail and ticketing systems.

8.2.1.4 This separation is required mainly for security reasons. In fact, data transmitted on the first sub-network must be protected so that nobody outside the Murree Glass Train monorail system can have access to them (hackers by example).

8.2.1.5 The two sub-networks will be based on the Gigabit Ethernet standard. The Contractor will be responsible for fixing the bit rate. It must include bandwidth for all data transmissions on each sub-network.

8.3 Optical Fiber

8.3.1 To interconnect the gigabit Ethernet nodes, optical fiber cables will be used. Mono Mode Fiber (ITU T G 652 D) will be deployed. Each DTS sub-network is supported by one optical fiber cable, all along the line (stations, OCC and depot). These two optical cables must be absolutely independent with no common way wherever on the line.

8.3.2 These cables, compliant with IEC 60794 requirements and others specifications presented in this document, will consist of 24 fibers at least with a reserve of 50 %, separated in different tubes, by example 4 tubes of 6 fibers each. Each fiber and tube must comply with a colour code to allow the easy identification.

8.3.3 Cables will be deployed along the guide beam to form a complete ring. In stations and building, two separated ways must be used for cable entering the technical room and cable going out of the technical room. Sufficient cable must be set in reserve when entering or leaving the station or building to allow future repair operations on cables

8.3.4 Cables will be connected on connection points which allow separating “upstream” and “downstream” directions of the cables. Moreover, the cable connection points for first and second sub-network must be clearly segregated.

8.3.5 **Gigabit Ethernet nodes**

8.3.5.1 In each station, depot, OCC and more generally in each location where needed, an industrial gigabit Ethernet node, compliant with Railway environment (shock, vibration, electromagnetic fields, surge voltages), will be installed for each sub-network.

8.3.5.2 Standard interfaces are required. Example, Fast-Ethernet 10/100 base T, RJ 45 ports for connecting system subscribers will be used. The number of RJ 45 ports must be adapted to the location where the node is located and the number of required connections. This number will be fixed by the Contractor; including a reserve of 30 %. Unused ports must be disabled. Each node must also present 2 single-mode optical ports to connect to other nodes.

8.3.5.3 Each node will present diagnostic Lad’s indicating power, link, data status, errors.

8.3.5.4 Nodes can be configured either with a laptop directly connected to the node or to a remote connection from an authorized distant laptop or workstation.

8.3.5.5 Virtual LAN will be created to separate the transmissions of each subscriber system, so that it is possible to set a bit rate limit to each sub-LAN. TCP/IP protocol will be used for transmissions.

8.3.5.6 The reconfiguration time in case of cable cut or node failure must not exceed 0.5 second (½ second) example the ring structure and the use of Rapid Spanning Tree Protocol (RSTP) can be used to achieve this.

8.3.5.7 In case of lengths exceeding 100 meters between gigabit nodes and equipment that must be connected to them, additional standard equipment with appropriate interface

may be used.

8.3.6 **Supervision**

8.3.6.1 The system shall include Network Management Systems (NMS) using SNMP for each sub-network. NMS will be located in the OCC's building, on SCADA workstations or on separated workstations. In this later case, one workstation for each network will be provided.

8.3.6.2 The NMS shall provide control and configuration of each sub-network system, maintain configuration and routing data base for all network elements, gather and log alarm events from the network element and generate performance statistics (Quality of Service – QoS), system availability and performance.

8.3.6.3 NMS shall provide complete transmission network reconfiguration facilities in case of interconnection link failure or traffic overrun. Any change in the configuration (hardware, software and parameters) should be kept in log file for roll back and future investigation. The log file size should be configurable (minimum 2 months capacity).

8.3.6.4 On nodes and workstations, the access to the configuration must be protected by login + password to identify the user.

8.3.7 **RAM Requirements**

i. The availability of DTS subsystem from OCC shall be 99.99%.
ii. The MTTR shall not be longer than 0.5 hour for Gigabit Ethernet devices.

8.4 Clock

8.4.1 Functional specifications

i. The Master Clock system provides services for time synchronization to all lines Systems and for displaying time in different places. Network Time Protocol (NTP) will be used.
ii. The primary digital master clock installed in the OCC shall be synchronized with the Global Positioning System (GPS) time system. A backup master clock receiving antenna shall be provided. The primary and backup master clocks work at the same time but only the primary master clock is used as reference. When the primary master clock is down, the backup master clock automatically becomes the time reference. Consequently, a failure on one of the master clocks or receiving antenna has no impact on clock transmission.

iii. Time signal from the master clock shall be transmitted via the DTS to the sub-master clocks at all stations and depot. All OCC equipment shall be synchronized with the master clock.

iv. The Clock System shall provide an accurate, centralized and fully synchronized time reference for all systems throughout the Islamabad-Murree Monorail system. The Clock System includes, but shall not be limited to:

v. Digital master clock/backup master clock + GPS antennas located at OCC

vi. Digital sub-meter clocks at each station and depot, synchronized by the master clock

vii. The clock system functions are:

viii. To provide time synchronization inside the stations,

ix. To display time in stations, OCC, Maintenance Centre, depot,

x. To provide time synchronization for systems (e.g., data transmission network, telephone switching equipment, Signaling equipment, centralized control equipment, automatic fare collection and distributed data processing equipment, etc.)

xi. Clock system will be interfaced with Equipment Control Monitoring System.

xii. The reference time delivered by the Master Clock system shall allow synchronization of any time display and time stamping of any client system with the single reference master clock.

xiii. Provision has to be done for including clock time on broadcast video screen if required.

8.4.2 Slave Clocks

a. Digital and analogue slave clocks are required.

b. Digital slave clocks shall be 24-hour types with displays showing hours, minutes and seconds.

c. Sufficient numbers of clocks shall be provided in the OCC, depot, all staffed rooms, stations as may be required for the efficient use of the Islamabad-Murree Monorail system. The clocks installed in public areas shall be sized, designed and installed such that they can be read from any position easily, and shall be optimized for all lighting levels.

d. Digital clocks shall be provided in all places where synchronous time keeping of the line system is required.

e. Digital clocks shall be provided as follows:

- OCC,
- CCTV room,
- Maintenance Centre,

- Stations (hall, platform, chief room and other staff rooms),
- Power supply control room,
- Administrative rooms,
- Depot operation rooms,
- Vehicles.
- Security room
- Off line room at OCC

f. Other places shall be fitted with analogue type clocks, showing hours and minutes.

g. The clocks to be installed in the Depot are all analogue clocks (except depot operation rooms) and shall comprise:

- Classic clocks for offices,
- Clocks for the Depot halls, simple or double sided, which must be legible at a distance of 80 meters,
- Clocks for the siding tracks, double sided, which must be legible at a distance of 100 meters.
- In administrative buildings, analogue clocks will be installed in administrative rooms, halls, corridors, etc.
- All digital and analogue slave clocks have to be protected against dust and water. In public areas, they have to be protected against vandalism.

8.4.3 Monitoring and Administration

a. The system shall provide fault indication and diagnostic facilities providing details of faults, down to card level.

b. These services shall be for the use of operation and maintenance personnel.

8.4.4 Performances Requirements

8.4.4.1 The master clock system shall ensure a real -time accuracy better than +/-1 second per month.

8.4.4.2 The primary requirement for protection of the system against Power Supply failures shall be to maintain the safety of passengers and personnel in the event of power loss with particular respect to emergency situations that may arise at such a time.

8.4.4.3 The secondary requirement for such protection shall be to maintain revenue- earning service during periods of localized power loss that do not immediately affect the safety

of passengers and personnel.

8.4.4.4 The system equipment supplied in stations, OCC and depot shall be protected for 2 hours against power supply failure.

8.4.4.5 As a minimum, the system shall allow extension of 50 % capability, in terms of slave clocks, by addition of new modules where relevant, without replacing any component.

8.4.4.6 In case of link failure with GPS due to receiving antennas, master clocks must continue to display time reference with accuracy better than ±1 second per month during 12 hours.

8.4.4.7 In case of link failure between master and sub-meter clock or master clock failure, slave clocks must continue to display time reference with an accuracy better than ±1 second during 12 hours.

8.4.5 RAM Requirements

a. The availability of the master clock system shall be 99.95 % which is equivalent to almost 4.5 hours of unavailability per year.
b. The MTTR shall not be longer than 0.5 hour.
c. Any hazards arising from the RAMS study and relating to communications shall be addressed in the Detailed Design and shall be subject to the Islamabad-Murree Monorail system approval.

8.5 Telephone System

8.5.1 Functional Description

8.5.1.1 The Telephone System shall consist of a network of highly reliable state-of- the-art digital Internet Private Automatic Branch Exchange (IPBX). The IPBXs shall be modern, digital, Integrated Services Digital Network (ISDN) compatible and non-blocking telephone switching systems. Redundancy for important interfaces/modules such as power supply, processors etc. shall be provided. The IPBX system shall be equipped with automatic self-checking programs operable during normal operation of the equipment. Failures shall be remotely alarmed at the OCC. There shall be no single point of failure within the IPBX system.

8.5.1.2 The IPBX network shall be designed such that there is redundancy and diversity in terms of the communication links between IPBX s for call routing and call

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establishment. Failure of a single link shall not degrade performance of the Telephone System.

8.5.1.3 A network management and maintenance system for the Telephone System shall be provided for managing and maintaining the Telephone System. The Telephone System shall continue to operate even if the management and maintenance system is taken out of service. An interface shall be provided at the IPBXs for connection of the portable computer for local management and maintenance of IPBX.

8.5.1.4 The IPBX network shall provide interface to the multi-channel Voice Recording System such that incoming and outgoing calls, as may be required are recorded.

8.5.1.5 Sufficient IP telephones, with necessary handset holder (where applicable) shall be provided in the control rooms, offices, administration, operation, maintenance, technical, equipment and staff rooms in the OCC, stations (technical rooms, staff room) and depot (technical rooms, staff room). Each OCC controller position shall be provided with IP telephones.

8.5.1.6 Direct Inward Dialing from, and external dialing to Public Switched Telephone Network (PSTN) shall be available to telephone extension users of the Telephone System, according to the services/profile defined for the users. The Contractor shall liaise directly with the relevant telecommunications authorities for connection of sufficient external lines. For redundancy reasons, there will be 2 independent links with the PSTN.

8.5.1.7 The IPBX system shall be installed with at least 30% spare capacity, including shelf space and cabling. The grade of service shall be maintained when the spare capacity is brought into service.

8.5.1.8 The telephone system shall consist of:

i. Automatic (administrative) telephone, for any communication inside the Murree Glass Train Monorail system or between the Murree Glass Train Monorail system and the public network,
ii. Direct telephone, used for internal operation calls,
iii. Intercom system. This designates intercom functions in administrative, operational or maintenance areas.
iv. Public telephones for passengers are not considered but provision will have to be done by the Contractor to allow for installing of public telephone in each station platform. These public telephones will not be linked to Murree Glass Train

Monorail IPBX system.

8.5.1.9 Faxes, based on IP links, will also be installed in different places (OCC building / depot).

8.5.1.10 A phone desk receiving external calls will be placed in OCC building. It will be possible to dispatch all incoming calls to people in OCC building / depot / stations.

8.5.2 Operational Requirements

8.5.2.1 The system shall mainly enable the operational and maintenance staff working in the line (stations, depot, OCC building) to contact the OCC, stations, depot and PSTN (according to defined rights in a dialing number table to built later during design stage). Each room in stations, OCC building / depot, will be equipped with at least a phone (automatic or direct, to be defined by Contractor according to the type of use).

8.5.2.2 The main telephone links to be provided are the following but not limited to:

i. OCC control room to Murree Glass Train Monorail System, Police and Civil Defense/ Rescue 1122

ii. OCC control room to the depot at site or any technical or maintenance room,

iii. For stations, direct line telephone(s) shall be provided for two-way communication between the station control locations of these stations, and the OCC according to the Murree Glass Train Monorail system requirement.

8.5.2.3 In the OCC building will be located the main IPBX of the network. In all stations an IPBX will be installed. Links between OCC IPBX and stations IPBX will be through by the DTS system.

8.5.2.4 All telephones and faxes are linked to the corresponding IPBX with Ethernet cables.

8.5.2.5 To ensure instant, uninterruptible conversations between key points on the Murree Glass Train Monorail system, a number of point-to-point telephone circuits shall be provided. These may be configured as direct lines in the IPBX system. For centralized operation of the system, all switching equipment shall be operated from the OCC but will be also operated locally in a particular station far from the OCC in case of degraded situations, that is to say to guarantee redundancy when central IPBX is out.

8.5.2.6 An interface with the radio system must exist so that it will be possible to call people using a radio handset.

8.5.3 Telephone Services

8.5.3.1 The telephone system shall provide internal and external communication.

8.5.3.2 The services provided by the Telephone System shall support all communication types used by modern urban transit organization and provided by modern professional telephone network.

8.5.3.3 The Contractor shall liaise with all external agencies linked by direct lines to ensure compatibility and connection. Each incoming and outgoing call shall be recorded and time stamped, at the start of the call, with time and date from the master clock system.

8.5.3.4 Further details of information associated with the call such as the identity of the telephone operator terminal, dealing with the call, and the identity of the calling station shall also be recorded.

8.5.3.5 Voice recording shall allow recording during 14 days. All incoming and outgoing communications with the OCC are recorded.

8.5.3.6 The telephone system shall be 100% non-blocking for all calls between telephone extensions.

8.5.3.7 For calls to / from the OCC operator positions and the PSTN, the telephone system shall also be 100% non-blocking.

8.5.3.8 The grade of service for calls to the PSTN from any extension enabled for external calls shall be good.

8.5.3.9 The following typical services are required:

i. Simple call (with automatic or direct phone/line)
ii. "back and forth" Call: during a call between A to B, A can answer a call coming from C and then go back to B
iii. Transfer call: A calls B and can transfer this call to C so that B and C are in communication
iv. Automatic call forwarding
v. Automatic recall
vi. Conference
vii. Interception of call
viii. Voice mail

8.5.4 Telephone Terminals

8.5.4.1 OCC Operator Console

i. Each operator position on the OCC control desks shall be equipped with a telephone operator console.
ii. An OCC operator console shall include a display to enable rapid identification of the number / location of all incoming calls and to list the calls in order of arrival.
iii. An OCC operator console shall include 2 handsets for automatic and direct calls with the additional facility to enable the plugging-in of a headset. A loudspeaker for hand free operation may be provided.
iv. The display shall be capable of simultaneously indicating a minimum of 10 incoming calls.
v. Calls arriving from direct line connections shall be listed separately, enabling

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calls to be dealt with on a priority basis.

vi. The telephone consoles shall include audio and visual indicators to alert controllers to take immediate action in response to a call. A visual indicator also indicates that there is one or several messages in the voicemail. There will also be a register able to memorize up to ten names and phone numbers.

vii. A single key press or selection shall be all that is required to select any of the direct lines. Telephone consoles for direct calls present at least 5 selection buttons.

8.5.4.2 Station Operator Console

It will be similar to the OCC Operator console.

8.5.4.3 Administrative phones

Standard state of the art telephone shall be provided. The numbers shall be decided by the Contractor with the consultation with TE.

8.5.4.4 Direct line telephones

For direct phones, hand set type with single key press or selection shall be required to select the any of the direct lines. Loudspeaker facility may also be provided.

8.5.5 Faxes

Digital faxes will be provided

8.5.6 Direct Line Services

8.5.6.1 The telephone system shall provide dedicated direct line voice communication services between key designated locations for high priority / emergency communication.

8.5.6.2 The OCC Supervisor position shall have direct access with, Civil Defense/Rescue 1122, Police, and other services as required.

8.5.6.3 These important lines must be monitored to detect any problem at every time.

8.5.7 Technical requirements

8.5.7.1 The functional analysis shall be submitted by the Contractor for the approval to TE. The main principles are as follows but not limited to:

(i) The telephone system shall be capable of handling the traffic which shall be generated by future extensions and ever-growing office automation, The telephone system shall be able to manage voice over IP, especially the telephone communication, and shall be consistent at least with H323 standards (International Standards of Audio & Video), Telephone facilities for operational and emergency use shall be as safe as possible, with a high

degree of grade of service.

(ii) The telephone system shall be constructed utilizing solid state technology; non-blocking, digital switch.

(iii) To allow full operation flexibility, all operation features for each extension shall be achieved through the telephone system by means of software control.

(iv) The telephone system shall employ dual tone multi-frequency (DTMF) Signaling to telephone instruments.

(v) The system shall have at least 30% extra capacity for future expansion.

8.5.8 RAM Requirements

Specific performance criteria for the telephone system are as follows:

(i) Availability: the system shall be available at all times. To achieve this requirement all main common equipment shall be duplicated,

(ii) Direct calls are characterized by a very high level of availability; this means that when such type of communication is requested, it must be established in a very short time i.e., less than 2 seconds,

(iii) Call handling capacity: the system shall be capable of handling a traffic of 0.23 Erlang per extension to give an overall grade of service of 1%,

(iv) Flexibility: the system shall be flexible in respect of its ability to accommodate changes and expansions without being put out of service,

(v) Resilience: the system shall be capable of establishing calls through different routes, to accommodate any possible failure

(vi) Maintenance: the switching equipment shall be capable of detecting faults through self-diagnosis.

(vii) Reliability: in the event of a loss of the power supply to the telephone system, the telephone system shall automatically revert to the last activated user's function, as opposed to a default configuration, without the requirement for any manual intervention once the power has been fully restored.

(viii) The system equipment shall be protected for 4 hours against main power supply failure (in all stations, depot and OCC building).

(ix) The availability of the Telephone system shall be 99.99 %.

(x) The MTTR shall not be longer than 0.5 hour.

(xi) Any hazards arising from the RAM study and relating to communications shall be addressed in the Detailed Design and shall be subject to the approval of TE.

8.5.9 Intercom System

8.5.9.1 Functional requirements

(i) An Intercom System shall be provided to facilitate direct communication between passengers within stations/in vehicles and OCC. Hands free intercom units shall be provided at platform, on vehicles and in lifts or in escalators (or similar).

(ii) As part of the telephone system, all station platforms shall be equipped with intercom systems to allow communication between the OCC and the passengers upon their request. It will be the same for the lifts and the escalators (or similar).

(iii) Vehicles are equipped with emergency intercom {Passenger Emergency Communication (PEC)}. This equipment allow communication between the driver and, if no acknowledgement by the driver, the OCC and passengers upon their request.

(iv) Emergency Intercom System will be interfaced with CCTV,

- In station, when passengers call, the function will display the corresponding image on the OCC workstation.
- In vehicle, the image shall be displayed on the attendant (train operator) desk. In any case, it will be recorded in the vehicle onboard recorder).
- Full duplex intercom systems are to be installed typically:

(v) Inside vehicles at the door level,

(vi) In the center of each passenger platform,

(vii) Inside the elevators and near escalators,

(viii) Inside the lifts,

8.5.9.2 Technical Specifications

(i) The system shall comply with Industry standard electromagnetic compatibility requirements.

(ii) All equipment must work with IP interfaces.

(iii) In stations and trains, intercom will have visualization equipment (lamp, led, etc.) for call. The signal must be different for call establishment and for established call. Intercom equipment for passengers in stations and trains must be protected against dust, water and vandalism. They will be accessible to disabled people. In OCC, intercom equipment present audio and visual signal to alert operators about incoming calls.

8.5.9.3 Performance Requirements

Calls occurring while another call is in progress shall be queued in OCC operator workstation. A queuing list of up to 10 calls shall be available on OCC operator workstation. A call incoming in OCC will show the location of the intercom equipment that is calling. In the case of "no answer" of OCC operator, after a limit which will be determined with Murree Glass Train Monorail system, a new alarm will be transmitted automatically to centralized level (OCC supervisor).

The time to establish a communication shall not be longer than 2 seconds.

Verbal messages expressed under normal conditions shall be clearly audible. The audio level shall be at least 6 dB higher than the level of the normal ambient noise.

8.5.9.4 RAM Requirements

The availability of the intercom system shall be 99.5 % which is equivalent to almost 44 hours of unavailability per year.

The MTTR shall not be longer than 0.5 hour. Any hazards arising from the RAMS study and relating to communications shall be addressed in the Detailed Design and shall be subject to the approval of TE.

8.6 Closed Circuit Television System (CCTV)

8.6.1 General

8.6.1.1 The CCTV System shall be constructed on pan zoom IP colour cameras. There shall be no single point of failure within the CCTV System which may result in loss of CCTV surveillance of important areas such as stations, station platform doors, onboard vehicle surveillance, shunting zones and depot.

8.6.1.2 The system shall allow the OCC and security office to quickly and easily select picture(s) from camera(s) in any locations to be displayed on his console.

8.6.1.3 Video recording facility shall be provided for each console mounted CCTV monitor for continuous and time-lapse recording of the selected picture(s). These shall be switched to more elevated recording rate automatically by the occurrence of alarm(s). A separate video playback facility shall also be provided.

8.6.1.4 Three types of images shall be provided:

(i) Operating images. It shall correspond to traffic supervision and mainly vehicle management (mainly for drivers, OCC traffic operators).

(ii) Access images. It shall correspond to the access supervision (mainly for OCC traffic and communication operators)

(iii) Security images will correspond to ensure visual surveillance facilities to improve passenger and staff safety and security (mainly for OCC traffic, communication operators).

8.6.1.5 All these images shall be monitored from the OCC room and security office. The images shall be inserted on the operator console.

8.6.1.6 In the "off line data processing mode" room recorded video images from the vehicle or from station, operation and technical premises on line and depot shall be able to be monitored. (Video play back).

8.6.1.7 The Contractor shall have to be compliant with Pakistan laws regarding privacy.

8.6.2 Functional requirements

8.6.2.1 Vehicle Monitoring

(i) When Passenger Emergency Call (PEC) device is actuated, CCTV system displays, on a relevant screen located on the driver's desk, the relevant vehicle and accurately the PEC neighborhoods.

(ii) Video views from the vehicle shall be recorded on hard drive-in vehicle. It will possible to download "images" in Depot by wireless network and by manually operation in the CCTV Operate room.

8.6.2.2 Station monitoring

The OCC traffic and communication operators and security operators shall monitor the whole public area of the station with regard to the traffic (ridership), passengers' safety, general security of the passengers, the station infrastructure and to ensure rapid assessment in the event of an alarm.

a) In each station, CCTV system shall be provided to monitor(typically):
   - platforms: For drivers, boarding and alighting passengers' visualization, for OCC operator in order to evaluate the ridership (waiting and circulation zones)

b) escalators and lifts,

c) stations access (entrance and exit),

d) areas where money is handled by the public i.e. automatic gates, etc.,

e) emergency Intercom equipment,

8.6.2.3 Depot monitoring

i. The OCC traffic operator and security operator shall monitor the whole area of the depot with regard to the vehicles operating, safety, and security of the staff and equipment, depot infrastructure and to ensure rapid assessment in the event of an alarm.
ii. OCC communication operator shall be able also to monitor security and access CCTV.
iii. The depot access and security CCTV system shall be able to be monitored from the depot security guard room.
iv. Accordingly, CCTV system shall be provided to monitor:
    a. Depot operations. The CCTV shall cover all key areas such as areas where there are interfaces between staff, vehicles and equipment such as stabling tracks, operating transfer tracks, the washing machine area, and inspection room area.
    b. Depot security for surveillance of gates, perimeter of buildings, workshops, etc.
    c. Depot access for surveillance (cars park, buildings…)

8.6.2.4 On line monitoring

i. The OCC traffic operator shall monitor typical areas on line in order to evaluate operating, eventual conflict situation and to anticipate actions.
ii. Accordingly, CCTV system shall be provided to monitor:
    - All the shunting zones on line and then the depot connecting track. The purpose is to monitor the presence and the position of the vehicles and switches.
    - At terminus in arrival / shunting / departure / stabling (or reserve) position, so that the operators can check visually the presence or not of the vehicle.

8.6.2.5 OCC and security monitor

i. At the OCC, sufficient monitors shall be provided to facilitate effective surveillance of the station areas, commensurate with the operation philosophy proposed by the Contractor. The monitors shall normally be set up to provide quad display. The displays shall be flexibly programmable. The video switching

matrix shall provide facility to allow automatic sequential viewing of all cameras. The selection of number of inputs (cameras) for sequential viewing and the dwell time of the sequential outputs shall be independently adjustable. OCC and security shall be able to select pictures from cameras at any locations, or combination of pictures from different cameras such as for quad display to be presented on any monitor(s), including console mounted monitors.

ii. A video images priority management shall be provided between traffic image, security and access images.

iii. Colour monitors shall be of a screen size appropriate to the ergonomic design.

iv. CCTV control and monitoring shall be available on the OCC traffic and communication operator's workstation.

v. Suitable provision shall be made at the OCC supervisor workstation.

8.6.2.6 Cameras

i. All IP cameras shall be equipped with character generators capable of generating at least 16 user-defined alphanumeric characters for identification of the viewed areas. All live and recorded video images shall contain text identifying camera location, be dated and time- stamped, synchronized with the Clock System.

ii. The cameras shall be to relevant industry standard as applicable a monorail rail system.

8.6.2.7 Monitoring and Administration

i. The system shall provide fault indication and diagnostic facilities providing details of faults down to card level.

ii. Among the monitored system failures, the system shall report those failures that are likely to generate disruptions to the vehicle service and inconvenience to passengers.

iii. The indications on the OCC console shall ensure that the relevant controllers are alerted and shall enable any appropriate action to be implemented to minimize disruptions to the vehicle service and inconvenience to passengers.

8.6.2.8 Performance requirements

Color monitors shall be of a screen size appropriate to the ergonomic design. They should suit similar applications and as per industry standards.

8.6.2.9 RAM Requirements

i. The availability of the station, trains and depot CCTV system shall be 99.7 % per station which is equivalent to almost 26 hours of unavailability per year.

ii. The availability of the OCC CCTV system shall be 99.7 % for the link between

any station and OCC, which is equivalent to almost 26 hours of unavailability per year.

iii. The MTTR shall not be longer than 0.5 hour.

iv. The MTBF of the station, trains and depot CCTV system shall be at least equal to 20,000 hours.

v. The MTBF of the OCC and security CCTV system shall be at least equal to 20,000 hours.

vi. Any hazards arising from the RAMS study and relating to communications shall be addressed in the Detailed Design and shall be subject to the approval of TE.

vii. Video transmission between stations, depot and OCC/security shall take advantage of the network features. Digital video transmission seems to be appropriate. However, should the Contractor propose a transmission by means of dedicated network, he shall provide substantial rationale for such a choice. Its implementation shall be subject to the approval of TE.

8.7 Public Address (PA) System

It will be possible to broadcast in each station sound announcements and music. In the Depot, an independent PA system will be installed for depot operations only.

8.7.1 General

8.7.1.1 The PA system shall be used to broadcast music, live and pre-recorded announcements catering to:

i. Station (platforms, corridors)

ii. Vehicles,

iii. Depot workshop and stabling tracks areas

8.7.1.2 The above three mentioned facilities shall be able to work with independent functionalities.

8.7.1.3 The PA system at the stations shall be used also as the main means of controlling evacuation in an emergency. The PA System shall be interfaced to the Equipment Control and Monitoring Systems; Fire Alarm System or other system as may be required for triggering of pre-recorded coded message stored within the Digital Voice Announcer (DVA) and/or triggering of pre- recorded emergency evacuation message digitally stored in non-volatile memory within a resilient emergency announcement module supplied as part of the PA System under specific conditions.

8.7.1.4 PA system shall comply with relevant NFPA standards.

8.7.1.5 The Public Address system will be preferably based on a “full IP” transmission of the

sound information from a point to another in the network. Consequently, voice will be sampled in a digital signal to go through the DTS. At the other end, the reverse conversion is done to broadcast the announcement through the loudspeakers.

8.7.2 PA in OCC

8.7.2.1 PA facilities will be available on each OCC operator's workstation and the OCC communication center workstation. Workstations will be equipped with flush-mounted operation microphones with:

i. Gooseneck-mounted microphone or equivalent,

ii. Man, Machine interface with the PA commands and zones selection, for functional facilities (speech, cancellation), allowing the operator to address dedicated messages to any part of any station or Vehicle, any group of stations or Vehicles, all stations or all Vehicles and the depot.

8.7.2.2 A pre-recording of sound advertisements system will be installed in the OCC. Operators of the OCC can create, modify or delete messages. Operators of the OCC have access to this system to broadcast prerecorded announcements. It will be possible to program broadcast cycles for pre- recorded messages.

8.7.2.3 In OCC will also be located music readers and public radio system to broadcast music or radio programs in stations.

8.7.3 PA in station

8.7.3.1 General

i. The station PA system shall be able to receive, amplify, audio signals that originate from the OCC, the station office or automatically generated by the Fire alarm system and the PIS.

ii. From the OCC, the announcement will be pre-recorded messages, in live via an Operator's PA microphone, Music, Radio programs.

iii. Pre-recorded messages can be broadcast individually or in cycles.

iv. From the station office, the announcement will be only in live via an Operator's workstation similar to the OCC workstations.

v. From the fire alarm system, the announcement consists of an emergency message.

vi. From the PIS, it will consist of traffic messages.

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8.7.3.2 Priority

a) The messages will have the following level of priority,
   i. Emergency announcement,
   ii. Announcement from OCC in live,
   iii. Announcement from station in live,
   iv. Pre-recorded messages from OCC database ("one shot" broadcast),
   v. Pre-recorded messages from OCC database broadcast in cycles,
   vi. PIS announcements,
   vii. Music or radio programs broadcasting.

b) These priorities however can be changed by the Contractor at time of installations in consultation with TE.

8.7.3.3 Emergency broadcast facilities

When a fire alarm is activated, the first fire alert shall automatically activate the multi-channel voice recorder to record all one-way and 2-way emergency voice communications. If the first fire alert is not acknowledged within a given time of 30 seconds, the PA system shall broadcast a coded message throughout the station. The coded message shall be cycled at time intervals which shall be configurable by the authorized operator. If the fire alert is still not acknowledged after an elapse of further time of 8 minutes, the PA system shall broadcast the pre-recorded evacuation message, continually cycled, throughout the station to all areas advising staff and passengers to evacuate.

8.7.3.4 Live or pre-recorded messages

i. Live messages or pre-recorded messages shall be broadcast according to the zone selection:
   a) All the stations
   b) Group of stations or platforms
   c) One station or one platform

ii. Station is divided in several independent broadcast areas: platform, corridors, exchange area, etc. Operator (in OCC or station) can choose one, several or all areas of one, several or all stations to broadcast messages.

iii. The OCC and station operator shall be able to listen messages in station. The level of voice shall be monitored and adjusted if necessary.

iv. The pre-recorded messages shall be able to be planned according to dates and

time periods. Cycles of broadcast messages shall be carried out with a planned periodicity.

8.7.4 Vehicle PA

8.7.4.1 General

a) The vehicle PA system shall be able to receive, amplify, PA announcements or messages that originate from:

- Train operator (one PA desk accessible at each end of the train)
- OCC
- Automatically from the on-board PIS.

b) In the vehicle, the system shall be designed to provide the following.

- From the Train operator, announcement will be live.
- From the OCC, the announcement will be: Live via an operator's PA microphone in pre-recorded messages (individual broadcast or cycle broadcast)

8.7.4.2 Priority

I. The following will be priority for the vehicle PA system

a) Passenger Emergency call between Train operator and passenger

b) Passenger Emergency call between OCC and passenger

c) Announcement live from the Train operator

d) Announcement live from OCC

e) Pre-recorded messages from OCC ("one shot" broadcast)

f) PIS announcement

g) Pre-recorded messages from OCC broadcast in cycles.

8.7.4.3 Live or pre-recorded messages

a) Live messages or pre-recorded messages shall be broadcast according to the zone selection:

i. All the vehicles

ii. Vehicles on line or in depot

iii. Group of vehicles

b) The pre-recorded messages shall be able to be planned according to dates and time periods. Cycles of broadcast messages shall be carried out with a planned periodicity.

8.7.5 Depot PA

8.7.5.1 Depot PA shall consist of the following zones: Workshop area and Stabling tracks area

8.7.5.2 For the depot, the PA system shall be able to receive, amplify, PA announcements or messages that originate:

8.7.5.2.1 From the "vehicle maintenance room" and microphones near tracks for the workshop area from OCC and maintenance room for the stabling tracks area.

The above two mentioned services shall work independently.

8.7.5.3 The microphones are of "push-to-talk" type. For the workshop area, an alarm may be provided through depot PA system for maintenance people to know that a train is moving on the tracks.

8.7.5.4 The maintenance operator will use a console fitted out with zone selection and Gooseneck-mounted microphone or equivalent.

8.7.5.5 General design of the public address system including sound quality requirements shall be identical to in station standard. It must be adapted to the especially noisy environment.

8.7.6 General requirements

8.7.6.1 In the stations, the distribution of the audio signals shall be configured to ensure that a failure of an amplifier, a cable and/or a speaker does not render the PA system inoperative or result in the total loss of PA facility in any part of any zone. The UPS system is connected with the PA to feed it in case of normal supply failure. All equipment will have a frequency range going at least from 100 Hz to 10000 Hz.

8.7.6.2 The PA subsystem shall be suitably designed to provide audio messages intelligible above ambient noise, whatever the environmental conditions, e.g., structure condition, etc. The equipment must integrate a capacity reserve of 30 %.

8.7.6.3 Sufficient loudspeakers shall be provided. They will have to be protected from water and dust. Speakers supplied shall be appropriate to their intended use, and to maximize intelligibility and speech reproduction. The Contractor shall propose the speaker quantity, speaker types/specifications and finishes, in co-ordination with the Architects/Civil Design works for the Murree Glass Train Monorail systems acceptance. It shall be the Contractor responsibility to verify and confirm that the

speaker layout designs achieve the required performance criteria before finalizing the PA system design and proceeding with the installation. They will have to be established with a sufficient height to be protected from vandalism. Loudspeakers will be distributed for each zone of stations and vehicles on two independent feeders for redundancy reasons.

8.7.6.4 The PA system shall provide high sound pressure level (SPL), but not exceeding 100 dB under all circumstances. It shall provide uniform sound coverage of ±3dB, minimized reverberation, ambient noise monitoring to ensure PA System output is always 10dB (-1, +2dB) higher than the ambient noise level. The reference height of the measurement shall be between 1.2 & 2m above the floor level. Good intelligibility of at least 0.5 RASTI (Rapid Speech Transmission Index) for 90% of areas and remaining 10% areas with RASTI below 0.4 shall only be scattered uniformly among the stations areas and shall not form clusters of appreciable size.

8.7.6.5 The reverberation times (RT60) at 1 kHz will not exceed 1.8 seconds in any public area. In areas where the ceiling height is lower than 5m, the target reverberation time (RT60) at 1 kHz is less than 1.6 seconds. Automatic SPL (Sound Pressure Level) compensation shall be based on Ambient Noise Monitor readings with due consideration for day night ANL weightage. The ambient noise system shall provide a SPL compensation range of at least 10 dB and a maximum of 25dB to cope with typical ambient noise levels between 55 and 85 dB.

8.7.6.6 Low-frequency distribution from the station technical room shall be carried out by means of special cables. All cables for station and depot distribution will be special fire-resistant and halogen-free construction. In case of fire/flame on the cables, they must continue to work during 1 hour at least.

8.7.6.7 Digital Voice Announcer (DVA) shall be provided for storage of routine and emergency messages (including for vehicle PA system). Messages shall be recorded using digital technology and stored in nonvolatile memory. A minimum storage capacity equivalent to three hours of continuous speech shall be provided, with an expansion capacity to at least four hours by simple addition of memory cards. It shall be possible to edit announcements, erase unwanted announcements, record new announcements and broadcast them automatically at pre-selected intervals.

8.7.6.8 The announcements from the various control points shall be prioritized so that urgent messages which have been assigned with higher priority shall override lower priority messages from another announcement source or control point. The priorities shall be

programmable. Modification of system priority shall be controlled using password protection or other means acceptable to the Murree Glass Train Monorail system.

8.7.6.9 The digital PA system shall provide the following features:

i. Speech shall be digitized at the microphone source and switched in the digital domain. All audio signal processing shall be achieved in the digital domain and the overall signal to noise ratio from any microphone or line input to any zone output shall be better than 63dB.
ii. Digital audio protocol shall be to a recognized international standard.
iii. The DVA audio interface shall be to the same digital audio standard as the microphones.
iv. Messages shall be stored digitally and shall only be converted back to analogue at a point after the zone switching and selection stage.
v. System configuration and set-up including system alignment shall be achieved through software control via a maintenance terminal.

8.7.7 RAM Requirements

8.7.7.1 The availability of PA subsystem from OCC or stations shall be 99% which is equivalent to almost 4 days of unavailability per year. Same level will be applied to the vehicle PA subsystem.

8.7.7.2 The MTTR shall not be longer than 0.5 hour.

8.8 Radio System

8.8.1 General

8.8.1.1 The radio system must be based on a highly resilient digital trunked radio system based on a proven standard (TETRA) and operation. It should provide full-duplex, two-way radio communication and limited data transmission capability.

8.8.1.2 The radio system will be divided into different subsystems:

i. One for the operation of the train (data + voice: train alarms, intercom, attendant calls, onboard Public Address, etc…)
ii. One for the maintenance staff (voice)
iii. One for the operation staff (voice)
iv. One for the security staff (voice)

8.8.1.3 The radio coverage must be 100% along the guide beam and 98% in station (platform,

concourse, station master office, station sales office, technical rooms, etc) and in the whole depot.

8.8.1.4 The Radio System operates on radio frequencies in the UHF 400 MHz band. This band can be chosen according to Pakistan telecommunication authority.

8.8.1.5 It is the responsibility of the Contractor to liaise with the Pakistan telecommunication authority in order to identify all requirements needed to implement an efficient Radio System. In particular, the Contractor shall procure and install onboard radio equipment and Transmission Base Station (TBS) in order to have the necessary transmission coverage. The TBS shall be interfaced to the back base optical fiber network (DTS)

8.8.1.6 Independently, a local radio system, limited to the depot area and based on Wi-Fi standard, will be used for communications between a dedicated maintenance LAN in the depot and the trains in the depot or some portable equipment (e.g. laptop for maintenance) in the depot.

8.8.1.7 Depending of the technology chosen for the Signaling system, e.g. the Communication Base Train Control (CBTC), a separate radio network will be implemented by the provider of the Signaling system.

8.8.1.8 As an option, a local radio system, based on Wi-Fi standard, can be proposed all along the line. It will be used for onboard CCTV transmission from the trains to the OCC. It could be also used for Passenger Information System (PIS) data transmission from trackside or station to train if the digital trunked radio system doesn't allow the transmission of such data. Please note that PIS data transmission along the guide beam or in station stop is not mandatory but can be a plus for the monorail system.

8.8.2 Functional requirements

8.8.2.1 UHF 400 MHz radio

8.8.2.1.1 The radio system shall work 24x7 as defined in clause 8.8.3.1.2.

8.8.2.1.2 It shall be possible for operations and maintenance staff, attendants and security staff to be addressed, from the OCC, from a station or from the depot or the security office: selectively, by pre-defined or dynamically created groups and by a general call. Voice and data transmissions are required. Half
and full-duplex calls are possible. Text messages can be sent to all equipment

used.

8.8.2.1.3 Emergency and security systems shall be independent, however the security systems shall be end- to-end encrypted.

8.8.2.1.4 Radio coverage shall be provided in all areas of the Monorail system: stations, depot, Guideway, etc. This coverage is extended to the 100 meters around stations and Guideway for operations and maintenance staff.

8.8.2.1.5 A coverage probability of 100% in space and time over the Guideway shall be assumed. A coverage probability of 98% in space and time over a 100m section in station/depot shall be assumed.

8.8.2.1.6 To verify this coverage, radio power level and receiver threshold will be fixed. The Contractor will have to ensure coverage studies with measurements on site.

8.8.2.1.7 It shall be possible to get communications between maintenance staff or between operating staff or both without interfering to the OCC communication. OCC will have the highest communication priority.

8.8.2.1.8 It shall be possible to get communications between security staff and security office and between security crews without interfering to the OCC communication.

8.8.2.1.9 Emergency radio call shall be able to be transmitted to the OCC/security office from vehicle. They preempt all other calls.

8.8.2.1.10 Once established the communication it shall be possible for a call to be maintained whilst the portable radio equipment or the onboard radio equipment is displaced along the Murree Glass Train Monorail system without any intervention required by the user.

8.8.2.1.11 The design shall incorporate the possibility to easily expand the capacity of the radio network by adding equipment on site.

8.8.2.1.12 The system shall be able to manage typically up to 30 vehicles in service at any time, plus the handheld terminals dedicated for the operation and maintenance staff. The exact numbers of vehicle have to be arrived after discussion with Murree Glass Train Monorail system on their operational plan.

8.8.2.1.13 The Contractor shall study the radio communication possibilities during the most important activities period taking into account worse incident, so as to determine the number of simultaneous communications.

8.8.2.1.14 However, typical requirement of at least 8 independent communications shall be able to be set at the same time. One independent communication can involve 2 or more partners.

8.8.2.1.15 For all types of call, it shall be possible for the called party to identify the originator.

8.8.2.1.16 It shall be possible to call a monorail vehicle by its operational running number or by

another identification number to be agreed with the Murree Glass Train Monorail system.

8.8.2.1.17 Redundancy shall be provided for the radio base stations installed by the Contractor (including transceivers, power supply, CPUs, etc.), switches (in stations or central switch in OCC building), controllers, radio command and control panels, etc. such that there is no single point of failure within the Radio System, including the vehicle radio communication system. Actually, a radio base failure must have very limited impact for users.

8.8.2.1.18 When an on-board passenger emergency button is activated, the on-board system shall establish a call with the attendant driver desk. If the call is unanswered (driver desk is closed) it shall be immediately redirected to the OCC with the same priority as an emergency call. The operator console at the OCC shall display any vehicle on which passenger emergency button has been activated.

8.8.2.1.19 All radio sites (e.g., base station, core network) shall have standby power arrangements that allow for operation of the equipment without mains power for at least 2 hours.

8.8.2.1.20 The radio system will be interfaced with the IPBX so that it is possible to make calls with the public network or the internal telephone network. The calls (incoming and outgoing) with the public/internal network must have the possibility to be forbidden by a simple action of the administrator of the IPBX.

8.8.2.1.21 Radio equipment used by OCC or security office staff is based on the use of a workstation with dedicated software (man machine interface with all commands, selections, touch screen, etc. but no access to the operating system for the OCC operator) and gooseneck-mounted microphone or equivalent. Hand free loudspeaker may be provided.

8.8.2.1.22 The attendant in the train will have access to a radio equipment, located on the driving desks at each end of the train, with the same functionalities than the OCC radio equipment. A hand microphone (or a handset) and a loudspeaker are to be provided. An emergency button is also required on these desks. On board radio system will be redundant.

8.8.2.2 Wi-Fi in depot

The radio system shell work 24x7 as defined in clause 8.8.3.1.2.

Recorded on-board video images (if needed) and vehicle data communications shall be transmitted to the OCC by a broadband wireless connection when the vehicle reaches the depot.

8.8.2.3 CCTV Wi-Fi along the line

This is an option.

The radio system shall work 24x7.

This Wi-Fi network will be used to transmit CCTV frames from trains to OCC in real-time. When needed, an OCC operator can so have access to all cameras of a train. This Wi-Fi network could also be used for PIS data transmissions.

A coverage probability of 95% in space and time over a 100m section shall be assured for stations and tracks. To verify this coverage, radio power level will be fixed later. The Contractor will have to ensure coverage studies with measurements at site.

8.8.3 Technical requirements

8.8.3.1 General

8.8.3.1.1 The equipment shall be duplicated or contain redundant circuits. Transmission links shall be implemented with at least N+1 redundancy.

8.8.3.1.2 The availability of the UHF radio system shall be 99.99% based on a mean time to repair of 2 hours. For Wi-Fi, it shall be 95 % based on a mean time to repair of 3 hours.

8.8.3.1.3 Redundancy shall be provided for the radio base stations installed by the Contractor. A high level of voice intelligibility is required under normal operation of the radio system. As a minimum, the ITU P800 indication of voice quality based on a mean opinion score of 4 out of 5, or an equivalent agreed with Murree Glass Train Monorail system shall be demonstrated for the radio system.

8.8.3.1.4 The maximum permissible loss between the vehicle antenna and the cab radio is 3 db. Under normal conditions the handover success rate for calls in progress shall be no less than 99.5%. During handover a break in communications of less than 500ms is allowed.

8.8.3.1.5 The maximum call setup time shall be:

i. Emergency call: 2s;
ii. Mobile to mobile call: 5s.
iii. Vehicle to OCC call: 5s
iv. The quality of service of the network shall be such that the maximum

blocking rate for calls is 1%.

v. The call connection establishment failure shall be less than 1%.

vi. Recording shall be seamless 24 hours a day.

vii. 14 days of recording shall be stored.

viii. Radio equipment installed on vehicles shall be easily interchangeable.

8.8.3.1.6 The vehicle radio unit shall provide the radio interface for the train born systems that make use of this interface, i.e., Public Address system, Passenger Emergency Call device, other train equipment. Cab radios shall conform to ENV 50121-3 for electromagnetic compatibility. All on-board equipment shall be protected against shock and vibration in compliance with standards (or equivalent) defined in EN 50125-1 Railway applications, environmental conditions for equipment, equipment on board rolling stock using tests defined in EN 50155 applications, electronic equipment used on rolling stock.

8.8.3.1.7 All on-board equipment shall be capable of operating over a standard range of temperatures from -10°C to +50°C.

8.8.3.1.8 The on-board equipment shall be able to cope with relative humidity of 100% for short periods. The equipment shall cope with humidity level of Murree.

8.8.3.1.9 The cab radio shall be mounted in the vehicle cab in compliance with EN 50261 Railway applications (or equivalent), mounting of electronic equipment. Variations to this shall be presented for approval to TE.

8.8.3.1.10 All equipment mounted inside the vehicle cab shall be capable of withstanding the following maximum levels of sinusoidal vibration:

i). Frequency range: 5-200 Hz;

ii). Peak-to-peak amplitude: 7mm;

iii). Acceleration: 1.5g.

8.8.3.1.11 All equipment mounted external to the vehicle cab shall withstand the following maximum levels of sinusoidal vibration:

i). Frequency range: 5-1000 Hz;

ii). Peak-to-peak amplitude: 5mm;

iii). Acceleration: 2.5g.

8.8.3.1.12 An emergency power supply should be provided for on-board radios which will enable the attendant's radio to continue to operate for a period of 2 hours in the event of failure

of the vehicle's main power supply, based on the following cycle:

i). transmission: 20%;

ii). reception: 20%;

iii). Standby: 60%.

8.8.3.1.13 All fixed equipment in technical room shall be capable of operating in the following environmental conditions:

i). 0 to +50°C;

ii). 100% Relative humidity.

iii). IP 54 (protection against dust and water)

8.8.3.1.14 These requirements may be relaxed for equipment that is permanently installed in a dedicated climate-controlled equipment room and is subject to room temperature (+5 to +30°) at all times.

8.8.3.1.15 All fixed equipment in technical room shall conform to the following international standards (or equivalent) for vibration in a rail environment:

i. ISO 14837-1: latest version Mechanical vibration -Ground-borne noise and vibration arising from rail systems.

ii. All equipment shall conform to the following international standards for electromagnetic compatibility:

a) EN50121 specifically EN 50121-4 Emission and Immunity of Signalling and Telecommunications Apparatus;

b) EN 50081-2 Electromagnetic Compatibility (EMC) – Generic Emission Standard – Part 2: Industrial Environment.

A workstation will be dedicated to the radio management.

8.8.3.2 Hand portables

8.8.3.2.1 Sufficient hand portables shall be provided to operate and maintain the Murree Glass Train Monorail system. Each hand portable shall be provided with a battery, individual battery charger and a spare battery. Multiple unit chargers shall also be provided in sufficient quantity for all spare batteries to be charged simultaneously.

8.8.3.2.2 The activity of hand portable shall be typically of the following cycle:

i. transmission: 5%;

ii. reception: 5%;

iii. Standby: 90%.

8.8.3.2.3 Hand portables shall be capable of withstanding the following levels of continuous sinusoidal vibration:

i. Frequency range: 5-200 Hz;

ii. Peak-to-peak amplitude: 7.5 mm;

iii. Peak acceleration: 1.5g.

8.8.3.2.4 Hand portables must be used for about 5 years in similar environmental conditions.

8.8.3.3 Power supply

8.8.3.3.1 The DC power supply system will typically consist of rectifiers, battery with 4- hour autonomy and DC distribution.

8.8.3.3.2 The equipment to be supplied shall be electrically safe for users and maintainers. Conformance with EN 60950 is acceptable as evidence of this.

8.8.3.3.3 Output voltage shall be a nominal -50V DC (within the range -44V to -57V), with battery autonomy of 4 hours.

8.8.3.3.4 The equipment shall provide 4-hour backup at the maximum steady state loading.

8.8.3.3.5 In the event of battery discharge to –44V, the battery shall be recharged to 80% capacity within 24 hours.

8.8.3.3.6 All wiring and cabling shall be of the correct type and cross-sectional area for the circuits to which it is connected. All installations shall comply with the standards laid down in the National regulation on Wiring.

8.8.3.3.7 All cable and wiring shall be terminated in accordance with BS 7671: latest version (or equivalent).

8.9 Passenger Information System (PIS)

8.9.1 General

8.9.1.1 Introduction

The system shall provide all necessary information to passengers regarding monorail movement, emergency information, clock and other information at all stations and useful locations in the monorail network. The system shall be operated from OCC.

This system shall display messages in the passenger's area such as:

i. station closed,

ii. non-stop train,

iii. train schedule,

iv. last train,

v. monorail rules and regulations,

vi. Commercial information.

It also displays related messages such as the state of train's movement, time of waiting for 3 next trains in each station, service closing times, destination information and delay information.

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The system shall display emergency messages such as fire, accident and traffic breakdown to guide passengers.

All the information is adjustable by parameter from a workstation located in OCC.

8.9.1.2 PIS users

The users of this system are:

i. **Passengers:** they need to be informed about train in alls station's area and inside rolling stock.

ii. **Operators in OCC:** they need to supervise the system. They shall be able to send messages live (predetermined message) in any station; they advise maintenance staff when an equipment alarm is on.

iii. **Station chief:** he shall be able to announce any information in the station, especially in emergency case.

8.9.2 Typical requirement functions

8.9.2.1 Basic announcements

i. For users, the typical functions to be displayed are:

ii. On Platform:

a) Next train in ..... minutes and..... seconds.

b) Next train to destination _____(terminus).

c) Next train is out of service/without passengers.

d) Predetermined messages (_____*).

e) General information (_____*).

f) National or international news (_____*).

g) Time,

iii. On board:

a) Station _____ (at the opening doors).

b) Next station _____ (when the train is leaving the platform).

c) Train destination _____ (terminal)

d) Train does not serve _____.

e) Common Function on platform panels and inside panels.

Note: the display inside the rolling stock can be another method such as next station information can be symbolized by flashing a station fixed LED on the network line panel and rest of stations by fixed LED.

8.9.2.2 Announcement conditions

8.9.2.2.1 On board

8.9.2.2.2 Next station announcement

i. Vocal message: when the train stops in station after the opening doors, the announcement can be executed.

ii. Visual message: When the train closes the doors and starts (speed not null), the announcement can be executed. This message keeps active up to arrive into the next station's zone.

8.9.2.2.3 Station announcement

iii. Vocal message: few seconds before arriving to the station, a vocal message shall have to announce the station's name. A second message shall announce the station when the train is arriving in station (train speed not null).

iv. Visual message: when the train closes the doors and starts (train speed not null), the announcement can execute. This message keeps valid up to arrive into the next station's zone.

8.9.2.2.4 Announcement of station not served

Vocal message: When the train stops in station after the opening doors and station's announcement, the announcement of stations not served can be executed.

8.9.2.2.5 Another announcement

Other announcements can be decided in consultation with TE.

8.9.2.2.6 On platform and gate's area

Time of the train

On the displays, three trains are displayed permanently. Even if train does not stop, it shall be announced by flashing the line with a distinct color of characters.

8.9.2.2.7 Train on approach

When the train is on approach, the announcement shall flash with the label associated.

8.9.2.2.8 Train in station

When the train is on the platform, the announcement shall switch on fix with the label associated.

8.9.2.2.9 Train is leaving of the station

When the train is leaving the station, the announcement has to be cleared.

8.9.3 Administration of the PIS

a) Each screen and display which constitutes the PIS shall be controlled by OCC's operator.

b) The requirements for managing the system by OCC's operator are:

- Creating, modifying, suppressing audio / visual messages by unit or sequence into the database of the workstation, in function of train service.
- Assigning rights and access to users of the system, Broadcasting messages or sequence of messages in real-time to any station / group of stations and on board.
- Consulting and archiving alarms.
- Setting active or inactive messages, downloading database into interface equipment for visual, vocal and multimedia (optional) data.

c) The database can be downloaded from OCC or any station.

d) The required managing function by the Station master are:

- Processing locally to an announcement onto the displays of the station,
- Preventing messages from OCC's operator on the displays of the station,
- Receiving alarm of the station,

8.9.4 Technical requirements

8.9.4.1 Architecture

The application of the PIS can be on independent server or shared on the traffic server.

8.9.4.2 Communication support

The Contractor shall use the proposed telecommunication infrastructure.

8.9.4.3 Performances

i. The time between the validation of the operator action (to send a message) in real time and his reception into the on-board equipment (inside the rolling stock) doesn't exceed 4 seconds.

ii. The time between the validation of the operator action in real time and the reception of it into announcement equipment in station doesn't exceed 3 seconds.

iii. The downloading time of the media into display equipment shall be in accordance with the conditions of the traffic such as the media download and can be completely executed before the departure of the train.

8.9.4.4 Messages

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8.9.4.4.1 Introduction

i) The messages shall be grouped into distinct categories which ones are associated with a priority level. The priority can be modified as required. A higher priority message can interrupt a lower priority message even if the lower priority message is playing (or displaying).

ii) Information shall be initiated, controlled and modified live from OCC and locally.

iii) The nature of message shall be visual or/and vocal (trough public address system).

iv) Some messages shall be able to broadcast permanently or by periodically. It shall be possible to parameter it.

8.9.4.5 Parameters

The messages shall have to be parameter able to suit display method. The different types of displaying are: flashing, scrolling, rolling, wiping etc. The speed, the cycle of repetition shall have to be parameter able.

8.9.4.6 Priority of messages

The different levels of priorities are defined in order of the higher to the lower as:

i. Real-time messages from OCC's operator
ii. Real-time messages from station master
iii. Predetermined messages,
iv. General information,
v. Time, economic indicators

8.9.4.7 Language

All messages shall be displayed in two languages: Urdu & English. The predetermined vocal messages shall be able to be announced in two languages.

8.9.4.8 Display locations

The displays shall be installed in the way of being readable:

i. at the gate's area,
ii. at the end of platform,
iii. inside the rolling stock near doors,

8.9.5 RAM

8.9.5.1 LED's display

The availability should be equal to 99 % at least. The MTTR is 0.5 hour.

8.9.5.2 TFT display

The availability should be equal to 99 % at least. The MTTR is 0.5 hour.

8.9.6 Interface

The PIS shall interface with:

i. PA for sound announcement,
ii. Signaling system for displaying time waiting,
iii. PA inside rolling stock to inform passengers,
iv. "Telecommunication" activity for transferring database of equipment and real-time information
v. ATS for next trains display

8.10 Voice Recording System

8.10.1 Functional specification

8.10.1.1 A multi-channel Voice Recording System which shall be capable of unattended recording of all voice communication to and from all control points such as OCC and stations desks, depot control positions, all direct line telephone calls and those originating from equipment rooms, all radio channels, all non-routine PA announcements, all intercom calls shall be provided. The recording equipment, media and power supplies shall be duplicated; the non-active set being immediately and automatically available should the active set cease to record (hot redundancy, without human intervention). Actually, all data on active equipment are automatically duplicated every day on non-active equipment. Automatic switchover shall be alarmed; manual switchover need not.

8.10.1.2 All speech communications (telephony, intercom, radio, public address) involving OCC operators shall be recorded and time stamped through central voice recorder equipment.

8.10.1.3 The recording shall be triggered by voice.

8.10.1.4 The system shall facilitate flexible and easy replay and review at various adjustable playback speeds. Recordings shall be time and date stamped synchronized with the Clock System, and shall be traceable to the controller's desk and far end location between which the calls took place.

8.10.1.5 The system shall be fitted with two desks. Under normal operation conditions, one desk is assigned to recording, while the second can be used for reading or standby. The system shall provide facility for simultaneous recording and playback operations without affecting the redundancy features of the system.

8.10.1.6 The system shall be used for recording of audio signals in the frequency range from 300 to 3400 Hz. It will be located in OCC building.

8.10.1.7 All recordings shall be in digital format. The MMI will be designed so that it is possible to find a particular communication by choosing date and/or hour and/or type of call and/or people involved in the call, etc. A CD/DVD reader/writer and USB ports will make it possible to export data on CD/DVD or USB memory or External Hard Drive.

8.10.1.8 The voice recorder shall be power supplied by the OCC UPS.

8.10.1.9 The time synchronization shall be carried out by the clock subsystem.

8.10.2 Operational Requirements

i. The radio system shell work 24x7 as defined in clause 8.8.3.1.2.
ii. Recording capacity: 14 days minimum
iii. Track capacity: shall be addressed in the Detailed Design and shall be subject to the approval by the TE;
iv. Automatic start,
v. Automatic switchover
vi. Surveillance system with automatic spare track switchover,
vii. Possibility of simultaneous recording and playback of another track.

8.10.3 RAM Requirements

i. The availability of the recording system shall be 99.95 % which is equivalent to almost 4.5 hours of unavailability per year.
ii. The MTTR shall not be longer than 0.5 hour.
iii. Any hazards arising from the RAMS study and relating to communications shall be addressed in the Detailed Design and shall be subject to the approval of TE.

8.11 Digital Video Recording System

8.11.1 Functional Description

8.11.1.1 A video recording system shall be provided for recording all the CCTV video signals which may be useful to analyze later on an operation event.

8.11.1.2 The recorded images shall be monitor from the "off line data processing operation" OCC room.

8.11.1.3 The video recording shall be either on OCC request or performed automatically, either programmed or triggered on events or alarms.

8.11.1.4 The system shall allow simultaneous recording of all monitored cameras.

8.11.1.5 CCTV video signals shall be recorded in "first in first out". Any default on the recorder system shall be automatically reported to the OCC and Maintenance Centre.

8.11.1.6 It should not be possible to erase a CCTV video signal associated with an alarm associated with vehicle emergency intercom and or station emergency intercom without a special procedure.

8.11.1.7 The system shall facilitate flexible and easy reply and review.

8.11.2 Technical Specifications

8.11.2.1 The video recorder shall be installed in the communication cabinet in the technical room. It shall be possible to record and read at the same time without any signal lost. It should not be possible to lose any recording capacity.

8.11.2.2 The system shall be used for recording of video signals in accordance with standards in force.

8.11.2.3 The recording equipment and power supply shall be duplicated.

8.11.2.4 The video recorder shall be provided with an UPS.

8.11.2.5 Automatic switchover shall be alarmed; manual switchover need not.

8.11.2.6 The time synchronization shall be carried out by the clock subsystem.

8.11.2.7 All CCTV recorded signal shall be available at any time for the OCC.

8.11.2.8 The prime recording media shall provide a minimum of 14 days of continuous recording under normal conditions and facilities shall be provided to archive recordings.

8.11.2.9 It is possible to have access to these storage systems from the "off-line" room to view recorded images using the DTS.

8.11.3 Performance Requirements

i. Recording capacity: 24x7.

ii. Input capacity: All CCTV signals shall be recorded

iii. Automatic start,

iv. Automatic switchover

v. Surveillance system with automatic spare track switchover,

vi. Possibility of simultaneous recording and playback of another track.

8.11.4 RAM Requirements

i. The availability of the recording system shall be 99.95 % which is equivalent to almost 4.5 hours of unavailability per year.

ii. The MTTR shall not be longer than 0.5 hour.

iii. The MTBF of the system shall be at least equal to 25 000 hours.

iv. Any hazards arising from the RAM study and relating to communications shall be addressed in the Detailed Design and shall be subject to the approval of TE.

8.12 E-mail System

The Murree Glass Train monorail will be equipped with an e-mail network, so that people can work on personal computers and can exchange data through e-mails. The e-mails are transmitted through the second DTS sub-network that has absolutely no link with the first DTS sub-network.

8.12.1 Functional specifications

i. The LAN based network will consist of servers and workstations, equipped with software to exchange data. Software used correspond to market standards.

ii. Servers will be located in OCC building. Workstations will be located anywhere on the line stations, depot, OCC building.

iii. The different equipment of these networks are linked through the second sub-network of the DTS. It will be possible to limit the web access (Internet), so that only a few workstations can send/receive e-mails outside the Murree Glass Train Monorail system network. This will be defined during design stage. Any access to internet should be secured with a least a firewall, antivirus software, antispyware software.

8.12.2 Servers

Servers needed for network services, e-mail, domain control etc may be provided.

8.12.3 Workstations

Workstations of appropriate capacity and industry standard software and interface and display systems etc. shall be provided.

8.12.4 Printers

Printers of appropriate design shall be provided e.g. laser printers etc.

8.12.5 Firewall

A firewall is necessary to secure Murree Glass Train Monorail system e-mail network from web. All parameters are defined from the administration workstation. An antivirus, with automatic update, is also needed.

8.12.6 RAM Requirements

i. The availability of the servers and firewall shall be 97 %
ii. The MTTR shall not be longer than 0.5 hour.
iii. Any hazards arising from the RAMS study and relating to communications shall be addressed in the Detailed Design and shall be subject to the approval of TE.

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CHAPTER – 9

ELECTRIC POWER SYSTEM

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CHAPTER – 9

ELECTRIC POWER SYSTEM

9.1 General

9.1.1 This section lays down the standards for design and performance and general features of the High Voltage (HV) Electric Power System to be designed, constructed, tested and commissioned by the Contractor.

9.1.2 The location of the receiving Sub Stations shall be finalized by the Contractor in consultation with power supply authority. i.e., NEPRA (National Energy Power Regulatory Authority/ WAPDA (Water and Power Authority).

9.1.3 The Contractor shall supply and commission the SCADA System equipment for the control and monitoring of each high voltage electrical power supply system switching and protection equipment.

9.1.4 The electric power load to be connected shall comply with the NEPRA/WAPDA Regulations for electrical loads.

9.1.5 A power supply network exclusively for the Mono Rail System to which no other consumer connection is given, shall be applied for and procured from NEPRA/WAPDA. The traction supply system shall use components and designs proven to be reliable in other similar mass transit systems. Uninterrupted Power Supply (UPS) shall be provided as per requirements.

9.1.6 The system shall be so designed as to provide sufficient reserve whereby failure of any one electrical equipment does not lead to dislocation of supply warranting intervention.

9.1.7 Conductor Monorails system shall be installed throughout the route and Depot area. The system shall be designed to meet the traffic and other functional requirements.

9.1.8 The traction system should be sufficient to operate the Monorail Trains at designed speeds over the operating route, negotiating all gradients and curves. This should include starting from stand still on the steepest grade under crush load of 8 persons per sqm of standing space with all seats occupied.

9.1.9 The capacities, ratings and number of equipment proposed to be connected as determined by the Contractor through the engineering development, shall be demonstrated to the TE by simulation study and proper engineering for the services envisaged considering the possibility of equipment failures / malfunctioning. The short

circuit levels and load flow studies on the system during normal and abnormal working and failure conditions shall be determined and coordinated for its design of the Traction Sub-station equipment/Power distribution and RSS (Rectifier Sub Station) arrangements.

9.1.10 The traction system should not generate, or risk dangerous interactions with any other system.

9.1.11 Facilities/controls should be provided to manage and control safely the electric traction system in all foreseeable conditions.

9.1.12 Egress/fire evacuation measures shall be as per NFPA-130 edition, and fire detection and suppression shall be generally as per BCP- latest version. The Contractor shall develop the system with the approval of the local fire safety organization. Transformers in receiving sub-station shall be provided with on load tap changer. Contractor may use transformers in ASS and TSS with off load tap changers.

9.1.13 All 33 kV cables shall have FRLS outer sheath.

9.1.14 The Contractor shall operate and maintain the connections between NEPRE/WAPDA switching Station and the RSS

9.2 System Overview

9.2.1 The Contractor shall provide a SCADA System for the management of HV networks and BMS (Building Management System) for LV networks.

9.2.2 The SCADA shall control and monitor receiving traction and auxiliary power sub-station, associated 33kV distribution cable network and DC traction section feeders via guide beam cabins and disconnection switches. The level of automatic reconfiguration will be as required considering the importance of power supply network.

9.2.3 **HV Supplies**

a. High Voltage supply and Traction Sub Station power supply arrangements shall be finalized by the Contractor.

b. During loss of any supplies, the SCADA system shall automatically reconfigure the arrangement of the networks; reconfiguration of the traction system shall be transparent to normal Train service operation. Manual supervision of the HV network shall be by the Engineering Controller located at the OCC.

9.2.4 **LV Supplies**

HV Auxiliary Power Supply Systems shall be suitably transformed at each station, to the required voltage.

9.2.5 **Earthing and Bonding**

Earthing and bonding shall be provided for the electric power system.

9.3 Design Criteria

9.3.1 General

9.3.1.1 Voltage Unbalance

The overall supply voltage of electrical supplies taken by the Electrical Power system shall be in accordance with EN 50163.

9.3.1.2 Power Factor

The overall power factor of electrical supplies taken by the Electrical Power system shall be in accordance with supply authority stipulations, giving due consideration to energy conservation.

9.3.1.3 Harmonic Disturbance

The total harmonic disturbance to NEPRA/WAPDA HV distribution network shall not exceed the UK Engineering Council Recommendation G5/4.

9.3.1.4 Cables

All HV power cables shall be XLPE insulated or equivalent, in accordance with IEC 60332 – Part 3 and NFPA 130. Where protection is required, suitable ductwork shall be provided. In constrained areas FRLSOH cables shall be provided. Control and Power cables shall be separated throughout the route. All critical, duplicate and/or ring main cables shall be routed separately so that damage to one cable/route will not compromise performance and safety. All cabling and protection equipment shall also comply with the IEC/EN standards as a minimum requirement.

9.3.1.5 HV Power Supplies

The Electric Power supplied by NEPRA/WAPDA shall generally be, as follows:

i. Voltage: Uc +10% /-12.5%, where Uc is the nominal voltage; and

ii. Frequency; 50 +/- 3% Hertz.

The Contractor should ascertain actual variations in the recent past and should also provide suitable surge protection equipment/system.

9.3.1.6 Augmentation

The system design shall permit augmentation by way of adding main power transformers and traction transformer rectifier sets.

9.3.1.7 Bunching of Trains

The system shall permit operation allowing bunching of crush loaded Trains in an Emergency when headway may get reduced to 90 seconds.

9.3.1.8 Communication

The Contractor shall arrange direct line voice and data communications facilities between the WAPDA/IESCO/ and the OCC to enable good management of the power supply to the Murree Glass Train system.

9.3.2 Auxiliary Supply Substations (ASS)

9.3.2.1 Power Transformers

Power Transformers shall be in accordance with EN 60076. Two transformers shall be provided in each ASS, configured for redundant operation.

9.3.2.2 Switchgear

HV switchgear shall be Gas Insulated Switchgear (GIS) in accordance with IEC 60056, IEC 60186, IEC 60298, IEC 60376, IEC 66044-3, IEC 60517.
LV Switchgear shall be in accordance with EN 60439 – 1 and 60947-1/-/5.

9.3.2.3 Electrical Protection Systems

Protection facilities with fast discrimination and reliable operation, based on micro-processor technology, shall provide the protection scheme logic. The zones of protection shall overlap providing back-up protections. The scheme for protection shall be fully coordinated.

The Contractor shall ensure that discrimination between all forms of Station, substation protection such that equipment failures cause minimum disruption to the Mono Rail System operation.

An interlocking and protection scheme that prevents inadvertent or spurious re-energization of the supply shall be ensured.

9.3.3 Traction Power System

9.3.3.1 Traction supplies shall be distributed at 750/1500 V DC or as per design voltage in accordance with IEC 60850, Applications – Supply Voltages of Traction Systems. 750/1500 V DC Stringer type of current collection systems shall be provided in Depot.

9.3.3.2 Traction sub-stations (IESCO) shall be set up for feeding DC power supply as per design to the conductor rails. They shall be distributed all along the line so as to be evenly loaded so that the line will not be subjected to voltage levels unacceptable to the Rolling Stock in the event of shut down of a TSS. TSS may be installed for stations and one for the Depot. The number, capacity and configuration of the traction sub stations shall be decided by the Contractor in consultation with the TE to meet the overall reliability, availability and technical requirements.

9.3.3.3 Conductor Rails

(a) Design shall be in accordance with BS 7865, EN 50122-1 and EN 50122-2.

(b) The conductor Monorails and interface equipment shall be protected from switching surges and lightning strikes.

(c) The conductor rails are designed so that in the event of a single failure of a mechanical element the system shall not cause a hazard and wherever practicable allow continued operation of the Rail System.

(d) Conductor Mono rails system and equipment with a proven history of service on similar Mono Rail Systems shall be employed.

(e) The Conductor rails shall comply with international standards and shall have a continuous rating commensurate with power supply rating in still air at the highest maximum ambient temperature and solar radiation levels to be expected on the Mono Rail System. This rating shall be achieved without exceeding the Conductor rails conductor maximum temperature.

(f) Control and monitoring of DC circuit breakers provided for energizing the conductor rails shall be carried out from the ATS part of the OCC. Additionally, OCC shall have the control to trigger an Emergency de- energizing of the entire

line or a section there of.

9.4 Power Supply System

9.4.1 Both the sources of supply and transmission and distribution networks shall be reliable, with adequate redundancies built in. It is necessary to obtain power, at least one supply at high grid voltage of 230 or 110 kV from grid sub- stations.

9.4.2 The power supply system, including the Depot UPS shall be so designed as to support the system operations as per the operating plan. The design shall be based on the performance requirements and actual capabilities of the equipment to be supplied.

9.4.3 The system shall provide for:

a Integrity of traction and auxiliary power supplies, and the ability to restore supplies rapidly.

b Ability to re-start services as rapidly as possible after a total failure of traction current supply, particularly to absorb a short-term overload caused by a large share of the Rolling Stock starting within a short period of time.

c Economy in traction energy consumption by regenerative braking.

d Optimum number, capacity and location of sub stations with minimum occupation of space at grade.

e Well-designed sub-station buildings.

f Capacity for future system extension without extensive alteration to the existing power supply systems and service interruption on the existing part of the Rail system.

g Switchgear and circuit breakers shall be able to operate on three levels: remote control from OCC, local operation from the substations and manual operation directly on the component.

h System should be designed for ultimate capacity of operation, even if one of the 110 kV or 230 kV supply fails.

9.4.4 The power supply system shall be designed for normal operations and contingency operations. The following non-coincidental contingencies shall be assumed:

(a) Worst case Train delays and Train bunching.

(b) Failure of one traction sub-station.

(c) Power feedback from regenerative braking.

(d) Failure of one utility supply point/interface.

(e) Abnormal power supply system configuration caused by outright failures of

equipment including feeders, circuit failures and failures of transformers and rectifiers.

9.4.5 UPS system shall be installed to support power supply loads for Depots, essential Station facilities as well as for supporting essential loads of all critical equipment.

9.4.6 The UPS system shall provide high quality AC power to very essential loads under normal and abnormal utility voltage conditions, including power failure.

9.4.7 Standby Diesel Generator (DG) Sets

Standby DG sets shall be provided at the Stations and Depot. They shall cater to the following:

i Essential lighting;
ii Signaling & telecommunications;
iii firefighting system;
iv lift operations;
v fare collection system;
vi security system; and
vii UPS loads.

9.5 SCADA System

9.5.1 The main function of the Supervisory Control and Data Acquisition (SCADA) System is to provide remote monitoring and control for the traction power supply system from Operations Control Center (OCC). The System shall monitor the entire Traction Power System and Auxiliary Power System and automatically reconfigure the equipment in the event of a failure or maintenance activities, so as not to affect safety or normal operation of the metro services.

9.5.2 The functions provided by the SCADA shall include:

i Data acquisition and processing from the Remote Terminal Unit (RTU);
ii Alarm processing;
iii Provision of Man Machine Interface (MMI) for operator monitoring and control; and
iv Individual control, sequence of control and time schedule control.

9.5.3 The SCADA shall provide monitoring and both manual and automatic control of the

power equipment, including:

i. IESCO bulk power supply feeders;
ii. RSS equipment status and switching, including traction transformer on- load tap changer;
iii. Reconfiguration of the power supply system; and
iv. Metering.

9.5.4 The OCC equipment shall comprise the Engineering Controller workstation, mimic panels Digital Light Processing (DLP) unit or other systems, conforming to the Specifications set out in this Manual, displaying the entire Traction Power System and Auxiliary Power System. Two hot-standby redundant servers shall acquire real time equipment status from the Remote Terminal Unit's (RTU), process operator commands and perform the core SCADA functions.

9.5.5 Any change of state of an input shall be reported at the OCC within 4 seconds of the occurrence.

9.5.6 Any System reconfiguration time shall not exceed 10 seconds.

9.5.7 The SCADA system shall record any events caused by faults, malfunctions, warnings or alarm information generated automatically by the selected equipment.

(a) A central recording system shall be provided to record the following events, including but not limited to:
   i. Change of state of RTU input parameters;
   ii. Events designated as alarms
   iii. Faults
   iv. Control actions; and
   v. System generated messages, e.g., equipment malfunction, etc.

(b) Events shall be given an order of priority to allow them to be classified, sorted and filtered. Subject to the requirements of the operations plan, events shall be classified as:
   i. Emergency – this type of fault shall require instant attention in order to minimize interruption of the normal operation of the metro services or the risk of injury to people;
   ii. Urgent – this type of fault shall require reasonably prompt, though not instant attention in order to minimize interruption of the normal operation

of the Monorail services; and

iii. Non urgent – this type of fault shall be dealt with in a more convenient manner while more urgent events are dealt with first. This type of event shall not directly result in any degradation of the normal operation of the Monorail services.

9.5.8 Sub-station Equipment

An RTU shall be provided at each RSS and ASS sub-station to communicate with the central SCADA servers. The RTU shall interface with the Remote Input / Output (RI/O) units of which the field equipment to be monitored or controlled are connected.

A Local Control Panel shall be provided in each sub-station for the monitoring and control of all the equipment associated with a particular RTU.

For the event of loss of the OCC, a fallback arrangement shall be provided to enable the supervision of the entire Electric Power System.

Substation automation system shall be provided for all receiving sub stations and this will act as fallback arrangement for supervision of entire traction and auxiliary power network of the corridors.

9.5.9 Depot Equipment

Emergency vehicles capable of working under ATP shall be provided in Depots for faster and efficient response in the event of breakdown of power supply or an emergency generator shall be provided to supply the 3rd rail with sufficient power to move the trains one at a time.

9.6 System Earthing

9.6.1 Earthing and bonding equipment shall be embedded in the civil structures.

9.6.2 System protective earthing for providing electrical safety at Stations, substations, line-side buildings shall be provided. The Contractor shall engineer the earthing system on the basis of safety for people against hazardous touch and step potential and fire hazards and in accordance with provisions of IEC-61936.1. Power Installations exceeding 1 kV AC, IEC 60364-4-41: Low voltage Electrical Installations. Part 4-4. Protection for Safety against electrical shocks, and NFPA 130.

9.6.3 The Earthing system shall conform to EN 50122-1. Fixed Installations. Protective Provisions Relating to Electrical Safety and Earthing and EN 50122-2.-Fixed Installations. Protective Provisions against the effects of stray currents caused by DC traction systems.

The Earthing System for Stations, Depot and Line-side structures shall comply with the BS 7430 Code of Practice for Earthing.

9.6.4 At Stations and line-side structures, copper earth mats and connecting conductors shall be used. Down conductors fixed to viaduct columns, connecting the Structure Earth mat/spike to the viaduct bus bar may be provided as aluminum.

The conductance of Earth Systems and deep earth shall meet the criteria as below:

Location	Earthing System
	Conductance to Deep Earth
Traction Substation	2.0 Siemens / km
Stations, Depot and Buildings	2.0 Siemens / km
Structure Earthing (Viaduct and Tunnel)	2.0 Siemens / km

9.6.5 Structure Earthing System for viaduct sections of the guide beam

The equ-potential bonding of the metallic re-in forcing in stations and line-side buildings shall be connected to the associated Building Earth System specified in Chapter 10. Viaducts shall be sectionalized at, approximately two beam lengths, and the Bonding of metallic re-in forcing in viaduct structures, slab-guide beam bed; handrails, and the like, shall be connected to a common Structure Earth.

9.6.6 Insulation Coordination

Equipment shall have insulation levels according to EN 50124, Monorail Applications Insulation co-ordination.

9.7 Performance Specification

9.7.1 Auxiliary Power Supply System

9.7.1.1 The Contractor shall provide a 33 kV 3-Phase ring-main circuit within the Rail system infrastructure, providing redundant connections to Auxiliary Sub- station (ASS) at each station, Depot and on-line equipment rooms. Cable route diversification shall be provided.

9.7.1.2 Two ASS transformers shall step down the 33 kV 3-phase to 415 V 3-phase and 240 V 1-phase supplies. Each transformer and associated switchgear shall normally supply part of the ASS load and in the event of a failure or maintenance activities, one transformer shall automatically assume the full load of the ASS.

9.7.1.3 The ASS control panel fast acting protection equipment shall monitor the transformers and switchgear performance and immediately enable the isolation of defective equipment.

9.7.1.4 Each ASS shall be supervised by the Engineering Controller at the OCC, via the SCADA System. The SCADA System shall automatically re-configure the Auxiliary Power System during failure and maintenance activities alarm the Engineering Controller, record power consumption and maintain a log of events.

9.7.2 Traction Power System

9.7.2.1 Traction current shall be supplied to lines in sections, separated by gaps in conductor rails. Sections should be double end fed from Traction sub stations (TSS) except the sections towards a terminus which is single end fed.

9.7.2.2 TSSs shall be sized to accept suitable power over load (minimum 50%) for a duration of 2 hours.

9.7.2.3 Traction sub stations along with Auxiliary Sub-Stations (ASS) shall be located in the close vicinities or in the station building inside a room. Additional ASS shall be located at each maintenance Depot.

9.7.2.4 Each TSS shall have transformer-rectifier sets of suitable capacity with provision for an additional set to be installed at a future date, in order to supply DC voltage as per design to the conductor rails. From the TSS, DC cables of required voltage capacity shall be laid up to conductor rails and return current cables shall be connected to running rails. Self-cooled, cast resin dry type transformer-rectifier shall be provided for indoor application. Transformer and rectifier shall conform to IEC 61000, IEC 60146, EN 50327, EN 50328 and EN 50329.

9.7.2.5 Single phase XLPE insulated cables with minimum 400 mm sq. copper conductor or equivalent or more as per design requirement shall be provided for transfer of power from TSS to conductor rails. Number of cables required depends on power requirement.

9.8 Traction Supply Arrangements In Depot

Depot traction power shall be supplied from a separate Traction sub-station for depot area. Traction supplies and traction return systems shall be arranged such that the Depot traction system shall be normally segregated from the lines connecting to revenue service.

However, the Traction sub-station arrangement may have the flexibility to couple the depot to the main line during Depot traction supply outage conditions.

PUNJAB MASSTRANSIT AUTHORITY

CHAPTER – 10

BUILDING SERVICES

CHAPTER – 10 BUILDING SERVICES

10.1 General

A building management system shall be provided for control and monitoring of E&M services at Stations and Depots.

This section lays down the standards and performance requirements for the building services.

10.2 Electrical Services

10.2.1 General

a) The electrical power design shall comply with the relevant current international standards, local codes and statutory requirements.

b) The E&M equipment shall be classified into the following categories:
- Essential equipment; and
- non- essential equipment.

c) Essential equipment shall comprise the following:
- those required to maintain the Rail System safety; and
- Operationally critical facilities.

d) The electrical power system shall consist of IESCO 415 V, 3-phase, 50 Hz, 4-wire low voltage power distribution system, commencing from incoming LV cables connecting to the LV terminals of the 33/0.415 kV transformers.

e) Emergency backup supply shall be in the form of a UPS system and a Diesel Generator of adequate capacity at each Station and Depot. The LV power supply system shall include:
- MCC/LV switchboards / distribution boards and associated cabling;
- all LV supply routes for designated services, systems and cable galleries / ways in the Stations;
- normal lighting;
- emergency lighting for Stations and approaches to Stations;
- automatic power factor correction system to appropriate power factor;
- earthing and bonding system; and
- lightning and surge protection system.

A power system analysis shall be provided to verify that all equipment chosen re rated for the voltage, current and fault duty to which they are exposed.

10.2.2 Low Voltage Distribution

i The power supplies shall be distributed at either 415V three phase and neutral or 230V single phase and neutral as necessary. Where any other voltage is required for a particular piece of plant, the conversion shall be carried out via dry type transformers of adequate capacity to allow the use of power from this source.

ii The distribution system shall be designed to supply power with a variation of ± 10% in the worst case, including regulation of the transformer. All equipment, cables and components comprising the distribution system shall be designed to operate at a nominal temperature of 50°C.

iii All cables shall comply with IEC 331-1. The distribution system shall comply with national and international standards with respect to electromagnetic compatibility, corrosion protection, stray current corrosion and radio frequency interference (RFI) criteria, EN 50121-2, EN 50081 and EN 50082 for electronic equipment and CENELEC EN 50121 for fixed power supplies.

iv The 415V 3-phase 50Hz power supply shall be connected to the main distribution board (MDB) at each Station. From there it shall be distributed as required and shall include the provision of feeders to the plant rooms from the Station UPS.

10.2.3 Switchgear

All assemblies of switchgear and control gear shall comply with EN 60439-1.

10.2.4 Circuit Breakers

i. Circuit breakers shall comply with IEC 890, IEC 947, and EN 60947. Any circuit breaker shall have the design uninterrupted current rating (when enclosed in its operating environment with its rated operational voltage) the same as that specified for the switchboard. The circuit breakers shall also meet the fault conditions specified for the board.

ii. Low voltage air brake switches shall comply with IEC 408 with an uninterrupted rated duty and utilization category, AC 23A.

iii. Miniature circuit breakers shall be in accordance with IEC 898, BS 5486-12 or equivalent, the current rating and type of unit being appropriate to the application with nominal voltage to earth of 230V. The minimum category of duty for units of 50 amps and below shall be 9 kA (M3) and for all others Moulded Case Circuit Breakers (MCCB) shall be used.

iv. All MCCB shall have a 50kA rupturing capacity or as required by the design. When necessary, feeder circuit breakers shall incorporate reverse current

tripping.

v. All switches and isolators shall be lockable in the OFF position. Switches for 'emergency', 'essential' and 'semi-essential' shall, where necessary to maintain the service, also be lockable in the closed (ON) position.

vi. The circuit breaker shall comply with IEC 947-1 (5.5.4) and be of the break type having an uninterrupted rated duty and utilization category AC3.

10.2.5 Switchboards

a) Switchboards shall comply with IEC standard 439/1.

b) Switchboards shall be located in dedicated electrical equipment rooms, battery rooms and closets. Switchboards shall have sufficient space to house switchgear, control gear and components. Sufficient spare space
capacity shall be provided for anticipated future expansion. Adequate degrees of protection shall be provided for the equipment dependent on their location. Typically, these would be the following:

- IP 54 for outside installations but installed within an enclosure rated to IP 65;
- IP 54 for installations at mid-section;
- IP 54 for installations at platforms; and
- IP 43 for installations at concourse level or in plant rooms.

c) The short time withstand current of the switchboards shall be 50 kA for second and shall have a fault withstand classification of Class 3 for a supply voltage of 415V AC between phases, at 50 Hz.

10.2.6 Cabling

a. All cabling materials and installation shall comply with the requirements of IEC 331-1.

b. All conductors shall be enclosed in their entirety in armor sheaths, conduits, cable trays, boxes or cabinets which shall be capable of being subjected to temperatures up to 50°C for 1 hour. Sufficient spare capacity shall be provided for all cable trays, trunk, cableways and brackets for future expansion.

c. Cables for use on the 415V AC system shall be multi stranded copper cored XLPE Cables.

d. Armored XLPE insulated underground cables shall comply with BS 6346. Heat resisting cables shall comply with BS 6007.

10.2.7 Protection Circuits

a. Protection circuits shall be provided for all main and sub circuits against the following:
   - Excess current;
   - under and over voltage;
   - residual current; and
   - earth faults.

b. The protective devices shall be capable of interrupting (without damage to any equipment or the mains or sub circuits) the short specified maximum short circuit.

c. Discrimination shall be in accordance with BS 88, BS EN 60898, BS 7375 and any other applicable Standards.

10.2.8 Metering

All instruments and meters shall be completely segregated in instrument compartments.

10.2.9 Station lighting

10.2.9.1 General

a. Station lighting shall be energy efficient.

b. Lighting levels shall be graduated consistent with safety and comfort avoiding abrupt change in illumination levels.

c. The following general guidelines shall be followed:
   i. At Station entrances where users enter from sunlit streets, a graduation of the lighting level shall be provided;
   ii. escalators and stairways shall be well illuminated;
   iii. Lighting level at platform shall be higher than that of the Train. A reduced intensity shall be provided at platform ends (particularly the leading end) to reduce the glare to the driver while entering the Station. The need to highlight information panels and to illuminate the Train surface for the ease of users when alighting the Train shall be taken into account;
   iv. Lighting shall be sufficient to define a path for the prompt safe and orderly movement of patrons, employees and Emergency Services required for evacuating the system under an emergency;
   v. All Station premises to which users have access, including foot bridges,

subways, stairways, steps, ramps, and escalators should be permanently lit when there is no day light;

vi. lighting shall not blind Train operations;

vii. platform lighting should highlight the platform edge;

viii. Station name boards should be conspicuously visible along platforms at intervals, unimpaired by waiting Users, and well lit during hours of darkness;

ix. when CCTV is being used, particular care shall be taken as to the type and distribution of light fittings;

x. luminaires in Station Control Rooms shall be positioned so that no reflected glare from dials or monitor screens interferes with the operator's vision;

xi. outdoor lighting shall be provided as required outside Stations and shall have a dual control;

xii. lighting design shall take into consideration the use of daylight as far as possible for energy conservation purposes and suitable controls shall be provided accordingly;

xiii. multipurpose wall lighting and feature lighting shall be provided to illuminate signage, advertisements and specific areas such as help points and/or Designated Waiting Areas (DWA);

xiv. lighting in public areas shall be controlled by Station Management System;

xv. luminaires shall have the degree of protection dictated by their location. Where luminaires are subject to excesses of dust and water, a high degree of protection, typically IP 65 shall be employed. Mechanical protection of luminaires against damage from impact wherever the risk occurs, shall be provided in the form of wire guards or other such devices;

xvi. the light fittings shall not emit toxic gases in the case of fire;

xvii. any required illumination shall be arranged such that any failure of any single lighting unit shall not leave the area in total darkness;

xviii. in general, the luminaires shall have a minimum down light output ratio of 70%; and lighting levels shall be uniformly distributed throughout as far as possible and be designed to prevent glare, dark recesses and areas of poor lighting levels. Lighting levels should be graduated consistent with safety and comfort, avoiding abrupt changes in illumination levels.

10.2.9.2 Lighting Standards

The lighting system requirements shall comply with following standards:

i. BS 5266 – Emergency Lighting;
ii. EN 13201– Road Lighting;
iii. BS-EN 60598 – Luminaires;
iv. Building Code of Pakistan;
v. recommended practice of Illuminating Engineering Society (IES) of North America;
vi. Code of Practice for Interior Lighting (as per CIBSE) and CIE recommendations for Glare Control; and
vii. NFPA 101– Life Safety Code.

10.2.9.3 Emergency Lighting

i. Emergency lighting shall be defined as the lighting that is required to be provided for use when the LV power supply fails.
ii. Emergency lighting shall comply with IS 3217 – Code of Practice for Emergency Lighting. In the event of power failure, emergency lighting shall define a path of egress to assist in safe evacuation.
iii. The normal supply to emergency lighting shall be through an automatic changeover switch and UPS. The output of the UPS shall be channeled through separate circuits to feed each area.
iv. Emergency lighting shall be provided in all public areas, including passages, exit signage's, escalators and stairways, escape/exit routes including control rooms and plant rooms duly complying with BCP.
v. The Emergency light fixtures shall have self-contained battery power for a duration of minimum 2 hours.
vi. In each room at least one luminary shall be connected to the emergency supply. The minimum levels of illumination shall be maintained for at least three hours during the failure of the normal supply of electricity.

10.2.9.4 Illumination Levels

The following table indicates the design illumination levels that the Contractor shall provide, as a minimum, for both normal and emergency lighting levels:

Areas	Normal Level in lux	Emergency Lighting in lux
Signaling and Comm. rooms	200-250	25-50
Electrical switch rooms	200-250	25-50
TSS and ASS	200-250	25-50
Escalators and Lifts	250-300	25-50
Passenger Help Points (DWA)	200-250	25-50
Operations/control rooms	300-400 (Panel face)	200-250
Escape routes and stairs	50-75	50-75
Platform (Edge)	300-350	200-250
Platform (General)	200-250	30-75
Concourse	200-250	50-75
Subways/Passageways	150-175	150-175
Ticket Barriers	200-250	50-75
Mezzanine	200-250	50-75
Staff rooms	150-200	30-50
Toilets	100-150	25-50
First Aid room	250-300	75-100

10.2.10 Earthing and Bonding

10.2.10.1 General

a) Earthing and bonding shall accomplish the following minimum requirements:

i. Protect personnel and equipment from electrical hazards;

ii. achieve a reduction in potential to the systems neutrals;

iii. reduce or eliminate the effects of electrostatic and electromagnetic interference on equipment arising from auxiliary electrical systems;

iv. provide a single – point earthing method for each equipment, enclosures, cabinets, drawers, assemblies and sub-assemblies;

and provide a clean zero – volt reference point for signals in computer and related equipment.

b) Earthing and equ-potential bonding shall be provided for all electrical installations, to prevent the possibility of dangerous voltage rises and to ensure

that faults are rapidly cleared by the installed circuit protection.

c) The earthing shall be designed to comply with the local and international building regulations to ensure safety of persons. In particular Users and staff shall be protected from the possibility of high potential to structural earth potentials and carrying fault current to earth. Other design requirements of the earthing systems are to ensure correct operation of breakers and tripping devices and limitation of damage to plant, equipment or system failure and protection against interference. The provision of equ-potential bonds shall ensure that touch voltages (between conducting components accessible to persons) during a fault condition do not exceed 60V and avoid electrolytic corrosion of metal parts and structural elements.

d) Earthing systems shall comply with the following:

BS 7671	Requirements for Electrical Installations;
BS 7430	Code of Practice for Earthing;
BS EN 50122-	Protective Provisions relating to Electrical, Safety and Earthing;
	Safety and Earthing;
BS EN 50122-2	Protective Provisions against the effects
	of Stray Currents on DC systems;
BS 7375	Code of Practice for Distribution of
	Electricity on Construction Sites;
IEEE 80	Guide for Safety in AC Substation
	Grounding; and
IEEE 1100	Recommended Practice for Powering and Grounding of Sensitive Electronic Equipment.

Earthing

One common system earth shall be provided at each Station for the Station power supplies. The system provided must ensure that in the event of an earth fault being generated, it shall not affect any Signalling circuits.

Main Equ-potential Bonding

Incoming service to the Stations in metal pipe work or armoured cable shall be fitted with isolating joints as close as possible to the point of entry. On the Station side of the joints, the pipe/armour shall be bonded to the main System Earth with earthing cables or tapes. On the incoming side of the joints, the pipe/armour may be connected via an earth limiting device to mitigate stray current, if found necessary.

10.2.10.2 Supplementary Bonding

All sinks, wastes and metallic connections to sanitary equipment shall be bonded to earth by means of a minimum 10 sq.mm. earth cable. Bonding shall comply with the requirements of BS 7617. All ceiling space equipment shall be bonded to earth and the final bond taken to the local sub distribution board earth.

10.2.11 Lightning Protection

10.2.11.1 General

10.2.11.2 Lightning protection shall be provided to:

i. Protect above ground structures, Stations and ancillary buildings from direct lightning strike;
ii. protect the equipment located within the zone of protection; and
iii. protect personnel working within the zone of protection.

10.2.11.3 System Design

The lightning protection system shall be designed to comply with:

a. BS 6651: Code of Practice for protection of Structures against lightning;
b. BS 7430: Code of Practice for Earthing; and
c. BS 7671: Wiring Regulations for Electrical Installations in Buildings.

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10.2.12 UPS

10.2.12.1 General

i. UPS systems of proven technology shall be provided at all Stations, and the Depot to supply systems that require high security of supply. Separate UPS systems of adequate capacity shall be provided for various loads.
ii. The standby generator shall supply power to the UPS. In the event of a power failure, the UPS shall automatically and immediately commence operation to maintain this power supply to the high security loads for 120 minutes of operation even if the standby generator fails.
iii. The design criteria and the assumptions made in deriving them shall be furnished for all the systems.

10.2.12.2 Design of UPS

(a) The UPS shall be a dual redundant, on-line type (i.e., output power shall be taken from the batteries at all times other than when a bypass is in operation).

(b) Sufficient installed spare capacity shall be provided to enable the UPS systems functionality to be increased to maintain a further 20% load for the period of required autonomy, for each of the control and communications sub-systems it supplies. The control and communications sub-systems shall also be sized and configured such that it shall be capable of efficiently handling all necessary functions required for the initial design with a 100% expansion capability for the future.

(c) The rating of each half of the dual redundant UPS shall meet the following requirements:

Output	To suit the Contractor's Design Calculations
Duration of autonomous operations (at rated output)	180 minutes
Input supply	415 V +10%, -15%, 3- phase
Input supply frequency	50 Hz ± 3%
Input power factor	0.92
Steady state output voltage	415 V ± 1%, 3- phase,
Steady state output frequency	50 Hz ± 0.1% (free-running)
Output voltage adjustment	± 3,
Overload capacity	150% for 10 seconds
	120% for 10 minutes
Efficiency	Better than 90% for loads in excess of 25% of rated load and a power factor between 0.8 (lagging) and unity.
Noise generation	50dB(A) @1.5UPS cabinet.

(d) The UPS systems shall be suitable for continuous operation allowing for a system availability of 99.9% as minimum. The system reliability shall be better than 99.9%.

(e) All equipment enclosures located within control rooms and equipment rooms shall meet or exceed a rating of IP54.

(f) The radio interference level from the UPS shall be equal to or better than suppression degree "N" as defined in VDE 0875.

10.2.12.3 Codes and Standards

The UPS shall be designed to comply with international standards.

The selection of the battery type shall take into consideration the local environmental and health and safety regulations.

i). Batteries shall be suitable for the following charging duties:

ii). A fully discharged battery shall be charged to 75% of its rated capacity in 3 hours under float charge conditions; and

iii). A fully discharged battery shall be charged to 100% of its rated capacity in 6 hours under boost charge conditions.

10.2.12.4 Rectifiers

i. Duplicate rectifiers shall provide a smooth output with filters to remove harmonics. Harmonic voltage distortion presented to the mains supply shall not exceed 3%.

ii. Each rectifier shall be rated to meet the full load of charging the batteries together with powering the inverter while operating at rated output.

10.2.12.5 Inverters

i. The output of the inverters shall be a sine wave having less than 1% total harmonic voltage distortion content for linear loads, and less than 5% for 100% non-linear loads with a crest factor up to 3:1.

ii. Each unit shall have a dynamic response such that application or removal of a 100% step load causes an output voltage transient of less than ± 2% with a recovery time of less than 4 minutes.

iii. The inverters shall be capable of delivering its rated power into a load with a power factor between 0.92 lagging and unity.

10.2.12.6 Indications and Controls

i. A front panel mimic display shall be provided showing the UPS and bypass mode of operation.

ii. The monitoring and diagnostic system shall provide an audible alarm to provide warning and fault indication.

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iii. Battery voltage measurement points shall be provided such that faulty groups of batteries can be detected.

iv. Volt-free contacts shall be provided from the UPS systems in order to provide key status information remotely to the Station Management System (SMS).

10.2.12.7 Static Bypasses

The following static bypasses shall be provided:

i. Change over to reserve – this shall operate in the event of inverter failure (or manual operation) to transfer the UPS output to the reserve inverter;

ii. Change over to mains – this shall operate in the event of UPS failure, inverter overload (or manual operation) when the mains supply is live, to transfer the UPS output to the mains; and

iii. Manual bypass – this shall be a manually operated switch to take the entire UPS out of service, whilst the UPS loads continue to be supplied directly from the mains supply.

10.2.12.8 Interfaces with other subsystems

The design of the UPS systems shall interface with the following high security sub-systems in the event of loss of main supply. Such sub systems shall include, but not be limited to:

i. Emergency exit signage;
ii. emergency lighting and signage's;
iii. essential lighting in platform and staircase;
iv. safety equipment;
v. fire detection and fire pumps;
vi. control and communications;
vii. PA system;
viii. CCTV system;
ix. SMS system;
x. master clock system;
xi. AFC system;
xii. help point system;
xiii. FIDS;
xiv. radio system;
xv. Station telephones; and
xvi. Station Control Room (SCR) and OCC equipment including SCADA.

10.2.13 Diesel Generator

10.2.13.1. General

i. The Stations and Depots shall be provided with a Diesel Generator (DG) set (with automatic switch-over during and after power failures) to provide back-up supplies.

ii. The DG shall provide a 415 Volt 3- phase, 50 Hz, power supply in the event of a loss of supply from the electrical supply provider. The DG set shall be adequate to supply the essential light and power requirements and activate automatically in case of normal supply failure as well as the provision of normal and automatic switch over to main supply after the main supply resumes.

iii. The DG set shall be provided with fuel tank of adequate capacity to ensure a minimum running of 8 hours on full load.

iv. Average power factor shall be maintained at 0.92 lagging. The engine and alternator shall have an overload capacity of 10% for one hour.

v. The DG shall be rated for maximum ambient operating conditions (over 46°C).

10.2.13.2 Design

b) The generator set shall be designed to provide the following:

i. Low specific fuel consumption;

ii. low weight (kg) to kVA capacity ratio; and

iii. low space (sqm) to kVA capacity ratio.

c) The diesel engine which may be a two or four stroke, direct injection diesel shall conform to BS 5514 or equivalent.

d) The engine shall be fitted with heavy duty dry type air filters with replaceable elements suitable for operating in a dust laden atmosphere.

e) Engine cooling shall be by air blast cooling via a pusher type fan through motorized louvers. A separate oil cooler shall be used for the engine oil.

f) The alternator shall be 4-pole, 3-phase, salient pole, revolving field, brushless type, self-regulating, continuously rated and manufactured in accordance with IEC 60034.

g) The alternator shall be screen protected, fan ventilated and vertical drip proof to not less than IP 21.

10.2.13.3 Automatic Testing

When the DG is on automatic control and has not been run for 7 days, the set shall actuate an alarm, be started and run for a pre-determined period on no load conditions at idle speed.

10.3 Fire Detection and Suppression Systems

10.3.1. General

All means of egress shall be in conformity with NFPA 130 and BS.

10.3.1.1 The fire-fighting system is to be designed in accordance with Building Code of Pakistan latest version, and relevant International Standards.

i. The fire suppression, hydrant and hose reels system shall comply with the relevant Pakistan Standards, NBC- latest version and with the approval of local fire authorities.

ii. Gas flooding fire suppression systems shall be used in major panels viz 33 kV, MDB and essential power supply panel where protection by conventional water systems would be unacceptable.

iii. Total gas flooding fire suppression system shall be used in all critical equipment rooms viz., Communication rooms, signaling equipment rooms, Station Control rooms, etc. to minimize the property and revenue loss.

iv. Type and location of Portable fire extinguishers shall be as recommended by the local fire authorities.

10.3.2 Fire mains

10.3.2.1 The design of the fire mains shall comply with the local fire authorities' regulations, Building Code of Pakistan - latest version, and relevant Pakistan/ International Standards.

10.3.2.2 There shall be a fire main at each Station. The fire main and hydrants shall be fed with sufficiently reliable water supplied from the local mains supply via storage tanks.

10.3.2.3 The hydraulic design of the fire main and hydrant system shall comply with the NFPA 14 in respect of flow and pressure requirements for the maximum simultaneous

operation of two hydrants.

10.3.2.4 Booster pumps shall be installed where there is the likelihood of the supply water pressure falling below the regulation pressure required at the farthest hydrant point. Booster pumps shall comply with the requirements of NFPA 20.

Each fire main shall be fitted with a motorized isolation valve at the center point of the cross passages. There shall also be motorized isolation valves at the delivery point to each Station. These valves are to be controlled from the Station control room to isolate any sections of the fire main in the event of an accident or damage to a section of the fire main and the resultant flooding of the Station.

10.3.3 Fire hydrants and hose reels

10.3.3.1 Hydrants shall be located on either end of each Station and additional hose reel shall be provided as per local fire authority requirements in Station area and supplied from the fire main.

10.3.3.2 Each hydrant shall comprise a hose connection and a standard bronze gate valve.

10.3.3.3 Hydrants and hose systems shall comply with the relevant International Standards.

10.3.4 Sprinklers

Sprinklers are to be used for fire suppression system in the underground/ basement areas and property development/ commercial areas.
The sprinkler installations shall be a wet pipe type installed in accordance with the requirements of the local fire authorities and relevant International Standard codes.

10.4 Water Supply System

10.4.1 General

10.4.1.1 The water supply shall include all the incoming water supplies and the systems they supply, which shall be as per BCP- latest version, and shall include the following:

(i) Potable water supply;
(ii) Hose reel supply; and
(iii) Sprinkler supply.

10.4.1.2 The potable water supply system shall be designed based on number of projected users and staff based at each Station, Station cleaning water requirement and wastage allowance.

10.4.2 Pipe work and fittings for water supply system

10.4.2.1. The water supply pipe work for the potable water, chilled water refrigeration and firefighting services shall be galvanized steel and welded with expansion joints as necessary.

10.4.2.2 All sprinkler pipes shall be hot-dipped galvanized to BS EN ISO 1461 to achieve a galvanizing thickness of 100 microns. The pipe and fittings shall be designed for a minimum pressure of 16 bars. Fittings shall have wall thickness not less than those of the pipes. All sprinkler pipe work shall have identification bands, lettering and direction of flow indication at intervals not exceeding 5.0 m and at valves and branches.

10.4.2.3 Isolation valves may be either butterfly type of the wafer pattern in accordance with BS 5155 with corrosion resistant disc and stainless-steel shaft or gate type complying with BS 5150 with resilient covered disc.

10.4.2.4 Check valves shall comply with BS 5153 and shall be of the swing type suitable for vertical use.

10.4.2.5 Automatic air relief valves shall be provided with an isolation valve for maintenance.

10.4.3 Plumbing pipe work and valves

10.4.3.1. Water piping system that is durable, easy to maintain and aesthetically pleasing shall be provided.

10.4.3.2 Piping materials shall be stainless steel, galvanized steel or copper dependent on the application and the appearance required. Sanitary fittings shall be either chromium plated or stainless steel in locations such as toilets and washrooms.

10.5 Drainage System

10.5.1 General

Separate storm water and sewerage systems shall be provided for Stations which shall

be designed to comply with the following requirements:

a. BS EN 752: Drains and sewer systems outside buildings; and
b. BS 8301: Code of practice for building drainage.

10.5.2 Pipe work for drainage services

10.5.2.1 Drainage pipe work

The storm water drainage discharge mains shall be of galvanized steel and welded. The drainage discharge main shall be sized to ensure that in an emergency all drainage pumps shall deliver their design quantity.

10.5.2.2 Sewerage pipe work

i. The pumped discharge main for the sanitary sump shall be of ductile iron or heavy-duty polyethylene.
ii. All ductile iron pipes and fittings shall be lined internally with a lining of high alumina cement mortar in accordance with BS EN 598. Where zinc coating is proposed for the external finish, it shall be in accordance with BS EN 598 and be followed by an epoxy finish. This shall cover the internal surface of the socket.
iii. Flanged pipes shall comply with BS EN 545. Ductile iron flanges shall have the dimensions given in the relevant tables in BS EN 1092-2. All bolts and nuts for flange joints shall be of grade 4.6 of BS 4190 and shall be hot-dipped galvanized in accordance with the requirements of BS EN 1461.

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CHAPTER – 11
AUTOMATIC FARE COLLECTION SYSTEM

CHAPTER – 11
AUTOMATIC FARE COLLECTION SYSTEM

11.1 GENERAL INTRODUCTION

11.1.1 This section lays down the standards, system philosophy, performance requirements, minimum technical requirements, design requirements, testing and commissioning requirements, RAMS requirements, interface provisions, cybersecurity provisions, and documentation requirements for the Automatic Fare Collection (AFC) System to be designed, supplied, installed, integrated, tested, commissioned, and maintained for the Murree Glass Train Project.

11.1.2 A computer-based Automatic Fare Collection (AFC) System shall be provided, comprising both open-loop and closed-loop fare collection mechanisms, fully compliant with international standards and local institutional requirements.

11.1.3 The AFC system shall be:

- Simple and intuitive for passengers
- Easy to operate, administer, and maintain
- Efficient in accounting and auditing
- Capable of issuing single journey, multiple journey, stored value, period, and special tickets
- Amenable to rapid fare changes through parameterization
- Designed to operate with minimum manpower

11.1.4 The layout of the fare collection area, including information panels, signage, ticket vending machines, validators, and automatic control gates, shall reflect the logical sequence of passenger movement. Adequate queuing space shall be provided to cater for peak-hour patronage.

11.1.5 The AFC system shall be of modern, state-of-the-art design, fully aligned with the monorail system architecture, station design philosophy, and operational environment of the Murree Glass Train.

11.1.6 AFC equipment shall be installed at each station at convenient and ergonomically appropriate locations and shall be connected through a Local Area Network (LAN) to a Station Computer (SC) installed in the Station Master's room.

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11.1.7 The AFC system shall include Passenger Operated Machines (POMs) and/or Ticket Vending Machines (TVMs) for ticket issuance.

11.1.8 At each station, at least one manned Ticket Office Machine (TOM) / Extra Fare Office (EFO) shall be installed.

11.1.9 The AFC system at all stations shall include entry, exit, reversible, wide, and staff/emergency automatic gates to control passenger flow and validate fare media.

11.1.10 The AFC system shall provide, but not be limited to, the following equipment:

- Automatic Control Gates (retractable flap or swing type)
- Passenger Operated Machines (POMs) / Ticket Vending Machines (TVMs)
- Ticket Office Machines (TOMs) / Extra Fare Offices (EFOs)
- Ticket Readers for balance inquiry
- Portable Ticket Decoders (TKDs) for supervisory staff

11.2 INTRODUCTION & OBJECTIVE (OPEN-LOOP & CLOSED-LOOP AFC)

11.2.1 This document defines the Automatic Fare Collection (AFC) System requirements for the Murree Glass Train Project, incorporating open-loop EMV-based fare collection and closed-loop contactless fare media, suitable for a tourism-oriented, future-ready mass transit system.

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11.2.2 The AFC system shall be designed, supplied, installed, tested, commissioned, and supported by the EPC Contractor on a turnkey basis, fully compliant with:

- International AFC, railway, and payment standards
- Approved AFC Master Specification (MSS)
- Local regulatory and institutional frameworks

11.3 AFC SYSTEM PHILOSOPHY

11.3.1 Open-Loop Fare Collection The AFC system shall support open-loop fare payments, including:

Parameter	Specification
EMV Certification	EMV Level 1,2 and 3
NFC Standards	ISO/IEC 14443 A/B, ISO/IEC 18092 or superior standard
QR Support	ISO/IEC 18004
Communication	Ethernet / 4G / 5G / and Wi-Fi
Security	PCI DSS, Secure Access Module (SAM)
Environmental	IP65 minimum, conformal coated PCB
Interface	REST APIs, SDK enabled
OS	Embedded Linux /Windows IoT/Android 12.0 or Above

All certifications related to Mastercard, VISA, UnionPay, PayPak, and other schemes shall be the sole responsibility of the EPC Contractor.

11.3.2 Closed-Loop Fare Collection

The AFC system shall also support closed-loop fare media, including:

- Contactless Smart Cards (CSC)
- Contactless Smart Tokens (CST)

Both systems shall operate simultaneously and seamlessly.

11.4 CENTRALIZED INDIGENOUS AFC SOFTWARE (PITB)

11.4.1 All AFC equipment shall operate using Indigenous Centralized AFC Software provided by Punjab Information Technology Board (PITB).

11.4.2 The EPC Contractor shall:

- Integrate all AFC hardware with PITB software
- Provide full **SDKs, APIs, NDKs**, and documentation
- Ensure real-time integration with **train scheduling systems**
- Not impose proprietary back-office software

11.4.3 The AFC software shall be:

- Fully parameterized
- Capable of fare logic configuration
- Capable of reporting, auditing, and analytics
- Enabled with Mobile Device Management (MDM)

11.5 SYSTEM ARCHITECTURE & CONNECTIVITY

11.5.1 AFC equipment shall be arranged in a standard hierarchy:

- AFC Devices
- Station Computer (SC)
- Central Computer (CC)
- PITB Central AFC Servers

11.5.2 All Station Computers shall be connected via WAN to the Central Computer.

11.5.3 Network infrastructure shall include:

Parameter	Specification
Core Switch	Layer-3 Managed, Industrial Grade
Access Switches	Layer-2 Managed, PoE+, Industrial
Bandwidth	Gigabit Ethernet minimum
Redundancy	Ring / Dual-homing supported
Cybersecurity	Firewall, VLANs, ACLs
Protocols	TCP/IP, SNMP, NTP, HTTPS
Environmental	IEC 61850 / Industrial temperature
Power Backup	Connected to AFC UPS

11.6 PERFORMANCE REQUIREMENTS

11.6.1 AFC equipment shall meet station planning and capacity requirements.

11.6.2 The AFC system shall be a closed system while supporting open-loop transactions.

11.6.3 All transactions shall be recorded, processed, and archived at the Central Computer System (CCS).

11.6.4 The system shall support:

- Revenue analysis
- Traffic planning
- Marketing
- Station planning

11.6.5 The AFC system shall be modular and expandable.

11.7 STATION COMPUTER (SC)

The Station Computer shall:

- Control all AFC equipment at station level
- Download fare tables and software
- Generate station reports
- Monitor alarms and diagnostics
- Operate AFC equipment in stand-alone mode
- Store 7 days of equipment data and 30 days of station data

11.8 AUTOMATIC GATES (AG)

11.8.1 Automatic Gates shall validate fare media and control access between paid and unpaid areas.

11.8.2 Gate Design

- Retractable flap or swing type
- No tripod or turnstile gates
- Stainless steel enclosure

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- IP54 minimum (IP65 where exposed)

11.8.3 Emergency Operation

- Fail-safe open on power loss
- Open on fire alarm activation
- Emergency push button at ticket office

11.8.4 Types of Gates

- Entry Gates
- Exit Gates
- Reversible Gates
- Bi-directional Gates
- Wide Gates for mobility-impaired users
- Staff/Emergency Gates

11.9 TICKET OFFICE MACHINES (TOM / BOM)

TOMs shall:

- Sell all ticket types
- Analyze tickets
- Add value to CSC
- Process refunds and surcharges
- Interface with luggage weighing systems

11.10 TICKET VENDING MACHINES (TVM / TKM)

TVMs shall:

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Parameter	Specification
Payment Standards	EMVCo L1 & L2, PCI-DSS
Media Supported	EMV Cards, NFC/HCE, QR
Printer	Thermal, Boarding-pass/Card grade
Display	≥ 15” Industrial Touch Display
IP Rating	Minimum IP65
OS	Embedded Linux /Windows IoT/Android 12.0 or Above
Connectivity	Gigabit Ethernet, 4G/5G and Wi-Fi
Operating Temp	-10°C to +55°C

11.11 CENTRAL COMPUTER (CC)

The Central Computer shall:

- Collect station data
- Maintain fare tables
- Manage blacklists
- Interface with Central Clearing House
- Provide availability ≥ 99.9%

11.12 TICKETS & MEDIA

11.12.1 Ticket Types

- Single Journey
- Return Journey
- Daily Pass
- Weekly Pass
- Seasonal Pass

- Stored Value
- Staff / Employee Pass
- Promotional Tickets

11.12.2 Media

- CSC (ISO/IEC 14443 DESFire)
- CST (card or token)
- QR (ISO/IEC 18004)
- EMV cards & wallets

11.13 SECURITY REQUIREMENTS

11.13.1 Revenue Protection

- Anti-tamper design
- Counterfeit prevention
- Secure software access
- Full audit trail

11.13.2 Cybersecurity

- PCI-DSS compliance
- TLS 1.3 encryption
- Secure Element / SAM
- VAPT testing

11.13.3 Data Ownership

All AFC data shall be the exclusive property of the Employer.

11.14 POWER & UPS

Parameter	Specification
UPS Type	Online Double Conversion
Backup Time	≥ 6 hours
Standards	IEC 62040, IEEE
Input Voltage	220–240V AC
Output Regulation	±1%
Battery Type	SMF / Lithium (Industrial Grade)
Monitoring	SNMP / Network Monitoring
Environmental	Suitable for depot & station use

11.15 RAMS REQUIREMENTS

- Gates MCBF: 40,000 cycles
- TOM / TVM MCBF: 10,000 cycles
- Central Computer availability: 99.9%

Standards:

- EN 50126
- EN 50128
- EN 50129

11.16 DESIGN DOCUMENTATION

- Engineering Plan
- System Architecture
- FMECA
- Interface Management Plan

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- Software Specifications
- Installation Drawings
- Cybersecurity Reports

11.17 TESTING & COMMISSIONING

- Factory Acceptance Test (FAT)
- Site Acceptance Test (SAT)
- PITB Integration Testing
- Trial Operations

Standards:

- ISO/IEC 14443
- ISO/IEC 18004
- EMVCo
- PCI-DSS

Generic Per Station Components:

Sr. No	Item Description	Quantity per Station
1	Automatic Gate Machines (AGM)	6
2	Validators (Standalone / Integrated)	As Required
3	Ticket Kiosk Machines (Cashless)	3
4	Booking Office Machines (BOM)	4
5	Luggage Weight Machines	4
6	EMV POS Terminals	4
7	Handheld Ticketing Devices	As Required

Sr. No	Item Description	Quantity per Station
8	Central / Station Network Equipment	Lot
9	Industrial UPS with 6-hr Backup	Lot
10	Mandatory Spares (10%)	Lot

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CHAPTER – 12

COMMISSIONING OF THE MONORAIL SYSTEM

CHAPTER – 12

COMMISSIONING OF THE MONORAIL SYSTEM

12.1 General

This Chapter lays down the procedure, standards and tests for commissioning of the Monorail system.

12.1.1 Stages involved in commissioning the Monorail system are:

(a) The Contractor shall develop, implement and administer a surveillance and safety program and shall comply with the Safety Requirements.

(b) The Contractor shall ensure that:

a. The Safety Requirements as specified in the Safety Report of the Safety Consultant, after it has carried out safety audit at the design stage, are complied with; and

b. The Safety Requirements as specified in the Safety Report of the Safety Consultant, after it has carried out safety audit of the completed construction works, are complied with.

c. All statutory clearances towards electrical works have to be approved by Electrical Inspector.

(c) At least 60 (sixty) days prior to the likely completion of the Monorail system, the Contractor shall notify the TE of its intent to subject the Monorail system to Tests, including oscillation trials and trial runs. The date and time of each of the Tests shall be determined by the TE in consultation with the Contractor, and notified to the Safety Consultant, who may designate their representatives to witness the Tests.

(d) The TE shall observe, monitor and review the results of the Tests and trial runs to determine compliance of the Monorail system with the Specifications and Standards.

(e) If it is reasonably anticipated or determined by the TE during the course of any Test that the performance of the Monorail system or any part thereof does not meet the Specifications and Standards, it shall have the right to suspend or delay such Test and require the Contractor to remedy and rectify the defects or deficiencies.

(f) TE shall issue Completion Certificate if the Tests are successful and all the works are complete or the TE shall issue Provisional Certificate with punch List if Tests

are successful and the Monorail system can safely and reliably be placed in commercial operation though certain works are outstanding and not yet complete. Provisional Certificate can be issued for part opening of the line, provided 75% (seventy-five per cent) of the relevant corridor is completed.

(g) The Contractor shall submit the required application, along with all supporting documents, to the Safety Consultant for certification that the Monorail system is safe to enter commercial service.

(h) After completing and testing the project, the Contractor will submit a request to TE along with the Safety Certificate issued by the Safety Consultant. TE will then carry out the required inspections and tests, or have them conducted, in line with the applicable laws, regulations and the Agreement. Once TE confirms that the monorail system is safe for public use, it will issue the certificate of fitness and permit the system to open for commercial operation, with conditions it considers necessary.

(i) If the Safety Consultant believes that the Monorail system cannot be opened without risk to Users, the Consultant will prepare a report explaining the reasons and submit it to the TE. The TE will then determine condition that must be met before the system can be opened. Once those condition are fulfilled to the satisfaction of the Safety Consultant, the Consultant will issue the certificate of fitness and allow the Monorail system to open for use.

12.2 Commissioning

12.2.1 As part of the safety certification process, the Contractor shall submit an application to the Safety Consultant, which shall cover all aspects of commissioning of the sub-systems, in a form to be prescribed by Rules prepared by the Safety Consultant.

12.2.2 The application shall also describe the personnel to be deployed, their organization structure and responsibilities. All personnel in charge of O&M shall have been provided requisite training prior to deployment. The Contractor shall demonstrate that its proposed key personnel are skilled, trained and experienced in the commissioning and operation of the various systems.

12.2.3 The application shall describe measures to ensure the safety of personnel involved in the commissioning and of Users. It shall describe the Tests to be carried out that will verify the operability of the various sub-systems like Guideway, Rolling Stock etc.

12.2.4 The maintenance plan, maintenance manuals for the various sub-systems, infrastructure and trained personnel for maintenance as well as the tools and plants and equipment for maintenance shall be in place prior to undertaking trial runs.

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CHAPTER – 13

WORK SITE SAFETY, REINSTATEMENTS AND TRAFFIC REGULATIONS

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CHAPTER – 13
WORK SITE SAFETY, REINSTATEMENTS AND TRAFFIC REGULATIONS

13.1 General

This Chapter lays down the specifications and standards for traffic diversions/ regulations and work site safety.

13.2 Site Management

13.2.1 The following works, where necessary, shall be undertaken by the Contractor as part of development of the Monorail System, in accordance with the requirements of Applicable Laws and to the extent permitted.

1. Cutting/transplantation of trees;
2. Construction/ diversion of utilities such as storm water drains, sewer lines, water lines, communication lines, power lines etc.
3. Dismantling of existing roads and structures and shifting boundary wall to a desired location and restoring it back after completion of works;
4. Construction and maintenance of roads and diversions to conform to National highway specifications;
5. Maintenance of existing roads used for development of Monorail System to conform to National highway specifications and norms;
6. Reinstatement of services with new materials (except electric/ signal posts in good condition which may be reused) such as street lighting, traffic Signalling system, bus shelters/stands, footpaths including kerb stones, boundary walls, horticulture work and restore the site to its original position
7. Provision of barricading of works and the areas occupied by the Contractor to segregate them from public area;
8. Supporting/diverting of all utilities within the Right of Way (ROW);
9. Surveying, instrumentation and monitoring, of settlement for building protection, risk analysis, and preventive and corrective actions; and
10. Traffic management including decking, along with signage/traffic marshals.

The Contractor shall be responsible for obtaining relevant certificates and/or clearances from local authorities in relation to the foregoing.

13.2.2 Flood Protection

During construction, the Contractor shall be responsible for providing and maintaining adequate flood protection to ensure protection of the works.

13.2.3 Temporary Power Supply

The Contractor is responsible for arranging temporary power supply at the Site during the construction period.

13.2.4 Traffic management

13.2.4.1 A proper traffic management plan during construction shall be formulated by the Contractor in consultation with concerned traffic police and the TE, and submitted to the TE for his review and comments, if any. The traffic management plan shall be put in place before the start of any construction activity.

13.2.4.2 The execution of work shall be so planned that the inconvenience to the traffic is minimal. The temporary diversion, where constructed, shall conform to the following minimum standards:

i) Width of diversion road shall be sufficient, (or at least not less than existing width) for the traffic to be diverted; and
ii) The crust composition shall be as per standards.

13.3 Design of Temporary Works

The Contractor is required to submit design as required below to the TE:

13.3.1 Preliminary design submission, which shall cover the following:

i. the utility diversion plan;
ii. the preliminary ground treatment and building protection proposal; and
iii. the preliminary reinstatement drawings.

13.3.2 Definitive design submission, which shall cover the following:

i. utilities to be diverted /supported;
ii. proposed methods of predicting the ground movements adjacent to the excavations;

iii. prediction of effect on structures due to ground movements and the proposed protective measures to limit the effects to a degree not exceeding the limit;

iv. traffic or other civic service affected;

v. prediction of lowering of water table and its effect on (b) and (c) above;

vi. access roads and temporary road works;

vii. pumping systems;

viii. existing and proposed utilities;

ix. road works and works related to traffic management; and proposals for traffic control devices and road safety works.

13.3.3 Utilities Report

A report giving details of arrangements and working methods in respect of the existing utilities, including protection measures, diversions, reinstatements and program allowances shall be submitted to TE.

13.3.4 Temporary Works Design Report

A report along with drawings on the design of the temporary works to assess their effects on the permanent works and to enable these to be taken into account in the review of the definitive design shall be submitted by the Contractor to the TE for review and comments if any. The report shall include details covering type, location, material specifications, installation details and the requests warranties for the satisfactory field performance.

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13.4 Construction Requirements

13.4.1 Access to the Site

The Contractor shall be responsible for ensuring that any access or egress through the Site boundaries are controlled such that no disturbance to residents or damage to public or private property occur as a result of the use of such access or egress by its employees or representatives.

13.4.2 Traffic Control devices

a. Traffic control devices shall comprise traffic signs, road markings, safety barriers, pedestrian railings etc. Guidelines given in National highways specifications shall be followed in adopting appropriate road markings and traffic signs unless otherwise specified in this section.

b. The following general guidelines shall be followed:

i. The Contractor shall erect barricades, as per the drawing with gates around its areas of operations to prevent entry by unauthorized persons to his Works areas and necessary identity cards /permits should be issued to workers and staff by the Contractor. The Contractor shall submit a proposal for barricades of the complete perimeter of all Works areas to the TE. Painting of the barricades shall be carried out to the design and colors in consultation with the TE and the Contractor shall carry out re-painting of the entire barricades on an annual basis. No work shall be commenced in any Work area until the barricades installed by the Contractor are sufficient to prevent, within reason, unauthorized entry;

ii. Project signboards shall be erected not later than four (4) weeks, or such other agreed period, after the date of commencement of the Works. The types, sizes and locations of project signboards shall be in consultation with the TE before manufacture and erection. Other advertising signs shall not be erected on the Site;

iii. Hoardings, barricades, gates and signs shall be maintained in clean and good order by the Contractor until the completion of the Works;

iv. All hoardings, barricades, gates and signs installed by the Contractor shall be removed by the Contractor upon the completion of the Works, unless otherwise directed;

v. Damaged/worn-out barricades /hoarding shall be replaced within 24 hours; and Clearance of the Site: All Works which are not to remain on the Site after the completion of the Works shall be removed prior to completion of the Works and the Site reinstated to the condition as existed before the Works started except as otherwise agreed.

13.4.3 Road Markings – Specification

All road markings shall conform to. Road markings shall comprise of carriageway markings such as longitudinal markings on intersections, hazardous locations, parking, etc. and object markings such object within the carriageway, adjacent to carriageway and marking on kerbs.

13.4.3.1 Material

i. Hot applied thermoplastic paint with glass beads shall be used as carriageway marking materials.

ii. Road marking paint conforming to National Highway Codes shall be used for object markings.

13.4.3.2 Raised Pavement Markers (Cat's Eyes):

The cat's eyes or road studs are used to form a semi-permanent marking and provide improved visibility during night time and wet-weather conditions. These shall be either reflex lens type or solid white beads. These shall be provided at hazardous locations and while approaching important intersections, to supplement the paint or thermoplastic line markings.

13.4.4 Road Signs

There are three types of road signs viz., mandatory/regulatory signs, cautionary/warning signs, and informatory signs. Locations of signs shall conform to National highway Specifications.

13.4.4.1 Sheeting

The retro-reflective sheeting shall be used on the signs. The sheeting shall be weather-resistant and show colour fastness. It shall be new and unused and shall show no evidence of cracking, scaling, pitting, blistering, edge lifting or curling and shall have negligible shrinkage or expansion. A certificate of having tested the sheeting for these properties in an unprotected outdoor exposure facing the sun for two years and its having passed these tests shall be obtained from a reputed laboratory by the manufacturer of the sheeting and shall provide for review and comments, if any, of the TE. The reflective sheeting shall be high intensity grade with encapsulated lens or with micro prismatic retro-reflective element material as specified. The retro-reflective surface after cleaning with soap and water and in dry condition shall have the minimum co-efficient of retro-reflection (determined in accordance with ASTM).

13.4.4.2 Message/Borders

i. The messages (legends, letters, numerals etc.) and border shall either be screen-printed or of cut-outs. Screen-printing shall be processed and finished with materials and in a manner specified by the sheeting manufacturers.

ii. For screen-printed transparent colored areas on white sheeting, the co- efficient of retro-reflection shall not be less than 50% of the values of corresponding colour.

13.4.4.3 Colour Scheme

i. Unless specified otherwise, the general colour scheme shall be in accordance with international practice, the colour shall be as stipulated for Ready Mixed Paints".

ii. The colour shall be durable and uniform when seen in daylight or under normal headlights at night.

iii. Direction, destination and plate identification signs shall have green background and white messages (legends, letters, numerals, etc.) and borders.

iv. Colour scheme for facility information signs, other useful information signs and parking signs shall conform to the provisions contained in International Standard In respect of informatory signs, the messages/borders shall either be screen-printed or of cut outs, while for warning and regulatory signs, these shall be screen-printed.

v. Clustering and proliferation of road signs shall be avoided for enhancing their effectiveness.

13.4.4.4 Adhesives

The sheeting shall either have a pressure-sensitive adhesive of the aggressive tack requiring no heat, solvent or other preparation for adhesion to a smooth clean surface, or a tack free adhesive activated by heat applied in a heat-vacuum applicator, in a manner recommended by the sheeting manufacturer. The adhesive shall be protected by an easily removable liner (removable by peeling without soaking in water or other solvent) and shall be suitable for the type of material of the base plate used for the sign. The adhesive shall form a durable bond to smooth corrosion and weather resistant surface of the base plate such that it shall not be possible to remove the sheeting from the sign base in one piece by use of sharp instrument. In case of pressure sensitive adhesive sheeting, the sheeting shall be applied in accordance with the manufacturer's specifications. Sheeting with adhesive requiring use of solvents or other preparation for adhesive shall be applied strictly in accordance with the manufacturer's instructions.

13.4.4.5 Installation

i. The sign posts, their foundations and sign mountings shall be so constructed as to hold them in a proper and permanent position against the normal storm wind loads. Normally, signs with an area unto 0.9 sqm shall be mounted on a single post, and for greater area two or more supports shall be provided. Sign supports

may be of mild steel (MS), reinforced concrete or galvanized Iron (GI). Post end(s) shall be firmly fixed to the ground by means of properly designed foundation. The work of foundation shall conform to relevant National Highway Specifications.

ii. All components of signs and supports, other than the reflective portion and GI posts shall be thoroughly descaled, cleaned, primed and painted with two coats of epoxy paint. Any part of MS post below ground shall be painted with three coats of red lead paint.

iii. The signs shall be fixed to the posts by welding in the case of steel posts and by bolts and washers of suitable size in the case of reinforced concrete or GI posts. After the nuts have been tightened, the tails of the bolts shall be furred over with a hammer to prevent removal.

13.4.5 Roadside Safety Barriers

There are two types of safety barriers viz., longitudinal roadside safety barriers and median safety barriers.

13.4.5.1 Warrants

i. The longitudinal roadside barriers are basically meant to shield roadside obstacles and also for preventing the vehicles veering off the sharp curves.

ii. The warrants for roadside objects are mainly dependent upon the type of obstacle and the probability of their being hit. A barrier shall be installed only if the result of vehicle striking the barrier is likely to be less severe than the severity of accident resulting from the vehicle impacting the unshielded obstacle. Some of the commonly encountered roadside obstacles are bridge piers, abutments and railing walls, lighting supports, traffic signs and signal supports, trees and utility poles.

13.4.5.2 Types of Road side Safety Barriers

There are broadly three types of longitudinal roadside safety barriers:

i. Flexible type (like wire-rope fencing);

ii. semi rigid type, like:

- "W" beam type steel barriers; and
- three beam type steel barriers.

These steel barriers are of strong post type and usually remain functional after moderate collisions, thereby eliminating the need for immediate repair; and

iii. Rigid type (like concrete crash barriers).

The Contractor shall prepare standard safety barriers design and get it approved by the IE before the implementation

13.4.5.3 KERBS and DRAINS

Raised kerbs or drains shall not be provided between the carriage way and the barriers. These destabilize the vehicle balance and disturb its equilibrium before it strikes the barrier, thus defeating the essential purpose of safety and redirection of the impacting vehicle.

13.5 Survey Points

The Contractor shall carefully protect all the survey reference points, bench marks, setting out points, monuments, towers and the like from any damages and shall maintain them and promptly repair or replace any points damaged from any causes whatsoever. The Contractor shall regularly recheck the position of all setting out points, bench marks and the like to the satisfaction of the TE.

13.5.1 Protection of the Works from Weather

During construction of the Works, storm restraint systems shall be provided where appropriate. These systems shall ensure the security of the partially completed and on-going stages of construction in all weather conditions.

Damage and Interference

i. Work shall be carried out in such a manner that there is no damage to or interference with:

a) Watercourses or drainage systems;
b) utilities;
c) structures (including foundations), roads, including street furniture, or other properties;
d) public or private vehicular or pedestrian access; and

ii. Monuments, trees, graves or burial grounds other than to the extent that is necessary for them to be removed or diverted to permit the execution of the Works. Heritage structures shall not be damaged or disfigured on any account.

iii. The Contractor shall inform the TE as soon as practicable of any items which are not stated in the Concession to be removed or diverted but which the Contractor considers need to be removed or diverted to enable the Works to be carried out. Such items shall not be removed or diverted until the consent to such removal or diversion has been obtained.

iv. Items which are damaged or interfered with as a result of the Works and items which are removed to enable work to be carried out shall be reinstated to at least the same condition as existed before the work started. Any claims by utility agencies due to damage of utilities by the Contractor shall be borne by the Contractor.

13.6 Utilities

Responsibility of the Contractor regarding utilities is detailed in Appendix I to this chapter.

13.7 Structures, Roads and Other Properties

The Contractor shall immediately inform the IE of any damage to structures, roads or other properties.

13.8 Access

Alternative access shall be provided to all premises if interference with the existing access, public or private, is necessary to enable the Works to be carried out. The arrangements for the alternative access shall be as agreed by The Engineer and the concerned agency. Unless agreed otherwise, the permanent access shall be reinstated as soon as practicable
after the work is complete and the alternative access shall be removed immediately and the ground surfaces reinstated.

13.9 Trees

The Contractor is not permitted to cut any trees except in accordance with all Applicable Laws. The Contractor has to assess the number of trees existing within the

right-of-way and has to arrange permission from appropriate Government authorities for cutting back or removal of trees which are deemed to be affected by the right of way (i.e., within the limits of permanent works). The trees requiring to be felled will be removed from ground level by the Contractor prior to commencement of the works.

13.10 Removal of Graves and Other Obstructions

If any graves and other obstructions are required to be removed in order to execute the Works and such removal has not already been arranged for, the Contractor shall draw The Engineer's attention to them in good time to allow all necessary arrangements and authorizations for such removal.

13.11 Traffic Management Plan

The Contractor shall develop a detailed traffic management plan for the work. The purpose is to develop a traffic management plan to cope with the traffic disruption as a result of construction activities by identifying strategies for traffic management on the roads and neighborhoods impacted by the construction activities. The Contractor shall implement the traffic management plan.

13.11.1 Principles for Traffic Management Plan

The basis for the plan shall take into consideration the following principles:

(i) To minimize the inconvenience to road users and the interruption to surface traffic through the area impacted by the construction activities;

(ii) To ensure the safety of road users in the impacted area;

(iii) To facilitate access to the construction site, and to maintain reasonable construction progress; and

(iv) To ensure traffic safety at each construction site.

13.11.2 Integrated Traffic Management Plan

The Contractor shall prepare an integrated plan showing the arrangements to be made for accommodating road and pedestrian traffic, at individual construction sites and continuously along the alignment, to smooth traffic operations and for the safety of both construction workers and road users. The plan shall consider different measures such as:

The use of top-down construction to reduce the period of disruption to road users;

i. Proper phasing and timing of traffic signals;

ii. Modifications to intersection geometry;

iii. Changes in lane usage;

iv. Parking prohibitions;

v. Re-location of bus stops;

vi. Reducing width of footpaths and median;

vii. Right-turn prohibition;

viii. Work site access management;

ix. Minimizing the duration of any road closure;

x. Reversible lane operations;

xi. Modification of roadway alignment affected by the construction; and

xii. Other engineering measures as may be applicable.

13.11.3 Mitigation of Traffic Disturbances

(a) The Contractor shall manage the vehicular and pedestrian right of way during the period of construction. The Contractor shall take account of the need to maintain essential traffic requirements, as these may influence the construction process.

(b) The Contractor shall include local traffic diversion routes and assess traffic impacts caused by the construction in the affected areas.

(c) Where it becomes necessary to close a road or intersection, or supplementary lanes are required to satisfy the traffic demands, traffic diversion schemes to adjacent roadways shall be developed with quantitative justifications.

(d) Other considerations include:

(i) The minimum lane widths for fast traffic and mixed traffic shall follow the regulations of the different authorities;

(ii) Any roads or intersections that have no alternative access shall not be fully closed for construction;

(iii) Emergency access to all properties shall be maintained at all times;

(iv) Access to business premises and property shall be maintained to the extent that normal activities are not seriously disrupted;

(v) Where existing footbridges and underpasses are demolished or closed, provisions shall be made for pedestrian crossing to minimize the conflicts between a traffic lane;

(vi) Construction traffic shall be separated from other traffic wherever possible;

(vii) Any traffic related facilities (bus stops, parking, etc.) which are affected by the construction works shall be maintained or relocated to appropriate locations;

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(viii) Motorists, pedestrians, workmen, plant and equipment shall be protected from accident at all times;

(ix) Roadway designs, traffic management schemes, and installation of traffic control devices shall be in conformance with the requirements and regulations defined by the relevant authorities; and

(xi) Where applicable, utility diversions shall be incorporated in the traffic management plan.

13.12 Approval for Temporary Traffic Arrangements and Control

The Contractor shall make all arrangements with and obtain the necessary approval from the local authorities and the police department for temporary traffic arrangements and control on public roads. In the event that the Contractor, having used its best endeavor's, fails to secure the necessary approval from the transport authorities and the traffic police department for temporary traffic arrangements and control on public roads,

then the TE will use its best endeavors to assist the Contractor to secure such approval but without responsibility on the part of the TE to do so.

13.12.1 Temporary Traffic Arrangements and Control

i. Temporary traffic diversions and pedestrian routes shall be surfaced and shall be provided where work on roads or footpaths obstruct the existing vehicular or pedestrian access. The relevant work shall not be commenced until the temporary traffic arrangements and control have been implemented.

ii. Temporary traffic arrangements and control for work on public roads and footpaths shall comply with the requirements of the traffic police. Copies of documents containing such requirements shall be kept on the Site at all times.

iii. Temporary traffic signs, including road markings, posts, backing plates and faces, shall comply with the requirements of the traffic police and should be in accordance with the requirements of NHA All overhead traffic management signs that are fixed to bridges and gantries shall be illuminated at night. Pedestrian routes shall be illuminated at night to a lighting level of not less than 50 lux.

iv. Adequate number of traffic marshals shall be deployed for smooth regulation of traffic.

v. Temporary traffic arrangements and control shall be inspected and maintained regularly, both by day and night. Lights and signs shall be kept clean and legible. Equipment which are damaged, dirty, incorrectly positioned or not in working order shall be repaired or replaced promptly.

13.12.2 Particulars of Temporary Traffic Arrangements and Control

a) The following particulars of the proposed temporary traffic arrangements and control on public roads shall be submitted to the IE at least 28 days before the traffic arrangements and control are implemented:

i. Details of traffic diversions and pedestrian routes;

ii. Details of lighting, signage, guarding and traffic control arrangements and equipment; and

iii. Any conditions or restrictions imposed by traffic police or any other relevant authorities, including copies of applications, correspondence and approval.

b) Where concrete barriers are used to separate flows of traffic, the barriers shall be in a continuous unbroken line.

c) Site perimeter fencing and barriers along the roadway, shall have flashing amber lights positioned on the top of them every 50 m apart and at every abrupt change in location. Directly below the flashing light shall be fixed, in the vertical position, a white fluorescent light with a waterproof cover.

13.12.3 Use of Roads and Footpaths

13.12.3.1 Public roads and footpaths on the Site in which the work is not being carried out shall be maintained in a clean and passable condition.

13.12.3.2 Measures shall be taken to prevent the excavated materials, silt or debris from entering gullies on roads and footpaths; entry of water to the gullies shall not be obstructed.

13.12.3.3 Surfaced roads on the Site and leading to the Site shall not be used by tracked vehicles unless protection against damage is provided.

13.12.3.4 Contractor's equipment and other vehicles leaving the Site shall be loaded in such a manner that the excavated material, mud or debris will not be deposited on roads. All such loads shall be covered or protected to prevent dust being emitted. The wheels of all vehicles shall be washed, when necessary, before leaving the Site to avoid the deposition of mud and debris on the roads.

13.12.4 Reinstatement of Public Roads and Footpaths

13.12.4.1 Temporary diversions, pedestrian access and lighting, signing, guarding and traffic control equipment shall be removed immediately when they are no longer required. Roads, footpaths and other items affected by temporary traffic arrangements and control shall be reinstated to the current NHA specifications. The Contractor shall submit his design for the reinstatement to the relevant authorities and obtain their prior approval to carry out the work. Reinstatement works shall include, but not be limited to:

a) Parking bays;
b) footpath and kerbs;
c) road signage;
   i. street lighting;
   ii. landscaping;
   iii. traffic lights and control cable; and
   iv. road painting, Site utilities and access.

13.12.4.2 The Contractor shall be responsible for provision of:

i. Water, electricity, telephone, sewerage and drainage facilities to site offices, structures and buildings and for all site laboratories in accordance with requirements. The Contractor shall make all arrangements with and obtain the necessary approval from the relevant civil and utility authorities for the facilities; and power supply for his works.

ii. Access roads and parking areas shall be provided within the Site as required and shall be maintained in a clean, acceptable and stable condition. For lengths of roadway longer than 100 m and where vehicle movements exceed one hundred (100) movements/day and heavy commercial vehicle are to ply, the Contractor shall provide paved surfacing of adequate thickness and quality in consultation with the TE.

13.13 Security

i. The Contractor shall be responsible for the security of the Site for the full time the Site is in its possession. He shall set up and operate a system whereby only those persons entitled to be on the Site can enter the Site. To this end, the Contractor shall, in consultation with the IE, provide the specific points only at which entry through the security fence can be affected, and shall provide gates and barriers at such points of entry and whereby maintain a twenty-four (24) hour security guard, and such other security personnel and patrols elsewhere as may be necessary to maintain security.

ii. The Contractor shall maintain all site boundary fences in first class condition, and shall so arrange site boundary fences at all access drainage points of work areas that its use of such access points etc., are not restricted by the system or method of achieving the required security measures. Notices shall be displayed at intervals around the Site to warn the public of the dangers of entering the Site.

iii. During the progress of the Works, the Contractor shall maintain such additional security patrols over the areas of the Works as may be necessary to protect its own and its sub-contractor's work and equipment and shall co-ordinate and plan the security of both the work under this Contract and the work of others having access to and across the Site and the Works.

iv. In order to operate such a security system, it will be necessary to institute the issue of unique passes to personnel and vehicles entitled to be on the Site, and which may need to be separately identifiable according to the shifts being worked on Site. The Contractor shall, at the outset, determine, in consultation with the TE a system and the design of passes to suit the requirements of the foregoing and to suit the methods of work to be adopted by the Contractor. The Contractor shall at all times ensure that the field engineer has an up-to-date list of all persons entitled to be on the Site at any time. The Contractor shall also introduce a system of issue of passes to any outsider or person/vehicles belonging to agencies other than the TE who may have to visit the site in connection with the work.

v. The Contractor shall liaise with his sub-contractors and ensure that coordinated security procedures are operated, in particular in respect of vehicles permitted to pass through the Sites of different sub-contractors.

vi. Security measures shall be coordinated with the TE.

vii. Security and checking arrangements as necessary shall be provided with advice and help of the police.

CHAPTER – 14

WORKS AREAS AND TEMPORARY POWER SUPPLY

CHAPTER – 14
WORKS AREAS AND TEMPORARY POWER SUPPLY

14.1 Standard Engineering Conditions

14.1.1 The following standard engineering conditions apply to the portions of the Site where any part of the Works is undertaken:

I. Formation

a. The Site shall be formed to the levels agreed upon with TE.

b. The Site shall be surfaced in a manner, compatible with their intended use, and, in particular, footpaths and roadways and connecting facilities shall be clearly defined. Measures shall be taken to ensure that all areas are properly drained and kept free of static water.

c. The removal, diversion or reinstatement elsewhere as may be required of any existing works or installation whatsoever within the Site shall be carried out to the satisfaction of the TE.

d. Roads and Parking.

e. Space shall be provided within the Site for parking, loading/ unloading and maneuvering of motor vehicles.

f. Any damage done to the adjoining public roads and fixtures and properties (public or private) shall be made good by the Contractor to the satisfaction of the TE.

II. Drainage and Sewerage

a. All storm or rainwater from the Site including any access roads thereto shall be conveyed to the nearest stream course, catch-pit, channel or storm water drain as required. All temporary and permanent works shall be carried out in such a manner that no damage or nuisance are caused by storm water or rain water to the adjacent property.

b. No drain or watercourse shall be used without approval.

c. Damages or obstructions caused to any watercourse, drain, water- main or other installations within or adjoining the Site shall be made good to the satisfaction of the TE.

d. Treatment and disposal of sewage and wastewater from the Works area shall be provided to the satisfaction of the TE.

e. No permanent structures other than those required for the permanent works shall be permitted on the Site.

f. Electricity, water, telephone and sewerage shall be provided by the Contractor, as required, for all temporary buildings.

g. No potable water from the local authorities shall be used for heating, cooling and humidification purposes, or vehicle washing without the written consent of the authority concerned.

III. Pedestrian Access

Every existing pedestrian access throughout the Site shall be maintained in a usable condition at all times including lighting, signing and guarding.

IV. Fencing

The Site shall be secured against unauthorized access at all times. In particular fencing or the like shall be maintained, removed and re- erected in the new location wherever and whenever a Works area is relinquished in stages.

14.2 Work On Site

(a) The Contractor shall nominate a representative whose name and qualifications shall be submitted in writing to The Engineer for review not later than 4 weeks before his appointment and who shall be solely responsible for ensuring the safety of all temporary electrical equipment on Site. The Contractor shall not install or operate any temporary Site electrical systems until this representative is appointed and has commenced duties.

(b) The name and contact telephone number of the representative having been reviewed by the IE shall be displayed at the main distribution board for the temporary electrical supply so that he can be contacted in case of an emergency.

(c) Schematic diagrams and the details of the equipment for all temporary electrical installations shall be submitted by the Contractor, and these diagrams together with the temporary electrical equipment shall be submitted to the TE for his review.

(d) All electrical installation work on Site shall be carried out in accordance with the requirements laid down in BS 7375. All works shall be supervised or executed by qualified and suitably categorized electricians, who are registered as such under the NEPRA Act (1997) (Registration) Rules 2023.

14.3 Electrical: General Requirements

14.3.1 Temporary electrical Site installations and distribution systems shall be in accordance with:

(i) Pakistan Electricity Rules; (NEPRA)
(ii) the Power Companies' Supply Rules;
(iii) electricity and its subsidiary regulations;
(iv) IEE Wiring Regulations (16th Edition);
(v) BS 7375 Distribution of Electricity on Construction and Building Sites;
(vi) BS 4363 Distribution Assemblies for Electricity Supplies for Construction and Building Sites; and
(vii) any other applicable national standards.

14.3.2 Materials, Appliances and Components

All materials, appliances and components used within the distribution system shall comply with BS 4363 and BS 7375

14.3.3 Design Considerations

a) Distribution equipment utilized within the temporary electrical distribution system shall incorporate the following features:
   (i) Flexibility in application for repeated use;
   (ii) suitability for transport and storage;
   (iii) robust construction to resist moisture and damage; and
   (iv) safety in use.
b) All cabling shall be run at high level whenever possible and firmly secured to ensure that they do not present a hazard or obstruction to people and equipment.
c) The installation on Site shall allow convenient access to authorized and competent operators to work on the apparatus contained within.

14.4 Mains Voltage

(a) The Site mains voltage shall be as per the Electricity Authority, 415V/ 3- phase 4 – wire system:

- Single phase voltage shall be as per the Electricity Authority, 230V supply; and
- Reduced voltages shall conform to BS 7375.

(b) Types of Distribution Supply.

The following voltages shall be adhered to for typical applications throughout the distribution systems:

(i) fixed plant – 415V/3-phase;
(ii) movable plant fed by trailing cable – 415V/3-phase;
(iii) installations in Site buildings – 230V/1-phase
(iv) fixed flood lighting – 230V/1-phase;
(v) portable and hand-held tools – 115V/1-phase;
(vi) Site lighting (other than flood lighting) – 115V/1-phase; and
(vii) portable hand-lamps (general use) – 115V/1-phase.

(c) The Contractor shall carry out any conversion that may be necessary to enable him to use power from his source of supply.

14.5 Protection of Circuits

14.5.1 Protection shall be provided for all main and sub-circuits against excess current, under and over voltage, residual current and earth faults. The protective devices shall be capable of interrupting (without damage to any equipment or the mains or sub-circuits) any short circuit current that may occur.

14.5.2 Discrimination between circuit breakers and fuses shall be in accordance with:

i. BS 88;
ii. BS EN 60898;
iii. BS 7375; and
iv. Any other appropriate Pakistan Standards.

14.6 Earthing

14.6.1 Earthing and bonding shall be provided for all electrical installations and equipment to prevent the possibility of dangerous voltage rises and to ensure that faults are rapidly cleared by installed circuit protection.

14.6.2 Earthing systems shall conform to the following standards:

i. IEE Wiring Regulations (16th Edition);
ii. BS 7430;
iii. BS 7375; and
iv. IEEE Standard 80 Guide for Safety in AC Substation Grounding.

14.7 Plugs, Socket Outlets and Couplers

Low voltage plugs, sockets and couplers shall be color coded in accordance with BS 7375, and constructed to conform to BS EN 60309. High voltage couplers and 'T' connections shall be in accordance with BS 3905.

14.8 Cables

14.8.1 Cables shall be selected after full consideration of the conditions to which they will be exposed and the duties for which they are required. Supply cables up to 3.3kV shall be in accordance with BS 6346.

14.8.2 For supplies to mobile or transportable equipment where operation of the equipment subjects the cable to flexing, the cable shall conform to one of the following specifications appropriate to the duties imposed on it:

i. BS 6708 flexible cables for use at mines and quarries;
ii. BS 6007 rubber insulated cables for electric power and lighting; and
iii. BS 6500 insulated flexible cords and cables.

14.8.3 Where low voltage cables are to be used, reference shall be made to BS 7375.The following specifications shall also be referred to particularly for underground cables:

i. BS 6346 for armored PVC insulated cables; and
ii. BS 6708 Flexible cables for use at mines and quarries.

14.8.4 All cables which have a voltage to earth exceeding 65 V (except for supplies from welding transformers to welding electrodes) shall be of a type having a metal sheath and/or amour which shall be continuous and effectively earthed. In the case of flexible or trailing cables, such earthed metal sheath and/or amour shall be in addition to the earth core in the cable and shall not be used as the sole earth conductor.

i. Armored cables having an over sheath of polyvinyl chloride (PVC) or an oil resisting and flame retardant compound shall be used whenever there is a risk of mechanical damage occurring.
ii. For resistance to the effects of sunlight, overall non-metallic covering of cables shall be black in color.
iii. Cables which have applied to them a voltage to earth exceeding 12 V but not

normally exceeding 65 V shall be of a type insulated and sheathed with a general purpose or heat resisting elastomer.

iv. All cables which are likely to be frequently moved in normal use shall be flexible cables. Flexible cables shall be in accordance with BS 6500 and BS 7375.

14.9 Lighting Installation

14.9.1 Where Site inspection of the Works is required during the nights, the Lighting circuits shall be run separate from other sub-circuits and shall be in accordance with BS 7375 and BS 4363.

14.9.2 Voltage shall not exceed 55 V to earth except when the supply is to a fixed point and where the lighting fixture is fixed in position.

14.9.3 Luminaires shall have a degree of protection not less than IP 54. In particularly bad environments where the luminaires are exposed to excess of dust and water, a degree of protection to IP 65 shall be employed.

(a) The Contractor shall upgrade the lighting level to a minimum of 200 lux by localized lighting in all areas where required.

(b) Mechanical protection of luminaires against damage by impact shall be provided by use of wire guards or other such devices whenever risk of damage occurs.

14.10 Electrical Motors

(i) Totally enclosed fan cooled motors to BS 4999: Part 105 shall be used.

(ii) Motor control and protection circuits shall be as stipulated in BS 6164. Emergency stops for machinery shall be provided.

14.11 Inspection and Testing

14.11.1 Electrical installations on Site shall be inspected and tested in accordance with the requirements of the IEE Wiring Regulations (16th Edition).

14.12 Identification

14.12.1 Identification labels of a type reviewed by the TE shall be affixed to all electrical switches, circuit breakers and motors to specify their purpose.

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14.13 Maintenance

i. Strict maintenance and regular checks of control apparatus and wiring distribution systems shall be carried out by an electrician (duly qualified to carry out the said checks) to ensure safe and efficient operation of the systems. The Contractor shall submit for review by The Engineer details of his maintenance schedule and maintenance works record.

ii. All portable electrical appliances shall be permanently numbered (scarf tag labels or similar) and a record kept of the date of issue, date of the last inspection carried out and the recommended inspection period.

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CHAPTER – 15
UTILITIES

(CHAPTER – 15)

UTILITIES

a) General

Utilities are defined as public utilities above or below ground and include all live water mains, power cables, street lights, transformers, telephone posts, telecommunication cables, sewers, storm water drains etc.

b) Responsibility of the Contractor

The Contractor shall make his own enquiries and investigations, including excavating trial holes, to ascertain the existence, nature, location and size of utilities. A schedule of utility diversions and utilities to remain but to be supported (the utility diversion plan) will be prepared by the Contractor and submitted with the preliminary design. The schedule will list out utilities that:

i. will be diverted by the Contractor during the course of the Works; and
ii. will remain in place and require the use of specific construction methods to complete the works around and below or above the utilities including support of the utilities during construction.

The Contractor shall immediately inform the TE and the utility agencies of any:

i. damage to utilities;
ii. leakage of utilities; and
iii. discovery of utilities not previously identified.

Records of the existing utilities encountered shall be kept by the Contractor on the Site and a copy provided for the TE. The records shall contain the following details:

iv. location of utility;
v. date on which the utilities were encountered;
vi. nature and sizes of the utilities;
vii. condition of utilities;
viii. temporary or permanent supports provided; and
ix. Diversions made – temporary or permanent.

The Contractor shall include the details (plan, location, ownership, size and material) of all such utilities on

the as-built drawings.

DEFINITIONS

In this Manual of Specifications and Standards (the "Manual"), the following words and expressions shall have the meaning hereinafter respectively assigned to them:

TERM	DEFINITION
Abnormal Operation	shall mean a situation where the Train control and/or the Signaling system operates in an unscheduled situation;
Added Value Machines (AVMs)	shall mean the equipment utilizing which Users having a stored value ticket can increase the residual value of such ticket;
ALARP	shall mean the principle that no risk can be accepted unless reduced to As Low as Reasonably Practicable;
Alignment	shall mean the horizontal and vertical profile of railway Guideway beam & location of stations etc.
Automatic Train Operation (ATO)	shall mean the system which undertakes functions otherwise assigned to the TO;
Automatic Train Control(ATC)	shall mean the system for automatically controlling Train movements and directing Train operations. The ATC shall *inter alia*, incorporate provision for Automatic Train Protection (ATP) Subsystems and shall have features to enhance operational safety;
Automatic Train Protection (ATP)	shall mean the sub system of the ATC which alerts the TO regarding speed and automatically applies brakes if there is no reaction from the TO;
Automatic Train Regulation (ATR)	shall mean the sub system of the ATS which ensures that following disruption, the Train service returns to time tabled operation or to regular fixed headways;
Automatic Train Supervision(ATS)	shall mean the top-level system in real time Train control which regulates performance levels, monitors and controls the Trains in service and provides data to controllers to adjust the Train services to minimize the inconveniences caused by Train operation disruptions;
Auxiliary Equipment	shall mean auxiliary power supply equipment providing power for Train lighting, air conditioning, passenger facilities and emergency battery systems in the Trains;

auxiliary Power Converter	shall mean the converter that converts the traction supply voltage into more appropriate supplies for use by Auxiliary Equipment;
Auxiliary Power Supply	shall mean supply for lighting and power sub-network, required by all fixed low voltage electrical installations including electro mechanical installations at Stations;
Availability	shall mean the probability that an equipment or system can perform a required function under given conditions over a given time interval or similar measurement;
Bi-direction	shall mean the operation of Trains in either direction over the same section of Guideway subject to built-in safety systems;
Bogie/Cars	Frame for mounting of running gear, types, brakes drives and control gear retaining gear (types) for stable mounting on Guideway beams shall mean a four wheeled truck used in pairs under the rail car. The Bogie has a central pivot on which the car is supported which allows it to guide the car into curved Guideways;
Buffer Stop	shall mean the structure at the end of a Guideway to prevent cars as used in alignment exactly same as MJR (the standard end-stop / Mechanical Joint Restraint) from proceeding beyond the end of the Guideway beam
Cab Signaling	shall refer to the Signaling in the Train cab which governs the movement of the Train by conveying the limit of movement authority (LOMA) and the authorized speed, target distance / speed as deduced from the most restricting ATP condition, Signaling mode etc.;
elevation Car or Coach	In the cross slope of the running surface on Guideway beam inclined towards the center of the curvature to reduce the centrifugal force on the vehicle to negotiate the curve at higher speed shall mean a passenger carrying monorail vehicle either powered or non- powered;
Civil Speed Limit	shall mean the permanent maximum speed limit determined by the alignment and Guideway geometry for all Trains upon a particular section line, which speed limit shall not be exceeded at any time;
Command	shall refer to the facility to perform or modify a function of the System;

Construction Works	shall mean all works and things necessary to complete the Shall mean all works and things necessary to complete the Monorail System in accordance with the requirements includes Guideway s beams, Signaling systems and communication systems;
Correct Stopping Position	shall refer to the point at which Trains are required to stop in a station platform;
CBTC	The CBTC based Automatic Train Control (ATC) system shall consist of Automatic Train Protection (ATP), Automatic Train Operation (ATO) and Automatic Train Supervision (ATS) systems.
Degraded	Shall refer to all states or conditions, other than "normal";
Delay	Shall mean a delay caused due to the inability of a Train to move or due to reduction in the speed of such Train resulting from failures in the system;
Depot	Shall mean the area designated for train stabling and maintenance of Trains and other sub-systems of the Rail System;
Depot Controller	Shall refer to the Person who controls the movement of Trains inside a Depot, from the DCC;
Design Headway	Shall mean the minimum time interval between successive Trains operated at the permitted line speed, such that the speed of a following Train is not reduced by the Train ahead;
Detection	Shall refer to the ability to determine that a Guideway section or block is occupied by a Train, or the ability to verify that a point or signal has operated correctly as part of interlocking
Direction of Travel	The Normal (N) direction of travel shall be the left-hand Guideway, as viewed by a TO in the lead cab. The Reverse (R) direction of Travel shall be the right-hand Guideway, as viewed by a TO in the lead cab
NEPRA/WAPDA/IESCO	Shall mean a distribution company which is licensed to sell electric power;

"Document" or "Documentation"	Shall mean documentation in printed or written form, or in tapes, discs, drawings, computer program, writings, reports, photographs, films, cassettes, or expressed in any other written, electronic, audio or visual form;
Downtime	Shall refer to the time from when equipment, sub-system, or system becomes unavailable for use due to maintenance attention until the time it becomes available for use again;
Dynamic Brake	A generic term for the use of motors for braking which includes both rheostatic braking and regenerative braking;
E&M Equipment	Shall mean all equipment and systems to be designed, manufactured, supplied, installed, tested and commissioned under the for the operation of the Mono- Rail System and includes maintenance equipment, special tools building and facilities
Earthing or Grounding	Shall mean the connection of equipment enclosures and non-Current carrying metal parts to earth to provide safety to personnel, public and to the equipment;
EIG	Shall mean the Electrical Inspector of the Distributary Company;
Electro pneumatic Brake	shall refer to an air brake that will allow for immediate application of brakes throughout the Train length. (Brakes are applied or released by electric/electronic signal on each Coach);
Emergency	Shall mean a condition or situation that is likely to endanger the security of the individuals on or about the Rail System, including Users thereof, or which poses an immediate threat of material damage to any of the Project Assets;
Embedded E&M	shall refer to electrical and mechanical facilities, such as Earth mat, bonding, and the like, to be included within the structures.
Emergency Brake	shall mean the automatic brake system fitted to attain a restrictive braking distance/speed performance, which is applied continuously in emergency overriding any other control in operation;
Fail Safe	shall mean a design feature which enables a system (or element of a system) to revert to the safe condition in case of its failure;

Failure	shall mean an event which causes loss of function or performance within any part of the Signaling and / or Train control system and requires a maintenance intervention to restore full functionality and performance;
Fare Gates	shall refer to the barrier between the "paid" and "unpaid" area. The fare gate will read a ticket and release the gate when a valid ticket is presented;
General Rules	shall mean the rules for working of stations, Trains and methods of working;
Good Industry Practice	shall mean the practices, methods, techniques, designs, standards, skills, diligence, efficiency, reliability and prudence which are generally and reasonably expected from a reasonably skilled and experienced operator engaged in the same type of undertaking as envisaged under this Agreement and which would be expected to result in the performance of its obligations by the Contractor. Applicable Laws and Applicable Permits in reliable, safe, economical and efficient manner;
Horizontal Curve	shall mean a track which is curved in plan;
Illuminance	shall mean the luminous flux incident on a surface divided by the area of the surface and is measured in lux where 1 lux=1 lumen/m ²
Interlocking	shall refer to the system to prevent setting up of conflicting routes;
Kinematic gauge	shall indicate the dimensions measured from the track center, beyond which no part of the vehicle or Coach in motion may protrude;
Lifting System	shall mean a system by which Coaches are lifted from under their Bogies to an ergonomic working height, to facilitate Bogie disconnection, the vehicle body being supported by body supports at specific locations points when the Bogies are removed;
Limit of Movement Authority	shall refer to a section of line ahead of a Train which is clear for the Train to proceed;

Maintainability	shall mean the probability that a given maintenance action for a given equipment or system under given conditions of use, can be carried out in a stated time interval when the maintenance is performed under stated conditions using stated procedures and resources;
Maintenance	shall include visual inspection, adjustment, replacement or repair carried out on equipment, sub-systems or systems which results in the item undergoing attention being preserved within maintenance tolerances or returned to its design tolerances;
Maintenance Manual	shall refer to the repair, operation and maintenance manual evolved by the Contractor in consultation with The Engineer for the regular and preventive maintenance for the Rail system in conformity with the maintenance requirements, safety requirements and Good Industry Practice;
Man Machine Interface (MMI)	shall mean the interface between the Controller and the control system;
Manual	Shall mean this Manual of Specifications and Standards;
Maximum Safe Speed (MSS)	shall be the lowest of: (i) the Civil speed Limit, (ii) safe speed required to observed any Speed Restrictions in force, (iii) maximum permissible Train speed, and (iv) maximum speed set by the current operating mode and Train parameters;
Mimic	shall mean a graphical representation of the railway and its global operating status;
Modes of Driving	Automatic Mode (AM); is the Normal Operating mode of driving enabled by ATO and supervised by ATP; Coded Mode (CM); is a degraded operating mode of driving supervised by the ATP System; Restricted Mode (RM); is a degraded operating mode of driving during equipment failures, restricting the Train speed to 25 kmph;

Operating Headway	shall mean planned service intervals between all Trains offering passenger service. Operating headway should allow a defined margin over design headway;
Operating Manual	shall mean the rule book for operation of Trains will be evolved by the Contractor in consultation with The Engineer;
Overlap	shall refer to the safe distance provided beyond a signal in case the Train fails to stop at the signal when it is showing a danger aspect;
Parking brake	shall mean a brake designed to hold a stationary Train indefinitely with no air or electrical energy source available;
Permanent Way	shall mean railway track;
Points or Switch or Turn out	shall refer to the track mechanism operated to divert the Train where a single-track splits to become two tracks and equipped with moving rails to change the route;
Project	shall mean the construction, Testing & Commissioning of the Monorail System and includes all works, services and equipment relating to or in respect of the Scope of the Project;
Receiving Sub Station	shall mean the sub-station, which receives 220kV/132kV supply from Local Utility Agency and supplies power network of TSS and ASS at 33 kV;
Rectifier	shall mean a converter consisting of thermistors and diodes to convert AC to DC;
Regenerative Brake	shall mean the use of traction motors as generators when in braking mode to brake the Train by returning electrical energy to the conductor rails.
Reliability	shall mean the probability that an equipment or system can perform a required function under given conditions for a given time interval or given number of operations or similar measurement parameter;

Restraining rail	shall mean the additional rail fixed inside the track and by the side of the inner rail at an appropriate distance;
Retrofit	shall, as applied to Rolling Sock, mean the furnishing of parts of the Coach with new parts or equipment to constitute a modification of the original design;
Rheostatic Brake	shall mean the use of traction motors as generators to brake the Train using on board resistors to dissipate electrical energy;
Right of way	shall mean the constructive possession of the Site, together with all way leaves, easements, unrestricted access and other rights of way, howsoever described, necessary for construction, operation and maintenance of the Rail System;
Rolling Stock	shall refer to the fleet or rail borne cars with flanged wheels designed to operate on guiding rails, for carrying passengers. The words "Rolling Stock" and "Trains" as used in this Manual are interchangeable;
Route	shall mean a part of the line originating at a signal for which the points have been set and secured to enable the safe passage of a Train;
Safety Consultant	shall mean an experienced and qualified firm or organization appointed by the Contractor for carrying out safety audit of the Rail system in accordance with the Safety Requirements;
Safety Critical	shall mean a failure of the system, sub-system or equipment that will directly lead to a situation with the potential to cause harm, injury, damage to property, plant or equipment, damage to the environment, or economic loss;
Service brake	shall mean the brake used for routine stopping or slowing with variable and reversible control;
Service	shall mean the Glass Train service available for the use of fare paying passengers;
Service Affecting Failure	shall mean a failure which causes a delay to Train Services;

Spares	shall mean components, assemblies or sub-assemblies, which are used to replace items in operational use;
Specifications and Standards	shall mean the specifications and standards relating to the quality, quantity, capacity and requirements for the Monorail System, as set forth in this Manual, and any modifications thereof, or additions thereto, as included in the design and engineering for the Monorail System if the Contractor can demonstrate to the TE, prior to use by him, that such modification or alterations are superior or more pertinent to the Project than the specifications and standards specified in this Manual;
Station	shall mean a place in the Monorail System where Trains stop for the purposes of transporting passengers;
Station Dwell Time	shall refer to the Train halt time at stations counted from wheel stop to wheel start;
Station Working Rules	shall mean the rules issued by the Contractor for working of Trains at the station (SWR);
Structure Gauge	shall indicate the dimensions of a structural cross section within which no outside object, such as signal masts, sign boards etc. may protrude;
Sub station	shall include the RSS, TSS and ASS where electric equipment are located that receives and converts or transforms the received electrical energy into usable electrical energy;
Target Speed	shall mean the optimum speed at which the Train should be driven, as determined by the Train Control System and civil speed;
Tests	shall mean all the tests necessary to determine the completion of Monorail System.;
Third Rail or Conductor Rail	shall mean the additional rail mounted on insulators to the outside of and slightly higher than the running rails carrying power at high potential to be collected by Train through shoes attached to the Bogies;
Ticket	shall mean a card or token which has an electronically encoded data content indicating the validity and / or use of the ticket;
Ticket Office Machines (TOMs)	shall mean the equipment or devices used by Rail system officials to issue tickets at stations;

Ticket Vending Machines (TVMs)	shall mean the equipment or devices where passengers can get valid travel ticket for their journey;
Total Fire Load	shall mean the total heat energy of all combustibles available;
Track circuits	shall refer to the means by which the passage of Trains is detected and the information is used to control signals provided to control safe passage of Trains;
Track form	shall mean the track supporting structure (and includes elevated Guideway structure) and rail bearers/plinth beams as applied to ballast less track and excludes rails and fastenings;
Track Recording Car	Instrumented rail cars operated on the Rail System to have a continuous record of the track geometry under loaded conditions
Traction System	shall mean the system which provides electric power for movement of Trains;
Track work	shall mean the Permanent Way system as defined in paragraph 3.1.2 of this Manual;
Train	shall mean a series of railway Coaches that is hauled as a single unit by a locomotive or by integral motors for transporting users on the Rail System and includes a single Coach;
Train Operator (TO)	shall refer to the person in the cab in control of Train operation;
Transition curve	shall mean a curve connecting sections of track laid to different radii;
Traction Sub-station	shall mean a sub-system of traction power supply which provides operational power supply to the Trains via third rail and receives return current via running rail;
Trip Time	shall mean the time for a Train to travel from one terminal to the opposite terminal on the same line, with pre-determined dwell times at each intermediate Station. This time does not include any layover time at the termini;
Trouble Shooting Manual	shall refer to the manual giving step-by-step procedure to determine the cause for a given problem and then selecting the quickest way to solve that problem;
Under-floor Wheel Re-profiling Machine	shall mean a machine, which is used for re- profiling the steel wheels of rail Coaches while the wheels remain in-situ under the Coach;
Vertical curve	shall mean a track which is curved in elevation;

Very High Voltage	shall be as defined in Pakistan Electricity Rules;
Vital	shall refer to any and all such equipment, devices and systems that are necessary for the safe operation of the Rail system;
Working Instructions	shall mean instructions issued by the Contractor for safe working of the system;
Works	shall refer to all labor, materials and equipment to be fitted into the stations and structures that are necessary to implement the Operation and Maintenance requirements;
Others	Any capitalized term used herein not specifically defined shall have the meaning ascribed to such term in the Concession Agreement;

PUNJAB MASSTRANSIT AUTHORITY

ESTABLISHMENT OF TOURIST GLASS TRAIN FROM RAWALPINDI / ISLAMABAD TO MURREE

EMPLOYER'S REQUIREMENTS



GEOTECHNICAL INVESTIGATIONS,SEISMIC HAZARD ASSESSMENT,PILE TESTING, GEOLOGICAL MAPPING AND MATERIALS-RELATED STUDIES

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ESTABLISHMENT OF TOURIST GLASS TRAIN FROM RAWALPINDI / ISLAMABAD TO MURREE

EMPLOYER'S REQUIREMENT FOR GEOTECHNICAL INVESTIGATIONS, SEISMIC HAZARD ASSESSMENT, PILE TESTING, GEOLOGICAL MAPPING AND MATERIALS-RELATED STUDIES

1. INTRODUCTION

This document defines the minimum requirements for geotechnical investigations, seismic hazard assessment, pile testing, geological mapping, and materials-related studies for the Establishment of Tourist Glass Train from Rawalpindi/Islamabad to Murree. The investigations and mapping shall be carried out along the entire proposed alignment of the elevated corridor, as well as within any adjoining areas that may present potential geotechnical or geological hazards—such as landslides, rockfall sources, or unstable slopes—that could affect the safety or performance of the Project.

The EPC Contractor's scope of work comprises planning, execution, testing, analysis, and reporting of all required geotechnical, geological, seismic hazard assessment, pile testing and construction materials investigations required for the design and construction of the Project. The work shall include all field geotechnical investigations, laboratory testing, geological and geomorphological mapping, materials suitability assessment for concrete works and earthworks, pile testing, preparation of borehole logs and geological sections, interpretation of subsurface conditions, development of design parameters, and submission of comprehensive geotechnical, geological, material study and pile testing reports, together with all associated activities necessary to complete the investigations and mapping to the satisfaction of the Engineer.

2. STANDARDS AND SPECIFICATIONS

All geotechnical investigation, pile testing, laboratory testing, and geological mapping shall be carried out in accordance with the latest applicable American standards and specifications, including but not limited to ASTM, and relevant ISRM guidelines, and shall be performed under the supervision of the Engineer.

3. SCOPE OF WORK

3.1 Field Geotechnical Investigations:

The investigation shall be conducted along the *entire alignment*, including piers, stations and structure locations, as well as within adjoining areas that may pose geotechnical or geological hazards (e.g., landslides, rockfall, unstable slopes) affecting Project safety or performance. The

scope also includes identification and sampling of potential borrow or material sources required for use in concrete, backfill, embankments, and any associated pavement works:

3.1.1 Boreholes

- Minimum depth: In soil, depth of exploration should extend below the anticipated pile tip elevation a minimum of 20 ft, or a minimum of two times the maximum pile group dimension, whichever is deeper. All borings should extend through unsuitable strata such as unconsolidated fill, peat, highly organic materials, soft fine-grained soils, and loose coarse-grained soils to reach hard or dense materials.
  For piles supported on or extending into rock, a minimum of 10 ft of rock core, or a length of rock core equal to at least three times the pile diameter for isolated shafts or two times the maximum pile group dimension, whichever is greater, shall be extended below the anticipated pile tip elevation to determine the physical characteristics of rock within the zone of foundation influence. Note that for highly variable bedrock conditions, or in areas where very large boulders are likely, more than 10 ft. of rock core may be required to verify that adequate quality bedrock is present.
  Spacing: Boreholes shall be located to adequately characterize subsurface conditions along the alignment and at all structure locations, in accordance with relevant international standards and specifications. Additional boreholes shall be provided in areas with significant variability in soil or rock conditions, large structure spans, or other geotechnical complexities. Borehole spacing shall be determined using engineering judgment to ensure reliable characterization of subsurface conditions.
- Drilling shall be carried out using rotary drilling methods in soil, weathered rock and bedrock; however, where gravely soils are encountered and rotary drilling becomes ineffective, appropriate percussion drilling techniques shall be employed.
- SPT testing every 1.0 m or at every change of strata.
- UDS sampling from each borehole at representative depths
- Continuous rock coring with core recovery, RQD measurements and rock sampling
- Installation of piezometers where required.
- Installation of settlement markets and inclinometers where required

3.1.2 Test Pits / Trial Trenches

- Test pits up to 3 m depth at selected pier and station locations.
- Sampling, field density tests and visual logging.

3.1.3 Detailed Geological & Geomorphological Mapping

The EPC Contractor shall undertake comprehensive engineering geological mapping along the entire alignment corridor, including, but not limited to:

- Surface geology, lithology and weathering profiles
- Fractures, joints, faults, shear zones and discontinuities
- Identification of active or dormant landslides

- Rockfall sources, potential detachment zones, talus and debris slopes
- Slope morphology (gradient, aspect, height)
- Identification of soil springs, seepage zones and groundwater emergence points
- Identification of unstable colluvial deposits
- Mapping of erosion-prone and gullying zones
- Geological hazard zoning along the alignment

3.1.4 Sampling

- Disturbed and undisturbed soil samples
- Rock core samples
- Groundwater samples

3.1.5 Geophysical Investigation

The EPC contractor shall carry out geophysical investigations to supplement borehole data and provide continuous subsurface characterization. The investigations are expected to include, but are not limited to:

- **Seismic Refraction Survey**: To determine soil and rock layer depths, evaluate stiffness, and identify weak or highly weathered zones. Survey results shall be correlated with borehole logs to refine the subsurface model and support foundation design.

3.1.6 Pile Testing

The EPC Contractor shall implement a comprehensive pile testing program to confirm design assumptions and ensure construction quality. The testing program shall include, but not be limited to, the following:

(a) Full-Scale Pile Load Testing (Design Verification Tests)

- For each major stratigraphic section of similar geotechnical characteristics along the alignment, the EPC Contractor shall install a minimum of two (2) test piles per section.
- Each test pile shall be subjected to BOTH:
  - Static Load Test, and
  - High-Strain Dynamic Load Test (ASTM D4945)
- These tests are intended for design verification, to:
  - Establish correlations between measured pile response and the geotechnical investigation data,
  - Confirm end-bearing and skin friction values,

- Develop or calibrate p–y, t–z, and q–z curves, and
- Validate pile design parameters for the project.

(b) Proof / Construction Quality Control Testing

- A sufficient number of high-strain dynamic tests shall be performed on production piles across the alignment in accordance with international practice or as required in the Project Specification, to confirm that installed piles achieve the required load-bearing capacity.
- Sonic Integrity Testing (low-strain PIT) shall be carried out on a sufficient number of production piles, selected across the alignment, in accordance with international practice or as required in the Project Specification, to verify pile continuity and detect defects.
- Cross-Hole Sonic Logging (CSL) shall be performed on a sufficient number of drilled/bored piles equipped with access tubes, again in accordance with international practice or as required in the Project Specification.

(c) Integration of Results

- The results from design verification tests (static + high-strain dynamic) shall be integrated with borehole data, laboratory results, and geophysical data to finalize design parameters.
- Proof testing results shall be used to verify the construction quality of all installed piles and that installed piles achieve the required load-bearing capacity.

3.2 Laboratory Testing:

Selected soil, rock, water samples and construction material source samples shall be sent to an approved laboratory for laboratory testing:

3.2.1 Soil Tests

- Index and classification tests
- Unconfined compression, direct shear and triaxial shear strength tests
- Consolidation/compressibility tests
- Proctor and CBR tests
- Soil chemical aggressivity and corrosivity testing

3.2.2 Rock Tests

- UCS, point-load index, and triaxial testing
- Slake durability
- Joint roughness and strength assessment

3.2.3 Water Tests

- Chemical analysis for corrosion/durability assessment

3.2.4 Construction Material Approval and Quality Control

The project demands construction materials capable of withstanding extreme weather conditions including freeze-thaw cycles, high humidity, seismic activity, and significant temperature variations. This section details the EPC Contractor's responsibilities and methodologies for material source approval for reliable quality control.

The material approval process will cover all construction materials including but not limited to:

- Coarse and fine aggregates for concrete and other construction purposes
- Cement and supplementary cementitious materials
- Steel reinforcement and structural steel
- Chemical admixtures
- Water for construction
- Glass and glazing systems
- Grouting and jointing materials
- Formwork and temporary works materials

All materials must comply with:

- Project Technical Specifications
- ASTM International Standards
- Pakistan Building Codes (PBC)
- International Building Codes (IBC)
- Seismic Design Provisions
- Environmental Regulations for Protected Forest Areas

FIELD STUDIES AND SOURCE INVESTIGATION

Field Reconnaissance and Preliminary Assessment:

Source Identification and Preliminary Survey

The EPC Contractor will conduct extensive field surveys to identify potential material sources within economically viable transportation distances from the Murree site. Geological mapping teams using GPS technology will survey potential quarry locations, assessing rock formations, accessibility, and extraction feasibility. Transportation route analysis will consider mountainous terrain constraints, seasonal weather impacts, and tourist traffic patterns.

For each potential source, preliminary assessments will include visual examination of material consistency, preliminary hardness testing using Schmidt hammers, and evaluation of extraction methodology. Environmental impact screenings will eliminate sources with unacceptable ecological consequences in the protected forest environment.

Sampling Methodology for Field Studies

Aggregate Sampling Protocols:

For quarry sources, sampling will follow ASTM D75 standard practice for sampling aggregates. The EPC contractor will establish sampling locations across the quarry face to obtain representative samples from different geological strata. Channel sampling method will be employed where a channel approximately 30cm wide and 15cm deep will be cut across the exposed face. Samples will be collected at regular intervals along the quarry face.

The sampling quantity will follow the minimum mass requirements:

- For coarse aggregate testing: Minimum 100kg sample
- For fine aggregate testing: Minimum 50kg sample

Samples will be obtained from at least three different locations within the quarry to account for geological variation. Each sample will be placed in heavy-duty polyethylene bags, sealed, and labeled with:

- Source identification code

- GPS coordinates of sampling location
- Date and time of sampling
- Depth from surface
- Sampler's name and signature

Water Source Sampling:

Water sampling will follow ASTM D3370 practices for sampling water. Samples will be collected from multiple points in each potential source:

- Municipal supply taps at entry point to project site
- Borewell water after 10 minutes of pumping
- Surface water from multiple points in streams

Specialized sampling containers will include:

- Plastic containers for general analysis (pre-washed with distilled water)
- Amber glass bottles for organic compound analysis
- Sterilized containers for bacteriological testing

Preservation techniques will include:

- Refrigeration at 4°C for bacteriological samples
- Acidification with nitric acid for metal analysis
- No preservation for immediate pH and turbidity testing

Cement and Admixture Sampling

For existing stockpiles at manufacturer facilities, sampling will follow ASTM C183 for cement and ASTM C494 for admixtures. Cement samples will be obtained from multiple points in silos using specialized sampling probes. Minimum sample size of 30kg will be collected, divided into three portions for initial testing, reserve, and referee testing if required.

Any other material including Stone, Bricks, Glass, Metallic Shapes etc shall be samples as per requirements of applicable international standards.

Preliminary Field Testing

On-Site Material Evaluation

EPC contractor will be responsible to conduct immediate assessments using portable testing equipment to eliminate obviously unsuitable sources before laboratory submission. For aggregates, visual inspections will check for color consistency, presence of deleterious materials, and particle shape characteristics. Hand crushing tests using geological hammers will assess friability. Acid tests with 5% hydrochloric acid solution will identify carbonate content indicating potential alkali-carbonate reactivity.

For soils and subgrade materials, field density tests using sand cone method will provide immediate compaction data. California Bearing Ratio tests using portable equipment will give preliminary strength indications. Moisture content measurements will guide earthworks planning.

Sample Preparation and Preservation

All samples will undergo immediate preparation in field. Aggregate samples will be reduced in size using mechanical sample splitters following ASTM C702 procedures to obtain representative test portions. Cement samples will be sealed in airtight containers. Water samples will be preserved according to test requirements and transported in cooled containers to maintain integrity.

Chain of Custody Documentation

A rigorous chain of custody system will track samples from collection through transportation to testing laboratories. Each sample transfer will be documented with:

- Transfer date and time
- Names and signatures of transferring and receiving personnel
- Transportation method and conditions
- Temperature logs for sensitive materials

- Seal integrity verification at each transfer point

Environmental and Logistical Assessments

Environmental Compliance Verification

Each potential source will undergo environmental audit checking for valid permits from Punjab Environmental Protection Agency. Historical violation checks through regulatory databases will be mandatory. Community impact assessments will document local stakeholder consultations through structured interviews and community meetings. Ecological surveys will identify potential impacts on Murree's sensitive forest ecosystem.

Transportation Logistics Analysis

Route surveys will identify constraints including narrow mountain roads, low bridges, and seasonal closures. Traffic management plans will address tourist season congestion. Loading and unloading facilities at both source and site will be evaluated for efficiency and safety. Backup transportation arrangements will be identified for monsoon-related disruptions, with alternative routes mapped and assessed.

LABORATORY TESTING AND COMPLIANCE VERIFICATION

Latest editions of all applicable international standards shall be applied for lab testing of construction materials

Laboratory Accreditation and Quality Assurance

Laboratory Selection and Accreditation

The EPC Contractor will engage three ISO/IEC 17025 accredited laboratories with specific scope for construction materials testing. Laboratory selection criteria will include:

- Accreditation scope covering all required ASTM tests
- Demonstrated experience with high-altitude material testing
- Capacity for rapid turnaround of test results
- Modern equipment with valid calibration certificates

- Qualified personnel with minimum 10 years' experience

A site laboratory will be established at the project site for routine testing and immediate quality control, supported by two fixed laboratories for comprehensive testing and referee analysis.

Laboratory Quality Control Procedures

Each laboratory will implement rigorous quality control procedures including:

- Calibration checks on all testing equipment
- Use of certified reference materials for test verification
- Participation in proficiency testing programs
- Internal audit program with quarterly reviews
- Documented procedures for each test method
- Environmental control monitoring (temperature, humidity)

Comprehensive Testing Programs

Coarse Aggregate Testing

Gradation Analysis (ASTM C136)

Samples will be prepared by quartering to obtain representative test portions of approximately 5kg. Sieve analysis will use standard sieves from 37.5mm to 75µm. Testing frequency will be as per requirements of Project Specifications.

Los Angeles Abrasion Test (ASTM C131)

Coarse aggregate shall be subjected to Los Angeles Abrasion test as per ASTM C-131 latest edition.

Specific Gravity and Absorption (ASTM C127)

Coarse aggregate shall be subjected to Specific Gravity and Absorption test as per ASTM C-127 latest edition.

Soundness Test (ASTM C88)

Samples will be subjected to five cycles of immersion in sodium sulfate solution and oven drying. Loss percentage will be calculated after each cycle.

Petrographic Analysis (ASTM C295)

Coarse aggregate shall be subjected to Petrographic Analysis as per ASTM C-295 latest edition.

EPC contractor shall also be responsible for conducting any other test required to evaluate the quality of coarse aggregate.

Fine Aggregate Testing

Fine aggregate sample shall be subjected to following testing

Sieve Analysis (ASTM C136)

Samples will be washed over 75µm sieve to remove fines before dry sieving. Gradation curves will be compared against specification limits for concrete sand.

Silt Content (ASTM C117)

A 500g sample will be washed in water with repeated decantation until water remains clear. Oven-dried material remaining will determine silt content.

Petrographic Analysis (ASTM C295)

Fine aggregate shall be subjected to Petrographic Analysis as per ASTM C-295 latest edition.

Specific Gravity and Absorption (ASTM C128)

Coarse aggregate shall be subjected to Specific Gravity and Absorption test as per ASTM C-128 latest edition.

Soundness Test (ASTM C88)

Samples will be subjected to five cycles of immersion in sodium sulfate solution and oven drying. Loss percentage will be calculated after each cycle.

Sand Equivalent Test (ASTM D2419)

Samples will be subjected to Sand Equivalent test as per ASTM D2419.

Deleterious Substances Test (ASTM C87)

Samples will be subjected deleterious substances test as per ASTM C87.

Soundness Test (ASTM C88)

Samples will be subjected to five cycles of immersion in sodium sulfate solution and oven drying. Loss percentage will be calculated after each cycle.

EPC contractor shall also be responsible for conducting any other test required to evaluate the quality of fine aggregate.

Cement Testing

Chemical Analysis (ASTM C114)

X-ray fluorescence spectrometry will provide complete chemical analysis.

Physical Tests

Cement sample shall be subjected to physical analysis to assure conformity to ASTM C150 latest edition.

Steel Reinforcement Testing

Steel samples shall be subjected to physical and chemical analysis as per latest edition of relevant ASTM standards.

Chemical Admixtures Testing

- Chloride Ion Content (ASTM C1218)

Performance Testing (ASTM C494)

Concrete mixtures with and without admixture will be compared for

- Water reduction percentage at constant slump
- Setting time difference

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- Compressive strength at 1, 3, 7, and 28 days
- Air content stability over 60 minutes

Water Quality Testing

Comprehensive Analysis

Full analysis will include:

- pH by potentiometric method (ASTM D1293)
- Chlorides by titration (ASTM D512)
- Sulfates by turbidimetric method (ASTM D516)
- Total dissolved solids by evaporation (ASTM D5907)
- Alkalinity by titration (ASTM D1067)

Acceptance Criteria

ASTM C1602 latest edition shall be applied for acceptance of water sample

EPC contractor shall be responsible for inspection, sampling and testing of Stone, Bricks, Glass, metallic shapes and any other construction material to be used in construction works as per relevant international standard and project specifications.

Specialized Testing for Murree Conditions

Freeze-Thaw Durability Testing

Given Murree's altitude and temperature extremes, specialized testing will include:

Freeze-Thaw Resistance (ASTM C666 Procedure A)

Concrete specimens will undergo 300 cycles of freezing at -18°C and thawing at 4°C. Dynamic modulus of elasticity will be measured every 30 cycles.

Scaling Resistance (ASTM C672)

Slab specimens will be subjected to freezing in the presence of 3% calcium chloride solution. Surface scaling will be evaluated after 50 cycles. Rating system will be 0 (no scaling) to 5 (severe scaling).

Thermal Compatibility Testing

Coefficient of Thermal Expansion (ASTM C531)

Measurements will determine expansion characteristics of concrete and glass.

Differential Shrinkage (ASTM C157)

Specimens will measure length changes under controlled humidity. This data will inform joint design and reinforcement requirements.

Seismic Performance Testing

Dynamic Modulus (ASTM C215)

Resonant frequency testing will determine dynamic elastic properties critical for seismic design.

Steel Strain Hardening

Tensile tests will continue beyond yield to determine strain hardening characteristics.

Testing Frequency and Documentation

Minimum Testing Frequencies

Coarse Aggregate: Full testing for source approval, gradation and moisture each delivery, soundness quarterly.

Fine Aggregate: Source approval testing, gradation and silt content each delivery, moisture weekly.

Cement: Mill certificate verification each shipment, daily temperature and lump checks, strength verification as per project specifications.

Steel: Mill certificate verification, random testing per project specification, visual inspection each bundle.

Admixtures: Batch analysis each delivery, performance testing as per project specifications.

Water: Complete analysis source approval, monthly monitoring, daily pH and clarity

Documentation Standards

All test certificates will include:

- Laboratory name, address, and accreditation number
- Unique test report identification
- Client and project details
- Sample identification and description
- Date of sampling and testing
- Test methods and standards used
- Test results with units of measurement
- Specification limits and pass/fail status
- Signatures of laboratory personnel
- Date of report issuance

It is pertinent to mention that all the inspections, sampling and testing shall be carried out in supervision of consultant representative. Any test which is not included in above mentioned tests shall also be conducted by the EPC contractor if required or as directed by Consultant or Client.

3.3 <u>Engineering Analyses and Design:</u>

Based on field and laboratory results, the EPC Contractor shall perform the following technical analyses and design; Suitability of borrow and construction materials shall be incorporated into design recommendations and construction considerations:

3.3.1 Subsurface Characterization

- Engineering classification of soil and rock
- Stratification at each pier, including soil and rock properties
- Groundwater and seepage conditions, including identification of springs and perched water zones
- Detailed geological and geomorphological mapping, showing surface lithology, weathering profiles, fractures, joints, faults, shear zones, landslide-prone areas, erosion-prone zones, and potential rockfall sources
- Preparation of geological sections integrating borehole logs, surface mapping, and inferred subsurface conditions
- Identification of weak seams, weathered rock layers, and potential slip surfaces

3.3.2 Pile Foundation Design Parameters

The EPC Contractor shall develop pile design parameters using a combination of geotechnical investigation data and pile testing results, including:

- End-bearing resistance (soil/rock)
- Skin friction values in all strata
- Rock socket parameters
- p–y, t–z and q–z curves for lateral, shaft and end-bearing behavior
- Soil springs and subgrade reaction values
- Group efficiency factors for pile groups
- Confirmation of design parameters through full-scale static and high-strain dynamic pile tests

3.3.3 Axial and Lateral Pile Capacity

Analyses shall include:

- Ultimate and allowable axial pile capacity
- Lateral resistance and deflection predictions
- Pile group capacity considering pile interaction

3.3.4 Settlement Evaluation

- Immediate and consolidation settlement
- Group settlement for piles
- Downdrag/negative skin friction (where applicable)
- Settlement of embankments at access roads

3.3.5 Slope Stability and Retaining Structures

- Stability assessment of natural slopes, cut slopes and fill slopes
- Analysis of landslide-prone areas using limit equilibrium and numerical methods
- Recommendations for retaining walls, anchored systems, soil nails, rock bolts and shotcrete
- Rockfall hazard assessment and mitigation design

3.3.6 Seismic Assessment

- Probabilistic Seismic Hazard Analyses (PSHA).
- The major tectonic features/faults affecting the seismic hazard to the project will be identified.
- Shear wave velocity calculation by geophysical survey for PSHA Study.
- Development of Design response spectra for use in the structural design of the project structures.
- Calculation of Seismic Design Parameters (Peak Ground Acceleration, Ss and S1 etc.) Report Preparation for PSHA.
- Liquefaction potential (if applicable in alluvial zones)
- Seismic soil/rock classification
- Seismic design parameters for piles and piers.

3.3.7 Construction Considerations

- Shoring and temporary excavation stability
- Groundwater control during construction
- Suitability of borrow materials
- Durability and corrosion potential

3.3.8 Construction Materials Evaluation

The EPC Contractor shall be responsible to evaluate quality of all proposed construction materials both natural and processed to confirm their suitability for use in foundations, concrete works, backfilling, embankments, and associated structures. Analyses shall include:

- Suitability assessment of borrow areas and fill materials based on strength, compaction characteristics, and durability etc.
- Evaluation of aggregates for concrete, including but not limited to gradation, strength, soundness, and potential AAR
- Assessment of embankment and subgrade materials for access roads
- Verification of water quality for concrete production
- Recommendations for material selection, treatment, blending, or replacement where required

3.4 Reporting:

The EPC Contractor shall prepare and submit comprehensive reports covering all phases of the geotechnical investigations, geological and geomorphological mapping, geophysical surveys, materials study, seismic hazard assessment and pile testing. The reports shall include methodologies, field records, laboratory results, interpretations, design parameters, and all supporting documentation required for verification. All reports shall be submitted in both hard copy and digital formats, complete with drawings, logs, photographs, raw data, processed data, and analysis files.

ESTABLISHMENT OF TOURIST GLASS TRAIN FROM RAWALPINDI / ISLAMABAD TO MURREE

EMPLOYER'S REQUIREMENTS



TOPOGRAPHIC SURVEY

December 2025

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Introduction

Topographic survey forms the basis for design. Poor quality of survey work produces not only incorrect designs but also results in post-construction problems. Thus, survey work should be of the top-most order and quality. An effort has been made to elaborate all the activities generally required in topographic survey in the following paragraphs. The consultant is required to undertake the requisite activities in an intelligent manner in the light of project requirements with due consideration to all the related legislation, e.g., *Rules for Publication, Classification, Issue and Custody of Maps-1981*; *Surveying & Mapping Act 2014*; *Surveying and Mapping Rules-2015*, etc.

The consultant should carry out detailed topographic survey using Dual Frequency Global Positioning System (DGPS) / RTK devices. A network of high-accuracy control points along the corridor should be developed involving at least four (04) instruments. The consultant will submit a detailed Topographic Survey Program with the actual human resources planned to be deployed. The consultant will specify the timeline of the survey program. The total number of equipment with models and calibration certificates not more than six (06) months old will be produced.

Table 1: Survey Standards and regulations

No.	Name	Code
1	Quality Management Systems - Requirements	ISO 9001:2015
2	General Requirements for the Competence of Testing and Calibration Laboratories	ISO 17025:2017
3	Geographic Information - Reference Model	ISO 19101:2002
4	Geographic Information - Spatial Referencing by Coordinates	ISO 19111:2007
5	Field Procedures for Testing Geodetic and Surveying Instruments	ISO 17123-1:2011
6	Field Procedures for Testing Geodetic and Surveying Instruments - Part 2: EDMI	ISO 17123-2:2003
7	Field Procedures for Testing Geodetic and Surveying Instruments - Part 3: Theodolites	ISO 17123-3:2001
8	Field Procedures for Testing Geodetic and Surveying Instruments - Part 4: Levelling Instruments	ISO 17123-4:2002
9	Condition Monitoring and Diagnostics of Machines - Part 1: General Guidelines	ISO 18434-1:2008

10	Organization and Digitization of Information about Buildings and Civil Engineering Works	ISO 19650-1:2018
11	Asset Management - Management Systems - Requirements	ISO 55001:2014
12	Quality Management - Guidelines for Quality Plans	ISO 10005:2018
13	Environmental Management Systems - Requirements with Guidance for Use	ISO 14001:2015
14	Geographic Information - Schema for Coverage Geometry and Functions	ISO 19123:2005
15	Geographic Information - Data Quality	ISO 19157:2013
16	Geographic Information - Metadata for Spatial Data	ISO 19134:2007
17	Land Administration Guidelines	FIG 1997
18	Geospatial Data - Requirements for Land Parcel Mapping	ISO 17522:2014
19	Optics and Optical Instruments - Field Procedures for Testing Geodetic and Surveying Instruments - Part 8: GNSS Field Measurement Systems in Real-Time Kinematic (RTK)	ISO 17123-8:2015
20	Cranes - Tolerances for Wheels and Travel and Traversing Tracks - Part 1: General	ISO 12488-1:2012
21	Geospatial Positioning Accuracy Standards - Part 4: Standards for Architecture, Engineering, Construction (A/E/C) and Facility Management	FGDC-STD-007.4-2002

Survey Monuments

Permanent ground monuments shall be made of concrete (1:4:8) with a 75 mm steel nail embedded at the center. Using spray paint and a stencil, the monument number shall be painted. The size of the monument shall be 150 mm square at the top and 300 mm square at the bottom. The height of the monument shall be 900 mm, out of which 750 mm shall be buried in the ground.

Besides the start and the end, it is required that monuments be fixed in the traverse line at an interval of about 300 to 400 meters. These shall be installed at locations that are least susceptible to disturbance or damage and do not pose a threat to traffic on existing roads, tracks, etc.

A detailed sketch of the benchmark location shall be prepared following standard formats, including clear instructions for locating the benchmark.

Accessibility and Long-Term Stability:

Ensure the location is open and unobstructed, facilitating easy measurements and future expansion of lower-level networks. The placement must also ensure long-term stability.

Stable Ground Conditions:

The monument should be placed on stable ground. Avoid locations with multi-path signal interference such as valleys, cliffs, and areas with strong electromagnetic sources like radar stations or high-voltage power lines.

Sky Visibility:

The surrounding sky view angle at the selected point must be ≥ 15°.

Photographic Documentation:

Photographs of the control monument shall be taken after installation is complete.

Observation Schedule:

Measurement sessions shall be planned according to the latest satellite schedule. The schedule must be reviewed, and sessions arranged before conducting measurements.

Signal Recording Settings:

- Signal interval: 10 seconds
- Satellite elevation angle: > 15°
- Minimum number of satellites: ≥ 4
- PDOP and GDOP values: ≤ 4

Antenna Height:

The antenna height shall be measured twice at the beginning and end of each session with a precision of 1 mm.

GPS Receiver Centering:

The GPS receiver shall be optically centered with an accuracy of 1 mm.

Horizontal Control

A minimum of four (04) DGPS Primary Control points shall be established at the start and end of the project, or as many as required such that the distance between these points does not exceed 10 km. The minimum observation time shall be at least ten (10) hours, or as required, for each of these points. These points will be validated/verified with International Fixed Stations in the WGS84/ITRF reference frames for an average ambiguity resolution of 50% or better to ensure a reliable network solution.

Vertical Control

Vertical control will be established using MSL from first-order SOP Bench Marks with double-run levelling. A digital level with an accuracy of 0.3 mm or better, and a single-section 2 m/3 m staff or invar staff with a change plate at the bottom, will be used. The maximum distance between two successive reading points shall not exceed 50 m. All horizontal control points shall be connected with monuments made for horizontal primary and secondary controls using double-run levelling to control the height as mentioned above.

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Monuments for Horizontal and Vertical Controls

The monuments for controls shall be as per ISO specifications. The ITRF controls and primary controls will be tied with two permanent points as per ISO specifications.

Technical Requirements for Base Control Points:

- The network shall be established in a triangular configuration.
- It shall be based on the WGS84 datum and the UTM Projection Zone.

Methodology: **The network shall be established using DGPS relative static positioning.**

- **Equipment:** Dual-frequency GNSS receivers shall be used for measurements. All equipment shall be tested and verified in accordance with applicable regulations before deployment.
- **Accuracy Requirements:**
  - Distance: 1:50,000
  - Angle: 3'

Topographic Survey (Scale 1:1,000); Including On-Ground Features, Buildings, Utilities, and Crossing Roads

- At important control sections, if large-scale structures are proposed to be built, the survey range may be reasonably extended, if necessary. Sufficient spot levels (points) shall be taken to create a topographic map at a scale of 1:1,000 with a 1:100 H: V scale.
- The Consultant is required to observe 10 cross-sections across the River, from bank to bank, including three cross-sections at the bridge site: one at the centerline and two adjacent to the centerline, upstream and downstream of the bridge. The benchmark (BM) used for the model study survey shall be incorporated into the traverse/level circuit.

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Centreline Points (stake) and Measurement of elevation of route stake

- The distance between centerline points shall generally not exceed 50 m. In the case of a pond, stakes shall be fixed on the bank at the point of inclination and waterline.
- The distance between stakes shall be 5–8 m on road sections with retaining walls.
- The distance between stakes shall be 10 m on interchange slip roads with a radius of less than 60 m.
- The distance between stakes shall be 5 m for 10 m before and after the chainage of the abutment, covering a total distance of 20 m.

- A minimum of three longitudinal sections (parallel to the alignment), including the center axis, left edge, and right edge of the bridge, shall be measured. In areas where topography changes or at bridge piers and abutments, additional stakes shall be established.
- For culverts, the chainage and elevation of the crossing point shall be measured. The longitudinal section of the water channel 50 m upstream and downstream of the crossing point shall also be measured.
- Stakes shall be placed at the edges of crossed roads and fixed at the crossing points. It is necessary to collect the coordinates, elevation, angle, width, and road level of the crossing points (within 50 m around the crossing point). For important crossed roads, the coordinates, elevation, and angle of the left, middle, and right lines shall be collected (within 100 m around the crossing point).
- The position of 10 kV high-pressure poles (towers) within 100 m of the route and the lowest elevation of the power line at the crossing points shall be recorded.
- The elevation of each stake shall be measured individually.
- Additional stakes shall be established where pipelines or buildings cross the alignment. The height difference between the bottom elevation of such pipelines or buildings and the ground shall be measured.

Riverine Survey for Crossing Canals – Short Bridge

Measure the center longitudinal section of the canal from 100 m upstream to 50 m downstream. Cross-sections of the canal shall be measured at 10 m intervals, perpendicular to the axis of the river. The canal edges shall be recorded along with all break points to clearly define the canal shape.

Riverine Survey for Crossing Rivers – Long Bridge

In the case of crossing a major river, sufficient cross-sections shall be taken to run the physical or numerical model for computation of water surface profiles. The location of cross-sections shall be determined according to the requirements of the software used.

Survey for Crossing Water Channels/Nullahs

Measure the center longitudinal section of the water channel/nullah from 100 m upstream to 50 m downstream. Cross-sections shall be measured at 10 m intervals, perpendicular to the axis of the channel/nullah. A minimum of five points shall be taken at each cross-section to correctly depict the top and bottom of the sloping bank, the width of the bank, and the center of the channel. For wider water channels/nullahs, the distance between cross-section points shall not exceed 5 m.

Survey Corridor

A detailed topographic survey shall be carried out within a corridor width equivalent to the Right of Way of the proposed alignment to meet the project requirements in the most effective manner. At locations where rivers or nullahs are crossed, the extent of the survey is detailed in the respective sections.

Mapping (Unit of Measurement)

Metric units shall be used throughout.

Scale

In addition to providing a soft copy, all mapping drawings shall be plotted at a scale of 1:1,000.

Detailed Survey Requirements

Buildings / Structures

- The plinth line of all permanent buildings.
- Construction type of building (e.g., brick (B), semi-concrete (SC), concrete (C), double storey (D), etc.).
- Ruins or partially demolished buildings or foundations, as determined by walls and masonry visible at the time of the survey.
- Names and type of usage of all buildings (e.g., schools, offices, etc.).
- Buildings under construction.

Roads, Tracks, and Footpaths

- Kerb line or edge of surfacing for carriageways, including edge line markings.
- Tracks.
- Pedestrian bridges and footpaths.
- Traffic islands (similar to kerb line).

- Road destinations for junctions' levels.
- Bridges (over railways, rivers, etc.).
- Levels over railway lines in case of at-grade or grade-separated crossings.
- For power transmission lines crossing the alignment, record the level of the electric wire with respect to survey control.

Industrial

- Name and type of industry, boundary wall, and building structures inside.
- Tanks (indicate type of material stored, e.g., fuel, gas, water, etc.).
- Sewage disposal works details.
- Substantial chimneys.

Boundary Features

- Fences.
- Gates.
- Boundary stones located or used for fieldwork.
- Walls.
- Burial grounds.
- Historical areas.

Railways

- Gauge faces of railway running rails, including elevations of rail tops.
- Level crossings.
- Platforms.
- Bridges (over roads, rivers, etc.).
- Station buildings.
- Telegraph poles (indicate reference numbers).

Survey

- Survey Department Trigonometric Stations.
- Permanent ground markers.
- Survey Department Benchmarks used (indicate reference number and level).

Woods, Trees & Recreation Areas

- Playing fields.

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- Land-use and vegetation.
- For trees within the survey corridor, assign a code defining the girth of each tree. Trees with varying girth, as specified in the CSR for payment, will be in respective layer.

Slopes and Earthworks

- Cuttings and embankments, including any protection works.
- Terraced slopes.
- Borrow pits / quarries.
- Retaining walls.
- Rock outcrops (if any).
- Mining tips (if any).
- Indicate the date of survey if ongoing earthworks are present and mark the affected area.

Services and Utilities

- Transformers (boundary fences only).
- Electricity substations and switch boxes (boundary fences only).
- Pylon lines (indicate levels at lowest point at sag and at pylon towers).
- Pylon bases.
- Pylon reference numbers and voltage of transmission.
- Radio and TV station masts or towers.
- Telecom poles.
- Electricity poles.
- Water mains pipes and stop valves (indicate diameter of pipe).
- Manholes (circular and square).

Water & Drainage

- Lakes.
- Ponds or mining pools.
- Reservoirs.
- Rivers (indicate names).
- Streams.
- Ditches (indicate width).
- Canals.

- Wells (indicate diameter or width).
- Swamps.
- Lined drains (indicate width, depth, and type).
- Water towers.
- Culverts.
- Waterfalls.
- Jetties (if any).
- The top of banks of all water features over 1.0 m wide shall be detailed, and the bottom of banks shall be indicated by the water level at the time of the survey.
- Direction of flow for all rivers, streams, and watercourses shall be indicated.
- Slopes with height greater than 1.0 m or with steep gradients shall be shown by contours, including river and stream banks, using conventional markings. The top and bottom of slopes shall be shown as dotted lines.
- Slope conventions shall be drawn as accurately as possible to indicate the actual shape of the slope face, including all berms and terraces.

Any other features not listed, as requested by the Client, shall also be shown.

Bridge Details

The bridge details shall be shown on a separate drawing for each bridge. The bridge observations, in the form of coordinates, shall include the following:

a. The coordinates and levels of the four corners of the bridge (points shall be on the adjacent road surface), as well as the two edges of the piers, abutments, and wing walls.
b. The coordinates and levels of the bridge deck up to the intermediate piers (if any).
c. Length, width, and type of construction of the bridge.
d. The type and location of services adjacent to the bridge.
e. The coordinates and levels of the centerline and the road on the bridge at approximate intervals of 5 m.

The cross-sectional clearance envelope on both sides of an overpass ridge (with respect to the road centerline passing underneath) shall show all relevant levels, offsets, and skew angles.

Culvert Details

Details of each culvert shall be shown on the survey plans, and a separate sheet with a tabulation of the following information shall be submitted:

- A sketch of the inlet and outlet structures, including all visible dimensions, to a scale of 1:200.
- Type of culvert and diameter.
- Chainage of the culvert at the road centerline.
- Skew angle of the culvert from the centerline.
- Length of culvert from each side of the centerline.
- Invert levels of the inlet and outlet.

For major culverts (diameter > 2.0 m), the outlet structures shall be properly measured with enough points recorded to enable accurate modelling in CAD.

String Labelling

Ground features, including break lines, shall be labeled with exact descriptions under the AUTOCAD LAYER NAME. Any additional labels may be submitted by the surveyor for client approval before use in the DGM.

Property Model

This model shall be created using a series of 3D null-level strings and text strings, including:

a. Strings of land lots (null-level strings)

b. Land use and type (text strings)

Attributes related to land type and use shall be appended in AutoCAD format. This information shall be used by the Surveyor when preparing Land Utility folders at the end of the survey.

Contours

After digital data collection, contours shall be generated using computer software.

- Contour interval: 1 m.
- The smoothness factor in the software shall not distort ground contour representation.
- Contours shall be well labeled.

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- Break lines affecting contour generation shall be carefully picked during data collection.
- Contours shall be shown as continuous lines, with a thicker line for every fifth contour (prominent contour).
- Contour and spot heights shall be differentiated from other details.
- Each contour value shall be indicated along the contours at intervals not exceeding 200 mm or along the edges of the mapping area.

Where ground surfaces are obscured due to undergrowth, ongoing earthworks, swampy areas, or other obstructions, and with prior client agreement, contours may be shown by broken lines to indicate that their accuracy cannot be guaranteed.

Longitudinal Profile and Cross-Section

- Longitudinal profile plans shall be plotted in A1/A3 size (as instructed by the Client) to a scale of 1:1,000 horizontal and 1:100 vertical, with a chainage interval of 25 m unless otherwise specified.
- Cross-sectional plans of existing roads shall be plotted in A1 size to a scale of 1:100 for both horizontal and vertical, with 25 m intervals.
- Plans shall show the specified chainage intervals, existing ground profiles, and all existing features.

Field Books and Records

- All field books and computer data shall be properly maintained and record all survey work truthfully.
- Survey work shall be recorded in ink, in a proper style, and according to best practices. Unsatisfactory work and errors shall be struck off; no superimposed writing or erasures shall be permitted.
- The Client's Representative may periodically check field books to ensure high standards. Spot checks may be requested if there is reasonable doubt about the accuracy of the survey work. The Surveyor shall comply unless the Surveyor can satisfy the Client’s Representative that such checks are unnecessary.
- All field books and computer data shall be certified by a qualified surveyor.

Topographic Survey Report and Plans

- Reports shall be submitted at a scale of 1:1,000 for the RoW

- Each control/traverse station shall be shown in the report along with coordinates, a location map/diagram, a sketch referencing permanent features, and at least one photograph.
- A list of all equipment with models and calibration certificates not older than 6 months shall be included.
- Names of surveyors shall also be submitted.

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ESTABLISHMENT OF TOURIST GLASS TRAIN FROM RAWALPINDI / ISLAMABAD TO MURREE

EMPLOYER'S REQUIREMENTS



STRUCTURE DESIGN REQUIRMENT

December 2025

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Clearance Code:		Document No:		Revision No:	

STRUCTURAL DESIGN CRITERIA

1.1 General

The primary purpose of this Structural Design Criteria is to establish, standardize, and finalize all technical data, design parameters, assumptions, codes of practice, analysis methodologies, design procedures, safety requirements, and construction guidelines to be adopted for the structural design of **culverts, drains, flyovers, bridges, abutments, retaining walls, parapets, approach slabs, and all associated structural components**.

This document ensures:

- Uniformity in analysis and design across all project components.
- Compliance with governing national and international standards.
- Safe, durable, and serviceable structures throughout their intended design life.
- Consideration of site-specific conditions such as seismicity, geotechnical environment, climatic factors, and hydrological influences.

1.2 Units of Measurement

All structural calculations, drawings, and documentation shall be executed using the **Foot–Pound System (FPS)** unless otherwise stated or required by specific code provisions.

1.3 Codes and Standards

The following codes and standards shall govern the design and analysis of the flyover and associated structures. The latest editions available at the time of design shall be considered unless the Client mandates otherwise.

Primary Design Codes:

- **AASHTO LRFD Bridge Design Specifications, 8th Edition – 2017**
  Governs bridge and flyover structural design, load requirements, detailing, and safety provisions.

- **ACI 318-14 — Building Code Requirements for Structural Concrete (2014)**
  Governs reinforced concrete design, detailing, development lengths, durability, and material specifications.
- **BCP 2007 — Building Code of Pakistan (Seismic Provisions)**
  Governs seismic zonation, structural seismic design requirements, and response spectrum parameters.

Material Standards:

- **ASTM A615** — Deformed and plain billet steel bars for reinforcement.
- **ASTM C150** — Specifications for Portland Cement.
- **ASTM C33** — Specifications for concrete aggregates.

Where a conflict arises between standards, the stricter requirement shall govern, subject to approval by the Engineer/Client.

1.4 Loads

All structural components shall be designed to resist loads and forces acting individually or in combination, as per AASHTO load combination requirements. The following load types shall be considered:

1. Dead Load (DC, DW)
2. Live Load (LL, IM)
3. Impact / Dynamic Load Allowance
4. Earthquake / Seismic Load (EQ)
5. Braking Force (BR)
6. Earth Pressure (EP)
7. Live Load Surcharge (LS)
8. Pedestrian Load (PL)

9. Wind Load (WL)
10. Temperature Load (TU, TG)
11. Stream Flow and Hydraulic Forces (WA, FR)

1.4.1 Dead Load (DL)

Dead load includes:

- Self-weight of structural components computed based on the geometry.
- Wearing course, parapets, kerbs, sidewalks, barriers, and other permanent attachments.

Material unit weights to be used:

- Pre-stressed / Reinforced Concrete: **150 pcf**
- Plain Concrete: **144 pcf**
- Asphalt / Wearing Course: **144 pcf**
- Soil / Backfill: **120 pcf**
- Reinforcement Steel: **490 pcf**

Additional superimposed loads such as utilities, conduits, lighting, and drainage appurtenances shall be included where applicable.

1.4.2 Live Load (LL)

Live load shall conform to **AASHTO LRFD Clause 3.6.1.2**, including:

- HL-93 vehicular loading (Design Truck + Design Lane Load).
- Multi-lane reduction factors.
- Dynamic allowance as applicable.

1.4.3 Impact / Dynamic Allowance (IM)

Shall be applied in accordance with **AASHTO 3.6.2**, considering the effect of dynamic amplification due to moving vehicles.

1.4.4 Earthquake Loads (EQ)

- Seismic zoning for Lahore shall be as per **BCP 2007**.
- Seismic analysis shall be performed using AASHTO response spectrum method.
- Soil factors, importance factors, and structural response modification factors shall be applied accordingly.
- Liquefaction potential and soil amplification shall be evaluated using geotechnical data.

1.4.5 Braking Force (BR)

Braking force shall conform to **AASHTO 3.6.4**, taken as the maximum of:

i. 25% of axle weight of design truck/tandem

ii. 5% of (design truck + lane load)

Applied longitudinally at deck level.

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1.4.6 Earth Pressure (EP)

Earth pressure on abutments, retaining walls, and buried structures shall be evaluated using:

- Active earth pressure (Rankine / Coulomb)
- Passive earth pressure
- At-rest pressure
- Including effects of surcharge, water table variation, and seismicity (Mononobe–Okabe theory).

1.4.7 Live Load Surcharge (LS)

Shall be applied to retaining structures as per **AASHTO 3.11.6.4**.

1.4.8 Pedestrian Load (PL)

Shall comply with **AASHTO 3.6.1.6**, typically 90 psf uniformly distributed unless otherwise specified.

1.4.9 Wind Load (WL)

Wind loads shall be calculated as per **AASHTO Article 3.15**, considering:

- Basic wind speed
- Exposure category
- Aerodynamic shape factor
- Shielding effects
- Wind load on bearings and piers

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1.4.10 Temperature Load (TU/TG)

Temperature effects shall include:

- Uniform temperature change
- Thermal gradient across depth
- Expansion/contraction effects
- Restraint forces in fixed components

1.4.11 Stream Flow / Hydraulic Forces (WA/FR)

Hydraulic forces due to stream flow, debris impact, scour, buoyancy, and water current shall be calculated.

Preliminary hydrological data will be used from the attached hydrology report.

1.5 Load Combinations

Load combinations and load factors shall strictly follow **AASHTO Table 3.4.1-1**, including:

- Strength Limit States
- Service Limit States
- Extreme Event Limit States

  The most critical combination shall control design.

1.6 Materials

Material specifications shall follow **NHA General Specifications (1998)** unless superseded by Special Provisions.

1.6.1 Concrete Strengths (f'c):

- Pre-stressed Girders: **5000 psi**
- Superstructure Components: **5000 psi**
- Substructure Components: **4000 psi**
- Deck Slab & Diaphragms: **4000 psi**
- Approach Slabs: **3000 psi**
- Lean Concrete / Blinding: **1500 psi**

Additional requirements:

- Minimum cement content, water–cement ratio, admixture use, and curing requirements shall comply with ACI 318.
- Concrete durability provisions shall be followed based on exposure conditions.

1.6.2 Reinforcement

- ASTM A615 / AASHTO M31, Grade 60 (fy = 60,000 psi).
- Welded splices shall comply with ACI and AASHTO requirements.
- Epoxy-coated rebars shall be used where required for corrosion protection.

1.7 Geotechnical / Foundation Parameters

Foundation design shall utilize parameters from the geotechnical report, including:

- Allowable soil bearing capacity
- Pile load capacity (compression, tension, lateral)
- Modulus of subgrade reaction (ks)
- Settlement limits
- Scour depth
- Earth pressure coefficients
- Soil stratification and groundwater conditions
- Liquefaction assessment (if applicable)

1.8 Stability Criteria

All retaining structures, abutments, and foundations shall meet the following stability requirements:

- **Factor of Safety against Sliding:** ≥ **2.0**
- **Factor of Safety against Overturning:** ≥ **1.50**
- **Resultant location:** Must fall within the middle third (kern) of foundation base.
- **Bearing pressure:** Within allowable limits under service loads.

1.9 Computer Software

The following software tools shall be used:

- **SAP2000** — For 3D modeling, global analysis, load combinations, and structural response evaluation.
- **CSI Section Designer** — For section capacity evaluation where needed.
- **AutoCAD** — For preparation of structural drawings.

Finite element modeling shall include:

- Modeling of girders, slab, diaphragms, piers, bearings, and boundary conditions.
- Load distribution as per AASHTO requirements.

1.10 Drawings

All structural drawings shall be prepared using **AutoCAD (FPS Units)** and shall include:

- General arrangement and layout plans
- Elevations and longitudinal sections
- Cross-sections
- Reinforcement detailing for all elements
- Girder reinforcement, tendon profiles (if PSC)
- Bearing and expansion joint details
- Abutment and pier details
- Bar bending schedules
- Construction sequencing notes
- Standard notes and specifications

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ESTABLISHMENT OF TOURIST GLASS TRAIN FROM RAWALPINDI / ISLAMABAD TO MURREE

EMPLOYER'S REQUIREMENTS



Public Health System

December 2025

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SECTION –1
DESIGN CRITERIA FOR WATER SUPPLY SYSTEM

1.1 GENERAL

For every scheme, prior to its planning and designing, the design parameters and criteria have to be carefully established. These are based on availability of funds, living conditions, climatic conditions, industrial and commercial activities.

Considering above factors the design criteria for the project is given below:

1.2 DESIGN PERIOD

As the time passes, the water demand increases in the project area, due to increase in population and industrial and commercial activities etc. Hence the system components are proposed to meet the future requirement up to a certain period which is called as the design period.

This project will be designed taking into consideration the water demand for full occupancy of the housing units and for all commercial and institutional activities for which certain time period is required that will the design period of this project.

1.3 WATER DEMAND

Water demands for the project area will be taken as follows:

(a) Non Domestic Water Demands

All other water demands, other than domestic are known as non-domestic demands. This includes water consumed by educational institutions, hospitals, markets, dispensaries, and commercial centres etc.

This will be taken as 20% of the average domestic day demand.

(b) Unaccounted-for Water

This includes water losses through leakages in the transmission and distribution mains, service connections, household plumbing and illegal

connections etc. A figure of 10% of average domestic day demand will be adopted for unaccounted-for water.

(d) Total Average Water Demand

Total average day demand is the total of domestic, non-domestic water demand and unaccounted-for water.

(e) Demand Fluctuation Factor

Water demand will vary on seasonal, daily and hourly basis. The magnitude of such variation is defined by the following factors.

(i) Maximum Day Water Demand Factor

This describes the ratio between the maximum day water demand and the average day water demand. The maximum day water demand will be taken as 1.5 times the average day demand. Max. day demand will be utilized for the source establishment and design of water treatment plants, transmission mains, pumping equipment and service reservoirs.

(ii) Peak Hour Demand Factor

This describes the ratio between peak hour water demand and max day water demand. This factor will be taken as 1.5 times the maximum day demand (or 2.25 times of average day demand). Peak hour demand will be used for the design of distribution network.

1.4 DESIGN OF WATER SUPPLY SYSTEM

The objective of piped system is to supply water at adequate pressure and flow. Pressures at any period in the system is maintained within the range whereby the maximum pressure avoids bursting of pipes and the minimum pressure ensures that water is supplied at adequate flow rate for all expected demands.

The hydraulic design of various components of the water supply system will be based on the following considerations;

1.4.1 Distribution Mains

(a) Capacity

The capacity of distribution mains will based on peak hour demand.

(b) Head Loss in Pipes & Fittings

The loss of head in the pipelines shall be calculated by using Hazen & William formula.

$$V=K.C.D^{0.63}I^{0.54}$$

Where

V=Velocity of flow (ft./sec)
D=Diameter of pipe (ft.)
I =Hydraulic gradient (i.e unit head loss in pipe)
C=Friction factor
K=0.849

Coefficient of roughness (C) values to cover losses in fittings and valves shall be as follows:

- uPVC / HDPE Pipe 130
- DI / MS Pipe 110

(c) Velocity Limitations

The maximum flow velocity in the pipe lines would not exceed 1.5 meters/sec.

(d) Pipe Materials

The material to be adopted for the main line will be as follow:

Pipe Size	Material
• 3” – 12”	HDPE, PE-100, PN 10

(e) Minimum Pipe Size

Recommended minimum size of distribution mains is 3”.

(f) Terminal pressure

The terminal pressure for the farthest point will be taken as 1.4 bar (14 meters). The desirable maximum pressure in the network will be 4 bars (40 meters).

(h) Pipe Bedding

Sand bedding minimum of 4" thickness will be provided for all pipe materials.

(i) Cover over Pipes

A minimum pipe cover of 3 ft. will be provided. However, under road of heavy traffic it will be 4 ft.

1.5 OVERHEAD WATER RESERVOIR

The Overhead water reservoirs will be sized on the basis of 6 hours of average day demand of the service area

1.6 COMPUTER MODEL FOR DISTRIBUTION NETWORK DESIGN

EPANET software version 3.2.0 developed by Environmental Protection Agency, USA, will be used for network analysis. It is capable to simulate reservoirs or elevated tanks, pumps at sources, booster pumps, pressure reducing valves, pressure sustaining valves and check valves.
The purpose of the program is to calculate water flows and velocities in pipes and pressures throughout a water distribution network given the layout of the pipes and other elements of the network. The various elements, in addition to pipes and nodes (which are junctions of two or more pipes) are:

- Source Nodes (where water enters the system) with or without pumps
- Booster Pumps
- Check Valves
- Pressure Reducing Valves
- Pressure Sustaining Valves

The pipe network pressure balancing will be done on electronic digital computer by using above mentioned software. The pipe network analysis is basically an iterative scheme and is based on the discharge balancing procedure. The friction losses in pipes have been evaluated using "Hazen and Williams" formula in the form given below:

$$Q = K\ C\ D^{2.63} S^{0.54}$$

and

$$S = \left[\frac{Q}{KCD^{2.63}} \right]^{\frac{1}{0.54}}$$

Where;

Q = rate of flow in ft^3/sec
D = pipe dia. in ft.
S = slope of the energy line (ft/ft)
C = Co-efficient of friction (It will be taken as 130 for HDPE and 110 for DI pipes)

The termination of the iterative scheme is based upon the sum of absolute values of all head changes computed in iteration. The whole computations are repeated for a number of iterations so that the error limit converges to a minimum acceptable standard.

Successive iterations compute head loss in each pipe and balance the system to produce pressure at each node, relative to the given head.

The analysis will be done for the following conditions to confirm suitability of pipe sizes selected.

- Night Flows (0.3 x Average Day Demand)
- Peak Hour Demand
- Max. Day Demand

1.8 LOCATION OF WATER DISTRIBUTION LINES

The water pipelines will be laid on either side of the road.

1.9 LOCATION AND SPACING OF VALVES

Sufficient shutoff valves will be provided (gate/ sluice valves) to permit isolation of parts of the water distribution system for emergency repairs and maintenance, without having to interrupt service to very large sectors. The locations and spacing of valves will be determined as per ground conditions. The provision of valves facilitates convenience in system operation; however provision of excessive number of valves will be avoided. Similarly washout and air valves will be provided at appropriate

locations. Air valves shall be of double orifice type. Some guidelines for deciding the locations of valves are given below:

- Not more than 3 valves at a cross
- Not more than 2 valves at a tee
- Preferably at a uniform distance from pipe intersections
- Not further apart from each other in a line than 400 m
- Air valves at all crest points
- Washouts at all valley points

Transmission Pipeline(s)

- Isolating valves at every 6500 ft.
- Air valves at crest points and in constant rising pipelines (of moderate slope) at every 3300 ft.
- Washouts at the lowest points of the pipelines or section

Valve chamber shall be provided for all sizes of valves on underground pipelines. An effort will be made to provide control valves in such a fashion so that an area not more than 0.5 hectares is affected during maintenance / repairs.

1.10 FIRE HYDRANTS

The capacity of fire hydrants to deliver water shall be 7 gallons per second. The minimum desirable spacing for fire hydrants will be 1000 ft. and it will be installed on pipes not less than 4" pipe.

1.11 RESIDUAL CHLORINE

Disinfected water will be supplied to consumers; residual chlorine of 0.2 mg/L will be maintained in the pipe network.

1.12 INDICATION PLATES

Indication plates will be installed at location of all type of valves and fire hydrants.

1.13 THRUST BLOCKS

Thrust blocks shall be provided at the bends, tees, dead ends etc. to encounter the thrust exerted by water pressure.

SECTION –2
DESIGN CRITERIA FOR SEWERAGE SYSTEM

2.1 GENERAL

The Design Criteria for proposed sewerage system is given as under which will be further detailed in the next design stages:

2.2 HYDRAULIC CRITERIA

2.2.1 Sewage Flow Estimation

Normally about 80 to 90 percent of the per capita consumption of water becomes wastewater. In the design of sewers, 80 percent of the total water demand will be taken as sewage flow.

2.2.2 Peak Flow Factor

Sewage flow does not remain uniform; it varies from time to time. Waste water collection system shall be designed to handle peak flows equal to average daily flow multiplied by the peak flow factor. The Peak Factor will be adopted to compute the Peak Flow which is shown in Table-2.1:

Table 2.1: Peak Factors

Population in Thousand	Peak Factor
Up to 5	4.50
5 to 10	4.00
10 to 25	4.00
25 to 50	3.50
50 to 80	2.50
Above 80	2.00

2.2.3 Design Depth of Flow

Sewer will be designed to flow at 0.75 of full depth under peak flow conditions to provide requisite air gap under which condition the sewer will flow up to 90 % capacity at peak flow. Thus the design flow will be calculated by multiplying peak flow with a factor of 1.12.

2.2.4 Flow Velocity

Minimum velocity in the sewer will be such that there should be no deposition in the sewer line. Minimum self-cleansing velocity is 2.0 ft./s under flowing full conditions. Preferably, it is taken as 2.50 ft./s for the designing of the system. Maximum velocity will not be greater than 8.0 ft./s.

Manning's equation will be used to determine the velocity in the sewer line:

$$V = 1.49/n \, R^{2/3} S^{1/2}$$

Where:

V=Velocity of flow in ft/sec
R=Mean hydraulic radius in feet
n = Roughness Co-efficient

2.2.5 Sewer Capacity

The full carrying capacity of the pipe will be calculated as follows:

Q= AV

Where:

Q= Flow in cusec/s
A= Cross sectional area in sq.ft.
V= Flow velocity in ft./s

2.2.6 Sewer Slopes

The minimum gradient for a section of sewer shall generally be taken which is necessary to satisfy the minimum velocity requirement (2.50 ft./sec).

The minimum recommended slopes to lay the sewer are mentioned in the Table- 2.2 given below:

Table 2.2: Sewer Slopes

Size of Sewer (Inches)	Generally Adopted Gradient
9	0.0045
12	0.0031
15	0.0023
18	0.0018
21	0.0014
24	0.0012
27	0.0010
30	0.0009
36	0.0007
42	0.00057
48	0.00048
54	0.00041
60	0.00036

2.2.7 Depth of Cover to Sewers

Minimum earth cover over the pipes will be 03 feet in order to provide building connections. Maximum depth of sewers will be 20 to 25 ft.

2.2.8 Location of Sewers

The Sewers will be positioned on both sides of all main roads while it will be laid on one side of 50 ft. streets.

2.2.9 Sewer Alignment

Sewer length between the manholes will be laid at a uniform gradient and diameter and straight in plan.

2.2.10 Bedding

Brick ballasts/crushed stone shall be used for pipe bedding except where the pipes require additional support in the form of concrete surround as appropriate.

2.2.11 Crossings of Other Utilities

Where the proposed sewers cross the other utilities, the sewer will be laid in such a way so as to avoid interference with these utilities. Sewers will be laid below water pipes wherever possible. If the water mains underpasses any sewer line it will be protected by concrete encasement at the crossing to minimize the risk of contamination of water supply.

2.2.12 Minimum Diameter of Pipes

The minimum diameter of pipes to be used shall be 9 inches.

2.3 PIPE MATERIAL

Sewers of 9 inches diameter will be reinforced cement concrete (RCC) pipes conforming to B.S. 5911:Part I : 1981, Class L. The larger diameter pipes 12 inches and above shall be RCC pipes conforming to ASTM C-76, Wall-B. However, class of the pipe will depend on the depth of the sewer and bedding type.

2.4 MANHOLES

2.4.1 Location

Manholes will be located according to conventional sewer network design i.e. starting point, junctions between sewers and change in direction and grades. Based on the sewer size, the spacing between manholes will be as follows:

Pipe Size	Interval
9”	50 feet
12”	100 feet
15	150 feet
18	200 feet
21–24”	250 feet
27-42”	300 feet
48–60”	400 feet
Above 60	500 feet

2.4.2 Manhole Dimensions

Following manholes dimensions will be adopted for sewerage systems of project area:

Table 2.3: Manhole Diameter

Size of Sewer(mm)	Diameter of Manhole(m)
9- 21 Inches	4 ft
24- 30 Inches	5 ft
33- 42 Inches	6.5 ft
45- 54 Inches	7.5 ft
60 Inches	8 ft
66 Inches	8 ft
72 Inches	9 ft

2.4.3 Change in sewer Diameter in Manhole

To minimize the risk of blockage in sewers, the diameter of the outgoing sewer must not be less than the diameter of the largest incoming sewer. The top of smaller sewers entering a manhole will normally be at the same level as that of the outgoing sewer.

2.4.4 Slope of channel within Manhole

All manhole invert levels used in the sewer calculations will be the center of the manhole and all distances and slopes will be calculated between centers of manholes.

2.4.5 Drop Connections to Manhole

The drop connections to manholes will be provided if the difference in pipe invert level is greater than 2 ft. otherwise no drop connections will be provided.

2.4.6 Manhole Steps

Malleable Cast iron steps shall be used in the manhole.

2.4.7 Manhole Covers

The size of manholes cover shall be 22 inch i/d. Concrete manhole covers will be provided with Cast Iron frames.

2.4.8 Manhole Material

RCC manholes will be constructed.

2.6 SEWAGE DISPOSAL STATIONS (SDS)

Sewage lift/ pump station will be required to pump sewage collected from various sewage zones to the disposal station.

a) Sewage Lift Station

Lift station will be provided wherever necessary. It will consist of a wet well and a dry well to house non clogging centrifugal pumps.

b) Sewage Pump Station

The sewage pump station will pump the sewage collected from the entire sewage zone. Pump house building will comprise of a wet well and dry well. Non clogging centrifugal pumps will be installed in the dry well.

Positive suction head will be provided to the pumps. Standby provision for pumps will be 50% of peak sewage flow.

Provision of flow measurement, adequate ventilation, safety equipment and pump lifting arrangements shall be made.

c) Wet Well

The wet well will be designed for a detention period as per following

Population	Detention Time
Population up to 25,000	10 minutes
25,000---50,000	5 minutes
50,000---100,000	4 minutes
100,000—200,000	3 minutes
Above 200,000	2 minutes

d) **Types of Pumps**

Non clogging horizontal centrifugal pumps shall be used.

e) **Screening Chamber**

The design parameters for screen chambers are as follows:

i) Bar screen inclined 45 to 60 degrees from the horizontal
ii) Clear opening between bars to be at least 1 inch but not more than 2 inches.
iii) Velocity of flow through bars to be 1.0 to 2.5 ft/s to facilitate hand cleaning.
iv) A convenient operating platform to be provided for hand cleaning and draining of screenings.
v) Adequate manually operated hoist to be provided for lifting screening containers from the operating platform to grade level.
vi) Stairway to be provided for access from the grade level to the operating platform.

Drainage facility shall also be provided in the individual screen channels to empty these channels for maintenance purposes.

2.7 FORCE MAIN

Force mains shall be provided to carry sewage to ultimate disposal point. The material of force main will be HDPE or CI. However, the material for manifold and suction pipes installed in the pump house will be cast iron.

SECTION – 3
DESIGN CRITERIA FOR STORM WATER DRAINAGE SYSTEM

3.1 GENERAL

The objective of the design of storm water drainage system is to ensure safe disposal of storm water at an economical cost by taking into consideration the adopted level of protection and requiring minimum operation and maintenance.

The following design criteria will be adopted for design of storm water drainage system for the project and will be improved at advanced stage of the design.

3.2 DESIGN RETURN PERIOD

The drainage systems in the urban areas are designed to handle storm runoffs having return periods ranging from nearly two (02) years to five (05) years depending on the value of the properties in the drainage area and the damages due to floods. Storm water drainage system of the project area will be designed based on two (02) years return period.

3.3 ESTIMATION OF RUNOFF

There are several methods of estimating the runoff. The choice of the method is based on the size of catchments being considered.

Rational Formula has been found simple to apply and accurate when used on small evenly shaped catchments. Rational Method is suitable for areas up to 3km^2.

3.3.1 Rational Method

In this method peak runoff is related to the average rainfall intensity over the duration of the storm:

$$Q = CIA$$

Where

Q	=	Peak runoff (cusecs)
C	=	Weighted runoff coefficient
I	=	Average rainfall intensity (in/hr)
A	=	Drainage Area (hectares)

3.3.1.1 Rainfall Intensity

The determination of the average rainfall intensity “I” to be used in the formula involves the following factors:

- Frequency of occurrence (Return period)
- Intensity duration characteristics of rainfall of design storm frequency

The rainfall intensity to be used in the Rational Method is obtained from "Rainfall Intensity-Duration-Frequency Curve (IDFC) for the City" for the corresponding design storm return period.

3.3.1.2 Time of Concentrations

Time of concentration is the time required for the maximum runoff to develop during a continuous uniform rain. Time of concentration consists of an inlet time or overland flow plus the travel time in the storm channel from the most remote inlet to the point under consideration. The travel time is estimated from hydraulic properties of the storm pipe or channel.

Therefore, the time of concentration T_c is defined by $T_c = T_i + T_t$ (minutes)

Where

T_c = Time of concentration (minutes)
T_t = Time of flow in the storm pipe or channel (minutes)
T_i = Overland Flow time (minutes)

Taking into consideration small watershed area, design of pipes and storm channels shall be carried out by using Kerby's method.

The Kerby equation is as under:

`

$$T_i = \frac{K[LxN]^{0.467}}{[S]^{0.235}}$$

Where

T_i = Inlet time or overland flow time (minutes)
K = 1.44 for SI units
L = Overland flow length (ft)
N = A dimensionless retardation co-efficient
S = Slope (ft/ft)

For application of Rational Method, Taxes Department of Transportation recommends that Tc be less than 300 minutes (5 hours) and greater than 10 minutes. Other agencies require Tc to be greater than 5 minutes. The reason is that estimates of Ti becomes unacceptably large for durations less than 5 or 10 minutes. For long durations (such as greater than 300 minutes), the assumption of a relatively steady rainfall rate is less valid. For rural environments, Kerby (1959) and Kirpich (1940) methods are useful for calculation of overland flow and channel flow respectively.

Keeping in view the above mentioned factors, the minimum time of concentration for pipes and channels is adopted as 10 minutes.

3.3.1.3 Runoff Coefficient

The runoff coefficient is the ratio of maximum rate of runoff to the average rate of rainfall in the area during the time of concentration. The land-use plan of the project area will be kept in view in the estimation of the runoff coefficients for the drainage system.

Use of runoff coefficient depends on urban planning and type of land use with value of 0.70 or greater in dense urban area and value of 0.20 or less in open areas.

Weighted runoff coefficients based on the percentage of different land surface types found in the catchment area has been developed for detailed design purposes. Values for runoff coefficient shall be used from the following Table 3.1 with respect to character of the tributary drainage area to calculate the runoff from different drainage areas:

Table 3.1: Land use and Runoff Coefficients

Land Use	Value of Runoff Coefficient (C)
Commercial – downtown area	0.70 – 0.95
Commercial – neighborhood area	0.50 – 0.70
Residential – single family units	0.30 – 0.50
Residential – multi units, detached	0.40 – 0.60
Residential – multi units, attached	0.60 – 0.75
Residential – suburban	0.25 – 0.40
Residential – apartment areas	0.50 – 0.70
Industrial – light	0.50 – 0.80
Industrial – heavy	0.60 – 0.90
Parks, cemeteries	0.10 – 0.25
Playgrounds	0.20 – 0.35
Railroad yards	0.20 – 0.40
Unimproved areas	0.10 – 0.30
Watertight roofs	0.70 – 0.95
Asphaltic cement streets	0.85 – 0.90
Portland cement streets	0.80 – 0.95
Paved driveways and walkways	0.75 – 0.85
Gravel driveways and walkways	0.15 – 0.30
Lawn, sandy soil – slope ≤ 2 %	0.05 – 0.10
Lawn, sandy soil – slope 2 - 7 %	0.10 – 0.15
Lawn, sandy soil – slope > 7 %	0.15 – 0.20
Lawn, heavy soil – slope ≤ 2 %	0.13 – 0.17
Lawn, sandy soil – slope 2 - 7 %	0.18 – 0.22

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Land Use	Value of Runoff Coefficient (C)
Lawn, sandy soil – slope > 7 %	0.25 – 0.35

3.4 HYDRAULIC DESIGN OF STORM WATER CHANNEL

3.4.1 Estimation of Velocity and Flow in Open Channel

Velocity of flow in channels may be determined by Manning's equation as under:

$$V = \frac{1.49}{n} (A/P)^{2/3} S^{1/2}$$

Where

V = Flow velocity (ft./sec)
n = Manning's roughness coefficient
A = Cross-sectional area of flow in channel (sq.ft.)
P = Wetted perimeter (ft)
S = Bed slope (ft/ft)

Typical values of Manning's coefficient (n) are as under:

Material	Manning's Coefficient (n)
R.C.C. Conduit	0.015
R.C.C. Pipe	0.013
Brick Lined Open Channel	0.017

Flow quantity in storm channels is determined by the following equation:

$$Q = AV$$

Where

Q = Flow quantity (ft^3/sec)
V = Flow velocity (ft/sec)
A = Cross-sectional area (sq.ft)

3.4.2 Cross-Section of Channel

Cross-sections of storm channels shall be designed to carry expected storm water runoff and considering the availability of land. Rectangular cross section shall be used and channel shall be of reinforced cement concrete.

3.4.3 Velocity of Flow

The velocity of flow in an open channel is an important design consideration. Excessively high velocities tend to cause channel erosion even in lined channels particularly if water is transporting a significant amount of sediments. If

velocities are too less i.e. less than 2.0 ft/s, sediments may settle out with the result that the channel will require regular cleaning and vegetation growth may become problematic for maintenance. Minimum velocity of 2.5 ft./s shall be adopted in design of storm channels.

3.4.4 Longitudinal Slopes

Longitudinal slope of channel shall be maintained in a way that minimum and maximum velocity of water shall not exceed permissible limits of velocity. If maximum velocity exceeds the permissible limits then drop structures shall be provided wherever necessary to reduce the velocity of flow.

3.4.5 Freeboard in Channel

Freeboard height of 6 inches shall be considered.

3.4.6 Location of Channel

Storm channels shall be proposed on both edges of main roads and on single side of 50 ft streets.

3.5 PUMPING STATIONS

Pumping of storm water shall be considered only in unavoidable circumstances when there will not be any option for disposal of storm water by gravity. If pumping of storm water shall be required at any location, then types of pump installations; wet-well and wet/dry-well for pumping station shall be studied keeping in view the site circumstances.

Suitability of different types of pumps like centrifugal, positive displacement and submersible shall be evaluated by considering merits and demerits of pumps and in consultation with the Client.

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ESTABLISHMENT OF TOURIST GLASS TRAIN FROM RAWALPINDI / ISLAMABAD TO MURREE

EMPLOYER'S REQUIREMENTS



Electrical Works

December 2025

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1. LOW VOLTAGE (LV) DISTRIBUTION BOARDS

1.1. SCOPE OF WORK

The work under this section consists of design, manufacturing, fabricating, supplying, installing, connecting, testing, and commissioning of all material and services of the complete Low Voltage Distribution.
The Contractor shall discuss the electrical layout with the Engineer and co-ordinate at site with other services for exact position of the electrical lines and equipment.

1.2. GENERAL

The Low Voltage Distribution Boards shall be sheet steel fabricated. These shall be suitable for surface mounting, semi-recessed or recessed in wall mounting. The Low Voltage Distribution Boards shall be totally enclosed, dust and damp proof. The Low Voltage Distribution Boards shall be complete in all respects with material and accessories, factory assembled, tested and finished according to the Specifications and to the normal requirements.

1.3. APPLICABLE STANDARDS/CODES

The latest editions of the following standards and codes shall be applicable for the materials specified within the scope of this Section:

BS 4752-1-		Triple Moulded Case Circuit Breaker
IEC 947	-	Single and Triple Miniature Circuit Breaker
IEC 947	-	Low Voltage Switch gear and Control gear
IEC 439	-	Factory Built Assemblies of LV Switch gear
IEC 4752		Switch gear and control gear for Voltages
BS 88	-	HRC Fuses
IEC 73	-	Colores for indicator lights and push buttons
IEC 446	-	Identification of insulated/bare conductors

1.4. COMPONENTS

The Low-Tension Distribution Board shall be provided with components for the satisfactory operation of the electrical system.

Typical component specifications are given below:

1.1.1. Bus Bars

The bus bars shall be made of high conductivity electrolytic copper and shall be completely isolated and mechanically braced for the specified fault level. The phase identification of bus bars shall be by colours applied on bus bars and these shall be red, yellow and blue for phase and white for neutral. The earth bus bar shall be green.

1.1.2. Moulded Case Circuit Breaker (MCCB)

The MCCB shall be of moulded case type, provided with fixed magnetic short-circuit and fixed thermal overload protections.

1.1.3. Miniature Circuit Breaker (MCB)

The MCBs shall be appropriate current ratings as required. They shall be provided with fixed magnetic short-circuit and fixed thermal overload protections.

1.1.4. Push Buttons

Push buttons shall be momentary make break contact type (normally open/normally close).

1.1.5. AC Voltmeters

The AC voltmeters shall be of digital type, suitable for flush mounting on switchboards, and shall provide a clear display for accurate measurement of voltage.

1.1.6. Ammeters

The AC voltmeters shall be of digital type, suitable for flush mounting on switchboards, and shall provide a clear display for accurate measurement of current.

1.1.7. Voltmeter Selector Switch

The voltmeter selector switch shall be complete with front plate, grip handle, and RY-YB-BR-OFF-RN positions.

1.1.8. Current Transformers

The current transformers shall be of air-cooled, ring-type construction and shall be suitable for the intended application. They shall be provided with adequate burden and accuracy class to ensure reliable measurement and protection functions.

1.1.9. Air Break Magnetic Contactors

The contactors shall be air break, suitable for the type of duty to be performed. Contactor shall be provided operating coil and auxiliary contacts wired up to terminals. The number of working auxiliary contacts shall be provided according to the system requirements.

1.1.10. Indicating Lamps

Indicating lamps shall be suitable for flush mounting, complete with base, auxiliary transformer and shall have rosettes of suitable colour.

1.1.11. Line up Terminals

Line up terminals wherever provided for control of lighting, power and control circuits shall be suitable for voltage and size of conductors. The line-up terminals shall be suitable for channel mounting. All necessary accessories shall be provided.

2. LOW VOLTAGE CABLE

2.1. GENERAL

The work under this section consists of supplying, installing, testing and commissioning of all material and services of Low Voltage cables and the accessories.

The Contractor shall discuss the electrical layout with the Engineer and coordinate at site with other services for exact route, location and position of the electrical lines.

The cable shall be suitable for nominal service voltage, have an insulated Conductor, shielded and sheathed. It shall be suitable for indoor and outdoor use in the transmission and distribution of electrical energy.

2.2. APPLICABLE STANDARDS/CODES

The latest editions of the following standards and codes shall be applicable for the materials within the scope of this section:

BS 6004	-	PVC insulated cables (non-armoured) for electric power & lighting
BS 6346	-	PVC insulated cables for electricity supply
BS 6746	-	PVC insulation and sheath of electric cables
BS 6360	-	Conductors for insulated cables
IEC 228	-	Conductors for insulated cables
BS 6500	-	Insulated flexible cords

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3. MEDIUM VOLTAGE (MV) CABLE

3.1. GENERAL

The work under this section consists of supplying, installing, testing and commissioning of all material and services of Medium Voltage cables and the accessories.

The Contractor shall discuss the electrical layout with the Engineer and coordinate at site with other services for exact route, location and position of the electrical lines.

The cable shall be suitable for nominal service voltage, have an insulated Conductor, shielded and sheathed. It shall be suitable for indoor and outdoor use in the transmission and distribution of electrical energy.

3.2. APPLICABLE STANDARDS/CODES

Latest editions of the following standards and codes shall be applicable for the materials within the scope of this Section:

IEC 183	-	Guide to the selection of HV cables.
IEC 502	-	Extruded solid electric insulated power cable for rated voltage from 1kV to 30 kV
IEC 540	-	Test methods for insulation and sheaths of electrical cables and cords.

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4. MEDIUM VOLTAGE (MV) CABLE TERMINATION KITS

4.1. GENERAL

The work under this section consists of supplying of Medium Voltage (MV) cable Termination Kits. It shall be suitable for indoor, outdoor and underground installations.

4.2. APPLICABLE STANDARD/CODES

The Latest editions of the relevant standards and codes shall be applicable for the materials within the scope of this Section.

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5. CABLE TRAYS

5.1. GENERAL

The work under this section consists of supplying, installing, and commissioning of all material and services of the complete cable trays.

The Contractor shall discuss the layout with the Engineer and co-ordinate at Site with other services for exact route, location and position of the cable trays for electrical lines.

5.2. APPLICABLE STANDARDS/CODES

Latest editions of the following standards / codes shall be applicable for the materials in scope of this Section:

BS 729 Hot dip galvanized coating on iron and steel articles

5.3. COMPONENTS

The cable tray system shall be of one manufacturer and shall include factory made trays, tray fittings, connectors and necessary accessories and supports to form a complete cable support system.

The cable tray system shall include the following tray elements:

- Straight cable trays and ladders
- Fittings as horizontal and vertical bends of various angles, crosses, tees, wyes, reducers, vertical riser elements
- connectors
- All necessary fixing accessories.

Manufacturer's standard accessories shall be used and site fabrication shall not be permitted. Horizontal run of cables laid on cable tray and exposed to direct sunlight shall be provided with covering at higher level to allow for ventilation. Cable tray shall be raised 15 cm from finished floor level.

5.4. Materials

The whole of the tray work, trays, fittings and supports shall be of mild steel hot dipped galvanized after manufacture to BS 729. The thickness of the protective sheath on any element shall not be less than 55 microns.

Cable trays shall be constructed from mild steel hot dip galvanized and of minimum thickness of 1.5mm.

Insert elements, bolts, screws, pins, etc., shall be mild steel cadmium plated.

Tray work shall have oval perforations. Ladder type trays shall be used for vertical runs as approved by the Engineer.

All trays (straight and fittings) shall be welded construction and be a heavy duty returned-flanged, perforated type, unless specified otherwise. The minimum thickness of heavy duty returned flanged cable trays shall be 1.5mm.

Tray components shall be accurately rolled or formed to close tolerances and all edges rounded. Flanges shall have full round smooth edges.

Ladder racks shall be of similar construction. The rungs shall be spaced at maximum 300 mm. The system shall allow for installing additional rungs and for replacement of rungs.

For all trays, flanges shall be a minimum of 50 mm deep, unless otherwise specified.

Cable tray width and radius of curved sections shall be selected to suit the number of cables as shown on drawings and to the approval of the Engineer

Cable trays and accessories installed in hazardous and extremely corrosive environments shall be heavy duty GRP or 316 S31 grade stainless steel.

PUNJAB MASSTRANSIT AUTHORITY

6. CONDUITS AND PIPES

6.1. GENERAL

The work under this section consists of supplying, installing, and commissioning of all material and services of the complete conduits and pipes.

The Contractor shall discuss the layout with the Engineer and co-ordinate at Site with other services for exact route, location and position of the conduits and pipes for electrical lines.

The Contractor shall ensure exact location and route of conduit and pipes as per site requirements and as directed by the Engineer.

6.2. APPLICABLE STANDARD/CODES

Latest editions of the following standards / codes shall be applicable for the materials in scope of this Section:

BS 6099	-	PVC conduits and accessories.
BS 3595	-	PVC pipes & accessories.
BS 4346	-	Cement Solvent for jointing

PUNJAB MASSTRANSIT AUTHORITY

7. POWER TRANSFORMER

7.1. GENERAL

The work under this section consists of design, manufacturing, fabrication, supplying, installation, testing & commissioning of all materials and accessories for the complete Power Transformers.

The transformers shall be complete, with all accessories and attachments. The Contractor shall discuss the electrical layout with the Engineer and co-ordinate at Site with other services for exact route, location and position of the equipment.

7.2. APPLICABLESTANDARDS/CODES

Latest editions of the following standards and codes shall be applicable for all materials in scope of this section:

BS90	-	Power transformers
BS14	-	Transformer oil
BS171	-	Specifications for power transformer
BS223	-	High voltage bushings
IEC 60076	-	Power transformers

7.3. COMPONENTS

The transformer shall be provided with the following accessories.

- Oil filling valve for vacuum filling of oil
- Oil drain valve with sampling device
- Bi-directional rollers
- Lifting lugs
- Dial type thermometer which shall have maximum temperature indicator pointer
- Stem type thermometer fitted in a pocket for indicating the oil temperature
- Diagram and rating plate
- Jacking pads
- Pressure release safety valve

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8. EARTHING

8.1. GENERAL

The work under this section consists of supplying, installing, testing and commissioning of all material and accessories of the complete earthing system

The Contractor shall discuss the electrical layout with the Engineer and Co-ordinate at Site with other services for exact route, location and position of the electrical lines and equipment.

The earthing system consists of earth electrodes, earthing leads, earth connecting points, earth continuity conductors and all accessories necessary for the satisfactory operation of the associated electrical system.

8.2. APPLICABLE STANDARDS/CODES

The latest editions of following standards/codes shall be applicable for the materials in scope of this section: -

BS 951	-	Earthing Clamps
CP 1013	-	Earthing
BS 2874	-	Nuts, bolts, washers, screws & rivets fixing.
BS 1433	-	Hard drawn bare copper conductor for earthing.
BS 6346	-	PVC insulated cables.

PUNJAB MASSTRANSIT AUTHORITY

9. LOW VOLTAGE SWITCHBOARDS

9.1. GENERAL

The work under this section consists of design, manufacturing, fabricating, supplying, installing, testing, and commissioning of all material and services of the complete LV (LV) switchboard for indoor installation.

The Contractor shall discuss the electrical equipment and power & control cables layout with the Engineer and co-ordinate at site with other services for exact locations and positions of the electrical lines and equipment.

9.2. LOW VOLTAGE SWITCHBOARD

The LV switchboard shall be sheet steel fabricated. The LV switchboard shall be totally enclosed, dust and damp proof. The LV switchboard shall be complete in all respects with material and accessories, factory assembled, tested and finished. The enclosures of LV switchboards and Bus Tie Duct shall be provided with rubber gasket and a lockable hinged door with cam fastener.

9.3. APPLICABLE STANDARDS/CODES

The latest editions of the following standards and codes shall be applicable for the materials specified within the scope of this Section:

IEC 947	-	Triple pole Air Circuit Breakers
BS 4752-1	-	Triple pole Moulded Case Circuit Breaker
VDE 0641	-	Single and Triple pole Miniature Circuit IEC 947 Breaker
IEC 947	-	LV Switch gear and Control gear
IEC 439	-	Factory Built Assemblies of LV Switchgear
IEC 4752	-	Switch gear and control gear for Voltages upto and including 1 kV
BS 88	-	HRC Fuses
IEC 73	-	Colors for indicator lights and push buttons.
IEC 446	-	Identification of insulated/bare conductors

9.4. COMPONENTS

The LV switchboard shall be provided with components as specified in these specifications.

Typical component specifications are given below: -

9.4.1. Bus Bars

The bus bars shall be made of high conductivity electrolytic copper and shall be completely isolated and mechanically braced for the specified fault level. The phase identification of bus bars shall be by colours applied on bus bars and these shall be red, yellow and blue for phases and white for neutral. The earth bus bar shall be green.

9.4.2. Moulded Case Circuit Breaker (MCCB)

The MCCB shall be moulded case. The MCCBs shall have fixed Magnetic Short circuit and fixed Thermal Overload protections. All incoming circuit breakers shall be MCCBs.

9.4.3. Air Circuit Breaker (ACB)

Air Circuit Breaker (ACB) shall be withdrawable metal-clad, flush mounted. Horizontal draw-out isolation and air break type suitable for installation on cubicle type of switchboard. They shall be three or four poles as specified. They shall consist of quick-make, quick-break, mechanically and electrically trip free mechanism to give double break in all poles simultaneously. The closing mechanism shall be stored energy type, either manually or electrically charged.

9.4.4. Miniature Circuit Breaker (MCB)

These shall have fixed magnetic short circuit and fixed thermal overload protections. The miniature circuit breakers shall have a short circuit breaking capacity as per international standards. These Circuit Breakers shall be suitable for working on lighting and power circuits.

9.4.5. Air Break Magnetic Contactors

The contactors shall be of air-break type, suitable for the duty required. The main contacts shall be silver-tipped, butt-type with double break per pole. Each contactor shall be provided with an AC operating coil and shall have a minimum of two normally open (NO) and two normally closed (NC) auxiliary contacts wired up to terminals. Additional auxiliary contacts shall be provided as required to meet the system requirements.

9.4.6. 9.4.6 Push Buttons

Push buttons shall be momentary make break contact type (normally open/normally close). These shall be suitable for flush mounting on switchboard, plastic faceplate etc. Push buttons shall have round/square head. These shall be of red color for 'ON' and green color for 'OFF' operations.

9.4.7. AC Voltmeters

AC Voltmeters shall be digital type and shall be suitable for flush mounting on front door of the switchboards.

9.4.8. Ammeters

AC Ammeters shall be digital type and shall be suitable for flush mounting on front door of the switchboards.

9.4.9. Voltmeter Selector Switch

The voltmeter selector switch shall be complete with front plate, grip handle, and RY-YB-BR-OFF-RN positions.

9.4.10. Ampere meter Selector Switch

The ampere meter selector switch shall be complete with front plate, grip handle, and R-Y-B-OFF positions.

9.4.11. Indicating Lamps

Indicating lamps shall be suitable for flush mounting, complete with base, neon lamp and shall have rosettes of suitable colour.

9.4.12. Current Transformers

Air-cooled, ring type current transformers shall be provided having transformation ratio. The current transformers shall be of suitable burden having accuracy class.

9.4.13. Line up Terminals

Line up terminals wherever provided for control of lighting, power and control circuits shall be suitable for voltage and size of conductors. The line-up terminals shall be suitable for channel mounting. All necessary accessories such as end-plates, fixing clips, transparent label holder caps and label sheets with marking shall be provided.

PUNJAB MASSTRANSIT AUTHORITY

LED ROAD LIGHTING

1.1 DESCRIPTION

The work includes supply, storage, installation, testing, and commissioning of poles, lighting fixtures, lighting control panels, transformers, cables, earthing, conduits, and related accessories as shown in Drawings and BOQ. Any minor items required for complete functionality shall be provided by the Contractor at no extra cost. Power supply for lighting will be taken from the nearest WAPDA source. All works shall be completed for proper and satisfactory operation.

The Contractor shall coordinate with the Engineer for exact locations of all electrical equipment.

1.2 GENERAL

Locations of poles, fittings, DBs, panels, transformers, and cables shown in drawings are tentative. Contractor must verify exact positions on-site and ensure proper light distribution after installation.

Installation shall comply with BS 5489, Pakistan Electricity Act, and WAPDA regulations. All materials shall be new, of high quality, and from reputable manufacturers. Components of each system shall preferably be from a single manufacturer or compatible with approved standards.

1.3 CONSTRUCTION OF POLES

Galvanized mild steel poles shall be manufactured as per drawings, with heights and outreach as specified. Poles may be one-piece or multi-piece with force-fit lap joints.

Poles shall be hot dip galvanized inside and outside per relevant standards. Fabrication surfaces must be properly cleaned before galvanizing.

Tolerances:

- Outside diameter: ±1%
- Wall thickness: ±10%
- Overall length: ±0.5%
- Weight: –0.3% / + not limited.

Poles must withstand 160 km/hr wind speed with safety factor 3, and deflection not exceeding 1/40 of the height above ground.

1.4 APPLICABLE STANDARDS

- ASTM A36 – Steel for pole and base plate
- ASTM A307 – Anchor bolts
- BS EN ISO 1461 – Hot dip galvanizing
- ASTM A123 & A385 – Galvanizing requirements

2.0 LUMINARIES

Technical Specifications of LED lights issued by Energy Department, Govt. of Punjab issued vide letter DOPP/252/LED/2014 dated May 20, 2014 (copy enclosed) shall be followed on the project in addition to the following:

1) The fixture shall offer composite system efficiency above 140 lumen/Watt (tolerance of +/-5%).

2) The complete fixture including all accessories shall have at least four (04) years warranty, after one year of Defect Liability Period (DLP), against any manufacturing defects and failures.

3.0 LIGHTING CONTROL PANEL

3.1 DESCRIPTION

The lighting control/distribution panel shall be a 14 SWG sheet steel, cubical, dust- and vermin-proof enclosure, factory-assembled and tested. It shall be suitable for front operation, easy maintenance, and installation on a concrete foundation with a detachable steel base frame. The panel shall provide adequate clearance from live parts, use components rated for minimum 600V insulation, and ensure front-access maintenance.

Photo-electric cell switches dust and water proof type and as per BS 5972 or WAPDA Specifications P-102 with upto date amendments.

All other components shall comply LV switchboard specifications.

INDOOR LED LIGHTING

All type of indoor LED light fixtures shall comply with the Punjab Energy Efficiency & Conservation Agency and National Energy Efficiency & Conservation Authority (NEECA) specifications.

A.General Requirements

1. Housing

The fixture shall have a full die cast aluminum housing providing adequate rigidity, strength and heat dissipation.

The housing shall have integrated driver and LED compartments for better heat dissipation and convenience in maintenance at the site, and shall feature highly reflective components and films to increase light output.

The optical LED compartment shall have thermally hardened (tempered) glass cover and high quality silicon gaskets. The glass shall be extra-white for maximum light transmission. The glass cover shall be tightly secured with the housing.

The fixture shall be rated for ingress protection class IP66.

2. Optics

The fixture for Group-I and Group-II shall have flexible optical systems for the wattage range in the respective group.

The fixture shall use high efficiency (greater than or equal to 90%) LED and optics system.

The light output ratio (LOR) shall not be less than 85%.

The fixture shall offer a composite system efficiency above 100 lumen/Watt.

The lens system design and high efficiency LED shall facilitate maximum spacing between the road lighting poles and coverage of wider roads {(according to Centre/Centre pole distance (in meters) and pole height (in meters) (to be filled in by procuring agency)}.

The multilayer optics design shall ensure adequate luminance and illuminance uniformity in the unlikely event of an individual LED failure.

PUNJAB MASSTRANSIT

The fixture shall offer choice of narrow, medium and wide beam light distribution.

The optical lens system shall feature long life with no discoloration (UV protection), highest possible light transmission and white painted circuit board for high reflectivity for maximum light output.

3. Surge Protection

The lighting fixture shall have separate surge protection to protect the electronic driver and LED system. Minimum surge protection rating shall be 10K.V.

4. IP Protection/Impact Resistance

The fixture shall have ingress protection class IP66 for long reliable performance and minimal maintenance requirement and an impact resistance of IK08 or above. No chemical glue shall to be used as that may cause breakdown of water-proof and dust-proof seal._AII synthetic materials shall be 100% UV Stable and scratch resistant.

5. Maintenance

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Both the driver and LED compartments shall be designed to be easily accessible for maintenance. Whatever method of securing/assembling of fixture used screws/ clamps, it is to be ensured that the fixtures are manufactured so that frequent opening/closing at site during maintenance does not compromise its ingress protection (IP) rating and the various components like terminal blocks, LED drivers etc are not dislocated from their designated position.

Gas Kets are to be properly secured in special groves made for the same and must not be fixed to the body by any adhesive material.

The components like LED drivers, terminal blocks etc must be easily detachable by using plug and play connectors/terminals to ensure ease of replacement at site and to be secured in the body of the fixture making special mounting arrangements so that the same are not dislodged/dislocated from their designated position.

6. Mounting

The mounting of the fixture shall be in axial orientation through suitable sized sidearm. The means for attaching the luminaire or external part to its support shall be appropriate to the weight of the luminaire of external part. The connection shall be designed to withstand wind speeds of 160km/h on the project surface of the assembly without undue deflection.

7. Future Compatibility

The fixture shall be fully compatible with future LED upgrades when they become available. It shall have a modular design to upgrade/replace with new LED modules or LED drivers at site conveniently with minimum effort. All electronic components/drivers shall be mounted on a separate tool-less gear-tray. LED compartment shall have a easy access for opening the glass cover.

B. LED Driver/Electronic Control Gear for LED Modules

The LED driver shall be designed to operate large array of high powered LEDs through current controlled output. The driver shall be suitable for 230V, +10%, -15%, 50Hz, single phase mains AC supply.

The LED driver shall have an efficiency of at least 85%.

The LED driver shall have energy saving/dimming options. So, that the driver can be easily programmed at site in a manner that different output wattages are available from the same fixture as per requirements. In the late night mode the fixture can thus be operated at various reduced wattages as per traffic conditions to have an energy efficient use.

The LED driver shall be Harvard, TCI, Phillips, Lumotech, VOSSLOH Schwabe or Lightech Make or equivalent (duly type tested as specified and full in conformance to the technical requirements/specifications).

The driver shall be rated for ingress protection class IP65

Drivers shall have a Power Factor (PF) of L: ≥ 0.90

a. LEDs

The LED chip shall be Philips Lumiled, Cree, Nichia or Osram make or equivalent (duly type tested as specified and in full conformance to the technical requirements/specifications).

The LEDs shall:

1. Be designed for lumen maintenance of L70 or 70% at the end of useful life at ambient temperature of 35 deg C.
2. Have a useful life of 50,000 burning hours at 50°C with certified by TM21 report.

- Have a minimum color rendering index (Ra) of 70(± 10) and a color temperature above 5000K and preferable 6500K.

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3. Have a color consistency within 7SDCM (Standard deviation of color matching) as defined by Mac Adam.

The bidder shall submit LED manufacturer authorization for the usage of its LED in the fixtures manufactured by them.

b. Thermal Management

Managing thermal properties in LED fixtures is most critical to ensure optimum performance of LEDs and reliability of the system.

The housing under the circuit board shall be specially designed to ensure perfect contact between the board and the fixture housing for efficient heat dissipation.

Only metal core PCBs shall be used to maximize heat transfer process and to offer reinforced electrical insulation via dielectric layer. The metal core PCB shall be mounted on the housing using a highly efficient thermal interface material. Use of silicon glue is not acceptable.

The housing over the driver chamber shall have additional ribs to ensure direct contact with the drivers. The housing shall have adequate surface area to ensure fast heat dissipation.

c. Photometrics

Fixtures shall have illumination Engineering Society (IES) Type II or III distribution pattern, with short or medium longitudinal distribution.

LM-80 LED and photometric test reports and IES files from a third party testing laboratory shall be available.

d. Warranties

The complete fixture including all accessories shall have at least three (3) years warranty, after one year of defect liability period (DLP), against any manufacturing defects.

e. Applicable Standards and Codes

The fixtures shall conform to the following latest standards and codes. It shall be the mandatory requirement that the bidder shall submit detailed type test reports from certified international testing agency/laboratory/body to establish its conformance to the specified international standards:

1. IEC 60598-1
2. IEC 60598-2-2
3. IEC 60598-2-3 (Road Lights)
4. LM-79 for the luminaries being offered
5. LM-80 for LED chips being used
6. **LM-82-12** - Approved method of measuring LPW @ 50°C.
7. IEC 62471 (Photo Biological safety test for the complete fixtures being offered as well as for LED Chips)
8. EN 55015: 2006 and 2007-Limits and methods of measurement of radio disturbance characteristics of electrical lighting.
9. EN 61547: 1995 / +A1 : 2000-Equipment for general lighting purpose EMC immunity requirements
10. EN 61000-3-2: 2006- Limitation of harmonic current emission
11. EN 61000-3-3: 2008- Limitation of voltage fluctuation and flicker
12. EN 62493- Assessment of Lighting Equipment related to human exposure to electromagnetic field (Environmental friendly)
13. IK test report—IEC 62262
14. Thermal Management Test (UL 1598)
15. **IESNA** (Illuminating Engineering Society of North America) - Lighting Handbook 10th Edition.

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16. **CIE** (International Commission on Illumination)
17. **IESNA RP-08** (reaffirmed 2005) - Roadway Lighting.
18. **CIE 115 -2010** – Lighting of Roads for Motor and Pedestrian Traffic.
19. **IESNA RP-19-01** - Roadway Sign Lighting.
20. **IESNA RP-20-98** - Lighting for Parking Facilities.
21. **CIE 129** – Guide for Lighting Exterior Work Areas.
22. **IESNA DG-19-08** - Design Guide for Roundabout Lighting.
23. **IESNA TM-16 -05** - Technical Memorandum on Light Emitting Diode (LED) Sources & Systems.
24. **IESNA DG-4-03** - Design Guide for Roadway Lighting Maintenance.
25. **IESNA RP-16-10** - Nomenclature & Definitions for Illuminating Engineering.
26. **IEC 60529** or **EN 60 529** (IP) and **EN 50 102** (IK) - Degrees of Protection Provided by Enclosures (IP Code for ingress protection and IK Code for Mechanical Strength)
27. **ANSI/NEMA/ANSLG C78.377-2008** - American National Standard for Chromatically of Solid State lighting products.
28. **CIE 126-1997** Guidelines for Minimizing Sky Glow and IESNA **TM-10** Addressing Obtrusive (Urban Sky Glow and Light Trespass) in conjunction with Urban Lighting.
29. **JEDEC** - Joint Electron Device Engineering Council.
30. **ASTM** - American Society for Testing of Materials.
31. **ASTM B 117-07a** - Standard Practice for Operating Salt Spray (Fog) Apparatus, 2007 or **ISO** International Organization for Standardization.
32. **ISO 9227** - Corrosion tests in artificial atmospheres (Salt spray tests, 2006)
33. **IEC 60068-2-68 ed1.0** - Environmental testing - Part 2: Tests - Test L: Dust and Sand.
34. **ANSI C82.77-2002** - Harmonic Emission Limits & **IEEE Std 519** 1992 - Harmonic Limits.
35. **General Guidance of Gulf Specifications and applications**.

The LED driver shall conform to the following standards and codes:

1. EN 61347-1: LED control gear general and safety requirements
2. EN 61347-2-13: particular requirements for DC or AC supplied electronic control gear for LED modules
3. EN 62384: DC or AC supplied electronic control gear for LED modules performance requirements.

f. TECHNICAL AND DESCRIPTIVE DATA AND DRAWINGS

Technical and descriptive data and drawings to be submitted shall include not be limited to the following:

1. Technical data of fixtures and driver
2. IES photometric file
3. LM-79 test report for each of the fixture type/wattage being offered.
4. LM-80 test report for LED used.
5. Lumen description test report at 1000, 2000, 3000, 6000 burning hours.
6. 3rd party IEC 60598 test report
7. Vibration test report
8. EMC test report
9. Salt spray test report
10. Photo-biological safety test report
11. Customer testimonials
12. Factory ISO certificate
13. Reports of other type tests stipulated in the respective standards/codes

g. International Independent Laboratories

For the specified requirements of type tests and type test reports by an independent authority/independent laboratory(specific to their status/approval for performance of specific tests) on the fixtures as defined in the project), the following laboratories shall be considered as independent laboratories:

1. KEMA Labs, Holland.
2. CESI Labs, Italy.
3. CRIEPI Labs, Japan.
4. Any other laboratory accredited by EA (European CO-Operation for Accreditation) or a member thereof.
5. Any other laboratory accredited by ILAC (International Laboratory Accreditation CO-Operation) or a member thereof.
6. Any other laboratory accredited by IAF (International Accreditation Forum) or a member thereof.
7. Any other laboratory accredited by STL (Short-Circuit Testing Liaison) or a member thereof.

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Section Officer
LG&CD Department

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ESTABLISHMENT OF TOURIST GLASS TRAIN FROM RAWALPINDI / ISLAMABAD TO MURREE

EMPLOYER'S REQUIREMENTS



AUTOMATIC PLATFORM GATE (APG) / PLATFORM SCREEN DOOR (PSD) WORKS

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AUTOMATIC PLATFORM GATES (APG) SYSTEM

1. PROJECT DESCRIPTION

The specified monorail system between the urban city of Rawalpindi/Islamabad and the hill station of Murree is likely to change the dynamics of tourism in the region and can easily able to provide reliable means of transport. Among the main benefits of monorail, one can distinguish that it can work without the heavily overloaded road system. The purpose is to ensure that the journey to Murree is a transformational, experiential aspect of the entire tourist experience in terms of scenic as well as comfortable train travel.

2. GENERAL

All materials, components units and equipment of Automatic Platform Gates (APG) systems for stations shall be designed, furnished, installed, tested and commissioned in accordance with codes and standards given in this document as well as the requirements specified. The specifications state the minimum requirements for the equipment, which shall be valid.

3. APG SCOPE OF WORKS IN GENERAL

The scope of work comprises designing, engineering, preparation of shop drawings, procurement, manufacture, testing, transport, erection, installation, obtaining approvals and completion of the APG works including relevant electrical and civil works. The work covered by this part of the specification shall include but shall not be limited to the following items:

A- DESIGN

a. Supply, shop-fabrication, delivery, installation, testing, commissioning, training, Operation & maintenance support and warranty of Automatic Platform Gates (APG)/ Platform Screen Doors (PSD) at all stations indicated in the Works Drawings.

b. Works include: structural supports, gate panels/frames, mechanical drives, sensors, gate control cabinets, local HMI, track side/train interface units, network/SCADA integration, power & UPS, interlocks with signalling/ATO, spares, documentation and training.

c. Conform to applicable national railway standards and internationally recognized guidance for PSD/APG systems and electrical/mechanical safety. Where national standards are silent follow best-practice references.

d. Door type & arrangement — specify full-height, half-height or waist-height APG per station type as shown in drawings; gates must be modular for replacement/retrofit.

e. Operation & timing — gates shall open/close synchronized with train passenger doors. Timing difference shall be constant and adjustable across stations; opening/closing speeds shall be within agreed tolerances (e.g., 2.5–4.0 s typical) to ensure passenger flow and safety.

f. Obstruction detection & safety — gates must detect and prevent closure on trapped objects or persons (including detection of gaps > specified mm and compression behaviour for smaller gaps). System must automatically stop/reverse on obstruction and alarm.

g. Interlocks — mechanical/electrical interlock with train doors and signalling system (CBTC/ATO or wayside signalling). Where signalling commands fail, provide secure authorized local controls for staff to operate gates.

h. Operation modes — include Normal (automatic), Manual (for staff), Emergency (fail-safe open or locked as required), and Maintenance modes.

i. Passenger safety — gates must prevent unauthorized access to track and minimize risk of falls; height and gap dimensions must consider local risk profile (full-height preferred for underground; half-height can be used where ventilation/visibility needed).

j. Visual & tactile aids — integrate LED indicators, audible warnings and tactile warnings near gate edges where required for people with disabilities.

k. Emergency egress — gates must permit emergency escape/unlocked egress in accordance with fire & evacuation rules; include manual emergency release accessible to authorized staff.

l. Structural capacity — gates, rails and supports sized for static and dynamic loads (including crowd loads, wind for elevated platforms, seismic per local code).

m. Materials & finish — corrosion-resistant materials suitable for environmental exposure (stainless steel/aluminium + tamper-resistant fixings). Glass/panels to be tempered & laminated safety glass minimum 10mm thickness or approved alternative depending upon span and wind load.

n. Clearances & gap — define maximum allowable gap between APG and train body and between adjacent modules (specify numeric tolerances).

o. Power supply & UPS — supply must include UPS (or local battery backup) sized to safely operate gates for a minimum specified time during power loss to allow safe passenger evacuation.

p. Control architecture — distributed control with local PLCs and redundant communications to OCC/ATO as required. All commands logged and time-stamped.

q. Signalling interface — explicit signalling protocol & physical interface shall be defined (e.g., door command lines, CBTC messaging). Provide necessary train-borne and wayside interface units.

r. Network & cybersecurity — comply with project ICT/cybersecurity policies; encrypted comms and access control for operator HMI.

s. Sensors — door-edge sensors, light curtains or optical scanners, position encoders, speed sensors and loop/pressure seals as appropriate.

t. Diagnostics & monitoring — provide remote monitoring, fault logging, health-status dashboards and alarms to OCC. Define alarms priority levels and notification paths.

u. The Contractor is responsible for coordination with Rolling Stock, Signalling, Civil & Stations packages for interface design and installation.

v. The APG/PSD system shall be properly earthed and bonded in compliance with IEC 60364, IEC 61992, and project electrical safety standards.

w. Penalty/liquidated damages for missed milestones, and performance penalties for non-meeting of agreed availability or safety requirements.

x. Gates and electronics rated for local ambient temperature, humidity, dust and pollution levels; specify IP rating for enclosures (e.g., IP54 or higher as required).

B- INSTALLATION

a. Preparation and submission of shop drawing (coordinated detail design drawings after coordination with all services) including installation details for approval.

b. Submission of equipment technical submittal as per approved design, manufacturer catalogues, certificates and sample testing etc. All information must be in English. All procurement shall be made as per approved technical submittal only.

c. All relevant civil works including opening, cutting, patching, repairing, masonry and concrete works, foundations, vibration isolator for APG equipment is in scope of contract.

d. Where retrofitting or first-installation on a new fleet, supply a trial/proto installation at a nominated station for operational validation prior to bulk supply. (if applicable)

e. Protecting coats of paint and coating against corrosion for equipment and other components complete in all respect.

f. Provide all security and safety measures during installation phase and O&M period.

C- TESTING & COMMISSIONING

a. Factory Acceptance Test (FAT) — manufacturer to perform FAT for gate modules, controllers and interfaces; provide FAT scripts, results and witness opportunity.

b. Pre-Shipment Inspection - complete APG/PSD system package inspection at the manufacturer's premises, including all boarding, lodging, travel (air tickets), and TA/DA for the Employer's nominated representatives for witness inspection activities.

c. Site Acceptance Test (SAT) — complete integration tests with rolling stock, signalling and OCC; test all operation modes, obstruction detection, fail-safe behavior, and recovery from power/signal failures.

d. Performance acceptance — verify gate timing, synchronization, and reliability metrics under normal and degraded modes.

e. Functional test, starting-up, initial operation, reliability test and performance test by qualified personnel of the Contractor in the presence of the Employer or his representative,

f. Clearing of faults and damage during the Warranty Period,

g. Maintenance concept — define preventive and corrective maintenance procedures, man-hours required, recommended spare parts list covering Defect Liability Period (DLP) of two (02) years, special tools and diagnostics.

h. Training — provide factory training for operations & maintenance staff, plus training materials and O&M manuals (electrical/mechanical/software).

i. Manufacturer Warranty & support — minimum manufacturer warranty period (24 months after successful SAT) with defined response times, technical support SLA and extended support options.

j. As-built drawings, wiring diagrams, software/firmware version lists, interface control documents (ICD) with signalling/rolling stock, FAT/SAT test reports, MTBF/MTTR calculations, and maintenance manuals.

k. Provide source code/builds for safety-critical control software per project policy.

D- HANDING OVER/TAKING OVER

a. Complete instruction manuals including table of contents, description of all operating, control, indicating, switching, alarm and interlock functions and conditions, completed with schematic and detailed graphical presentations, as well as instructions and directions for setting, going, interruption of operation, supervision, effective and economical operation, arrangements for repair, error detection and determination, correction and elimination of errors and of defects servicing schedules, repair and maintenance guides.

b. Lists of provided spare parts, tools, consumables, substitute materials and working stock availability required to run the APG/PSD system after taking over by the Employer/Employer's representative.

c. Detailed program for the training of the Employer's personnel and staff in the operation, service, repair and maintenance of the whole plants after final submission and approval of all above mentioned documents.

4. INTERNATIONAL STANDARDS CODES AND STANDARDS REQUIREMENTS

Following standards or equivalent international standards (in English) shall be fully complied by Contractor and their offered equipment/material:

IEC 60947-5-1:	Low-voltage switchgear and control gear
IEC 60529:	Degrees of protection provided by enclosures (IP Code)
BS 5512:	Specification for rolling bearings - dynamic load ratings and rating
BS 4675:	Mechanical vibration in rotating machinery. Requirements for
BS 1615:	Specification for anodic oxidation coatings on aluminium
IEC60034-1:	Rotating electrical machines - Part 1: Rating and performance
IEC 60034-11:	Built in thermal protection for electric motors rated up to 660 V ac
IEC 60085:	Electrical Insulation - Thermal Classification,

Minimum Qualification Requirement of Main Contractor/APG Sub Contractor:

i. Registered with Pakistan Engineering Council in relevant category.

ii. Minimum experience as Contractor in the execution of at least One (01) Mass Transit System (MTS) projects of similar nature and complexity within last fifteen (15) years; this experience should include supply, installation, testing and commissioning and operation & maintenance of APG/PSD system.

LIST OF RECOMMENDED MANUFACTURERS FOR ITEMS/ MATERIALS/EQUIPMENT OF APG/PSD WORKS

The Bidder should note that only Equipment/materials from the following approved manufacturers or approved equal shall be allowed to be used on this Project provided their products meet the specified requirements. Any approved or approved equal brands will be accepted only after meeting requirements of prequalification.

For Imported Items, Please note that complete APG/PSD system including control works, door controller, HMI, interconnecting cables, housings, glass, control and power cabinets, UPS, Transformers, station sensors and their interconnecting cables etc shall be supplied from Door manufacturers as a package. The other items are mentioned below.

SR. NO.	EQUIPMENT/ MATERIAL	RECOMMENDED MANUFACTURER/ SUPPLIER OR APPROVED EQUAL	COUNTRY (origin, manufacturing, assembly, testing & supply)
1.	APG/PSD	ADIS GRUPSA MANUSA CNYD	AUSTRAILIA SPAIN SPAIN CHINA
2.	Low Voltage Panel Distribution Board (DB)	SIEMENS PEL BILAL SWITCHGEAR MESI ERCON ELMETEC JEI QUALITY SWITCHGEAR	PAKISTAN
3.	LV and Control Cables	PAKISTAN CABLES	PAKISTAN

	and Wires (600/1000V)	PIONEER CABLES NEWAGE CABLES FAST CABLES	
4.	PVC Conduit and Accessories	POPULAR DADEX IIL MASTER	PAKISTAN
5.	Steel Conduit and Accessories	HILAL INDUSTRIES ILL JAMAL PIONEER ASHRAF INDUSTRIES	PAKISTAN
6.	MCCBs, MCB	SIEMENS ABB LEGRAND TERASAKI PANASONIC TELEMECANIQUE GREEN POWER SCHNEIDER ELECTRIC	FRANCE/GERMANY/ ITALY/JAPAN
7.	Magnetic Contactors	ABB PANASONIC GREEN POWER TELEMECANIQUE	ITALY/FRANCE/JAPAN
8.	ACBs, ELCBs	ABB SIEMENS TERASAKI LEGRAND SCHNEIDER ELECTRIC	ITALY/GERMANY/ FRANCE/JAPAN
9.	Relays and Timers	FINDER INTER	ITALY/TURKEY
10.	PFI Relays	NOKIAN ENTES	FINLAND/JAPAN/ TURKEY
11.	Voltmeters/Ammeters	CIRCULOR REVALCO INTER ENTES	ITALY/TURKEY
12.	Selector Switches/Push Button	KRAUS & NAIMER ABB LEGRAND REVALCO BOSCH, CLIPSAL	SWEDEN/FRANCE/ ITALY

13.	Indication Lamps	LEGRAND BRETER ABB TELEMECANIQUE	FRANCE/ITALY
14.	Terminal Blocks	LEGRAND ABB PHOENIX CABOUR	FRANCE/ITALY/JAPAN
15.	LV Change over Switch Capacitors	SOCOMEC, ABB, AMBER, NOKIAN, DUCATI	FRANCE/GERMANY/ JAPAN/PAKISTAN
16.	Paint	ICI, MASTER PAINTS, BERGER, NIPPON, GOBIS,	PAKISTAN
17.	Fasteners, Hanging Rods, Rawal Plugs etc.	FISHER , HILTI, SPIT, SIKLA, INKA, MUNGO, NORM, INDEX	AS PER MANUGACTURER'S FACILITY.
18.	Gateways Module, HMI, Sensors, cables etc	PREFERABLY MANUFACTURE PROVIDED OR DELTA CONTROLS JHONSON CONTROLS SEIMENS T.A.C HONEYWELL	AS PER MANUFACTURER / USA / CANADA /West Europe
19.	Glass (tempered and laminated)	GUARDIAN GUNJ GLASS TARIQ GLASS PAKISTAN SAFETY GLASS GLASS WORLD LAKHANI GLASS	UAE / PAKISTAN
20.	All equipment/ Materials other than stated above	Make and Country of Origin approved by Engineer	

NOTE 1: ALL EQUIPMENT/MATERIAL MUST BE SUPPLIED FROM AUTHORIZED/SOLE DISTRIBUTORS. MANUFACTURERS AUTHORIZATION CERTIFICATE IN ORIGINAL MUST BE PROVIDED.

NOTE 2:

For all approved equivelent manufacturer shall meet the minimum following criteria:

- Minimum twenty (20) years of international experience for same offered equipment.
- Minimum five (05) years national experience with local authorization representative and after sale service available in Pakistan.

- Compliance with international standards/codes of APG works applicable to relevant equipment.
- Most energy efficient equipment/model available in market and offered for the project.
- Testing facilities as per project requirement.
- Verifiable list of minimum two (02) projects in last ten (10) years in Pakistan. (Except APG/PSD SYSTEM)
- All major parts shall be supplied from the manufacturers' best source available in international market.
- International certificate of performance of proposed equipment/model available as per international standards.

NOTE: ALL EQUIPMENT/MATERIALS OTHER THAN STATED ABOVE SHALL BE SUBJECT TO PRIOR APPROVAL OF THE ENGINEER IN RESPECT OF MAKE & COUNTRY OF ORIGIN.

Initials of Signatory to Bid: _____

PUNJAB MASSTRANSIT AUTHORITY

ESTABLISHMENT OF TOURIST GLASS TRAIN FROM RAWALPINDI / ISLAMABAD TO MURREE

EMPLOYER'S REQUIREMENTS



HEATING, VENTILATING AND AIR-CONDITIONING SYSTEM

December 2025

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ESTABLISHMENT OF TOURIST GLASS TRAIN FROM RAWALPINDI / ISLAMABAD TO MURREE

HEATING, VENTILATING AND AIR-CONDITIONING SYSTEM

1. GENERAL

All HVAC materials, components, units, and equipment shall be designed, furnished, installed, tested, and commissioned in accordance with internationally recognized standards and the requirements of this document. This specification defines the minimum requirements for HVAC systems for the Islamabad–Murree Monorail Project, covering all stations, administrative areas, and depot facilities. Any equipment or accessories necessary for proper and reliable operation, even if not explicitly mentioned, shall be included in the Contractor's scope without additional cost. The EPC Contractor shall provide all works as part of the contract and shall not be entitled to extra payment.

2. CODES AND STANDARDS REQUIREMENTS

All systems and equipment forming part of the work shall be designed and constructed according to the latest relevant and international recognized codes and standards, as ASME, DIN, IEC, AHRI, SMACNA, NEPA, AMCA, ASTM, NEMA, I.E.E, TIMA, NFPA, Eurovent, or as listed in the "ASHRAE HANDBOOKS", latest editions.

3. SCOPE OF WORKS

The scope of work comprises designing, engineering, preparation of shop drawings, procurement, material testing, transport, erection, installation, testing, commissioning and acceptance obtaining approvals, if any, and completion of the HVAC works including relevant electrical and civil works. In general, the scope of work shall include the following items:

A. DESIGN

a. Submission of HVAC Load calculation on HAP, ventilation & static pressure calculation, Humidification calculations for winter season, Equipment Schedule, Bill of Quantities, HVAC equipment selection and design drawings for ducting piping etc. for approval.

b. Provision of Eurovent Certified Heating, ventilation and air-conditioning (HVAC) equipment. The proposed equipment VRF shall be high efficient as per ASHRAE 90.1 or equivalent and EER shall not be less than 10.

c. Critical Areas such as IT/Server Room, Monitoring Room and UPS Room shall be provided with 100% redundancy, as per actual heat dissipation load.

d. Battery/UPS Room shall be designed at 100% exhaust with special exhaust fans in order to avoid corrosion. The Air Conditioning shall be provided with stainless steel duct connected with ducted indoor units.

e. Design drawings shall include maximum information for installation. The information shall include but not limited to duct system with diffusers, grills, dampers, thermal insulation, Volume dampers, Fire dampers for fire zones, refrigerant piping, Low voltage (LV) power distribution and cabling, electrical works for main LT Panel to downstream of HVAC system including cabling, panels, conduits, breakers, etc.

f. Earthing of all metal parts of the complete air conditioning plant.

g. Draining system for all HVAC equipment and catch pit where required, including

all necessary accessories.

B. CONSTRUCTION

a. Preparation and submission of shop drawing (coordinated detail design drawings after coordination with all services) for approval.
b. Submission of equipment submittal as per approved calculation including selection sheet, manufacturer catalogues, certificates etc. All information must be in English. All procurement shall be made as per approved technical submittal only.
c. All relevant civil works including opening, cutting, patching, repairing, masonry and concrete works, foundations, vibration isolator for HVAC equipment foundation, drain layout etc. is in scope of contract.
d. All sheet metal duct work shall be of a standard construction and erected in a first class workmanlike manner. The duct work shall be constructed as per SMACNA Low Velocity Duct Construction Standards.
e. The delivery and installation shall not be limited to the above-mentioned parts. All deliveries and installations not particularly specified shall be added to ensure fully functioning systems and to meet the latest technical experiences and standards.
f. Protecting coats of paint and coating against corrosion for equipment and other components complete in all respect.
g. Port/warehouse inspections of major HVAC equipment as approved by the Employer's Representative.
h. Provision of all necessary documents for review and approval by the Employer's Representative before starting up.
i. Provide all security and safety measures during installation phase and O&M period.

C. TESTING & COMMISSIONING

a. Setting, adjusting, and balancing of all HVAC equipment and system.
b. Pressure test of Refrigerant piping system
c. Functional test, starting-up, initial operation, reliability test and performance test by qualified personnel of the EPC Contractor in the presence of the Employer's Representative,
d. Clearing of faults and damage during the Warranty Period,
e. All necessary spare parts, tools, devices, working and substitute material such as filter media, refrigerants, special detergents, oil and grease, corrosion inhibitor, fusible link, etc. for an uninterrupted, trouble-free operation.
f. As-built drawings marked-up, (coloured), diagrams, schedules and lists, showing all variations from the original approved documents.

D. HANDING OVER/TAKING OVER

a. Complete instruction manuals including table of contents, description of all operating, control, indicating, switching, alarm and interlock functions and conditions, completed with schematically and detailed graphical presentations, as well as instructions and directions for setting, going, interruption of operation, supervision, effective and economical operation, arrangements for repair, error detection and determination, correction and elimination of errors and of defects servicing schedules, repair and maintenance guides, lubrication charts and lubricating instructions.
b. Lists of provided spare parts, tools, special appliances, consumables, substitute materials and working stock required to run the complete HVAC plant 5 years after taking over by the Employer's Representative.
c. Detailed program for the training of the Employer's Representative's personnel

and staff in the operation, service, repair and maintenance of the whole plants after final submission and approval of all above mentioned documents.

d. After the training of the Employer's Representative's personnel and staff has been completed satisfactorily, the EPC Contractor shall submit all training minutes to the Employer's Representative, signed by all trained persons in order to confirm and verify the success of his training efforts.

4. DOCUMENTS/INFORMATION REQUIRED FOR APPROVAL

The EPC Contractor shall obtain approval of following items and execute project accordingly:

a. Design calculations along with design drawings for all areas.
b. Technical submittal for HVAC Equipment/ Material
c. Shop Drawings
d. Testing protocols
e. Samples of HVAC material
f. As-built drawings.

5. HVAC SYSTEM FOR SLAMABAD–MURREE MONORAIL PROJECT

5.1 Train Stations

The stations consist of two levels. Accordingly, the HVAC system required for these levels is described below;

5.1.1 Level 1 (Entry Level)

Facilities

This level includes not only the recreational and operational areas but all back-office facilities which are as follows;

- lounge,
- rest area,
- prayer hall,
- shops,
- offices,
- Command & Control Room,
- IT Server Room, and
- Toilets

HVAC Requirements

- All Level 1 spaces shall be air-conditioned in accordance HVAC Design Criteria (Section 7). The indoor units for offices/individual shall be ceiling concealed type or ducted type as per site conditions.

- Fresh air for the spaces shall be provided through DX-type Fresh Air Units, The minimum required outdoor air in accordance with ASHRAE Standard 62.1 or applicable local ventilation code. Flirtation requirement for the outside shall be as per ASHRAE Standards.

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- Redundancy shall be provided for:

  1. IT Server Room (N+1 minimum)
  2. Command & Control Room (N+1 minimum)

- Toilets, Store rooms and record rooms shall be ventilated using mechanical exhaust fans in accordance with the accordance with ASHRAE recommendations.

5.1.2 Level 2 (Platform Level)

The platform level is open from both sides, hence the nature ventilation shall be adequate to maintain the temperature in comfort range.

5.2 Depot Areas

The administrative areas including Command & Control Center, offices, etc. in depot areas shall be provide with the Air conditioning.

HVAC systems may be VRF or packaged type, designed per actual heat loads and occupancy.

Toilets, Store rooms and record rooms in the depot areas shall have exhaust fan for ventilation.

5.3 Sub-Station Buildings

The electrical and its ancillary rooms shall be provided with the mechanical ventilation system.

The administrative office areas shall be provided with the Split Air conditioning.

Toilets, Store rooms and record rooms in the shall have exhaust fan for ventilation.

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5.4 Control Requirement

An LCD type central controller shall be provided with VRF Units with option of fan speed, time schedule, temperature settings, mode selection, automatic storage of all settings when power off, etc.

Indoor units and Fresh Air Units shall also be provided with individual remote Control having features of ON/OFF, Temperature Control, Mode setting, etc.

Controls for DX type fresh Air Units as per satisfaction of Employer's Representative shall be provided.

The Control System shall be microprocessor based. It can be programmed to control the function of every device within the HVAC System.

6. DESIGN CONDITIONS AND DESIGN DATA

6.1 Design Ambient Condition

a) Summer dry Bulb Temp: 115°F
b) Coincedent Wet Bulb Temp: 84°F
c) Daily range: (Max.) 31 °F
d) Winter Dry Bulb Temp: 14°F
e) Wind Velocity:
- Summer 15 KPH
- Winter 22 KPH

f) Equipment Operating Temp: 14 °F - 115°F

The design conditions of the HVAC systems shall be carried out in consideration of the basic design concept which is mentioned in this section and entire specifications.

6.2 Indoor Design HVAC Criteria

The entire HVAC systems shall be carried out in consideration of the design indoor criteria as per ASHARE which are mentioned in this section;

Sr. No.	Area	Temp. (ºF) Cooling/Heating	Rel. Humidity (%) Cooling/ Heating	Noise Level dB(A)	Control by A/C
1.	UPS Room	79/72	50%/35%	40	Ducted VRF Type A/C with 100% redundancy
2.	Command & Control Room	75/72	50%/35%	40	VRF units with Conditioned Fresh Air Provision
3.	IT/Server Room	68-72	50%/40%	40	Ducted VRF Type A/C with 100% redundancy
4.	Offices/ Conference Room/Board Rooms	75/72	50%/35%	35	VRF System with Conditioned Fresh Air Provision (Heat & Cool)
5.	Prayer Room	75/72	50%/35%	35	VRF Units with Conditioned Fresh Air Provision (Heat & Cool)
6.	Driver Room	75/72	50%/35%	35	VRF Units with Conditioned Fresh Air Provision (Heat & Cool)
7.	Any other Room/Offices (if required by Client)	75/72	50%/35%	35	VRF Units with Conditioned Fresh Air Provision (Heat & Cool)

6.3 Ventilation Criteria

The ventilation shall be done as per criteria mentioned below;

Sr. No.	Area	Air Changes per hour (ACH)	Standards
1	Kitchen & Tea Room	25	ASHRAE 62.1
2	Toilets	20	ASHRAE 62.1
4	Store/Utility spaces	4	ASHRAE 62.1
5	UPS/Battery Room	6	ASHRAE 62.1
6	Electrical Rooms	6	ASHRAE 62.1

7. EQUIPMENT/MATERIAL SELECTION

All equipment/material must be supplied from authorized/sole distributors only. Manufacturer's valid authorization certificate must be provided by the Contractor.

Offered HVAC equipment shall meet the following requirements:

- Experience record of Principal Manufacturer in international market for proposed equipment shall be minimum 25 years.
- Experience of local sole/authorized distributor in Pakistan shall be minimum 7 years with same manufacturer.
- Compliance statement of specifications from the equipment manufacturer.
- Unit(s) shall be variable refrigerant flow (VRF) high ambient type (115°F operable), remote, air-cooled condensing unit, factory assembled, tested, cooling/heating, all DC inverter type, with multiple units connected through distributers/Y-connectors to outdoor unit. The unit shall be Eurovent Certified.
- The VRF Units shall be manufactured and supplied from Plants owned by Principal Manufacturer. Confirmation of the same shall be provided by Principal Manufacturer.

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ESTABLISHMENT OF TOURIST GLASS TRAIN FROM RAWALPINDI / ISLAMABAD TO MURREE

EMPLOYER'S REQUIREMENTS



FIRE FIGHTING WORKS

December 2025

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FIRE FIGHTING SYSTEM

1. PROJECT DESCRIPTION

The specified monorail system between the urban city of Rawalpindi/Islamabad and the hill station of Murree is likely to change the dynamics of tourism in the region and can easily able to provide reliable means of transport. Among the main benefits of monorail, one can distinguish that it can work without the heavily overloaded road system. The purpose is to ensure that the journey to Murree is a transformational, experiential aspect of the entire tourist experience in terms of scenic as well as comfortable train travel.

2. GENERAL

Fire protection systems shall be provided to protect life, property, equipment, and operation of the complete project including stations, depot facilities and substations.

The fire-fighting systems shall include, but not be limited to the following:

- Portable Fire Extinguishers,
- Firefighting water storage
- Firefighting pumps,
- Fire water ring main system, including hydrants and standpipe systems
- Automatic Sprinkler System
- Automatic Gas Extinguishing System

The systems shall be complete with all necessary piping, pumps, valves, mobile equipment, safety devices etc.

All materials, components units and equipment of Fire Fighting systems shall be designed, furnished, installed, tested and commissioned in accordance with codes and standards given in this document as well as the requirements specified. The system shall comply with all technical requirements specified herein, in addition to any supplementary technical requirements not explicitly detailed in this document.

3. INTERNATIONAL STANDARDS CODES AND STANDARDS REQUIREMENTS

Following NFPA standards or equivalent international standards (in English) shall be fully complied by Contractor and their offered equipment/material:

a)	ASME	American Society of Mechanical Engineers
b)	ASTM	American Society for Testing & Materials
c)	NFPA 10	Standard for Portable Fire Extinguishers
d)	NFPA 12	Standard for CO2 Extinguishing Systems
e)	NFPA 13	Standard for the Installation of Sprinkler Systems

f)	NFPA 14	Standard for the Installation of Standpipe and Hose Systems
g)	NFPA 20	Standard for Installation of Stationary Pumps for Fire Protection
h)	NFPA 22	Standard for Water Tanks for Private Fire Protection
i)	NFPA 24	Installation of Private Fire Service Mains and Their Appurtenances
j)	NFPA 25	Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems
k)	NFPA 2001	Standard on Clean Agent Fire Extinguishing Systems
l)	BCP	Building Code of Pakistan-Fire Safety Provisions 2016
m)	NEMA	National Electrical Manufacturers Association
n)	B.S.	British Standards

4. FIRE FIGHTING SCOPE OF WORKS IN GENERAL

The work covered by this part of the specification shall include but shall not be limited to the following items:

A- DESIGN

a. Submission of software based Hydraulic calculations for water based systems for most hazardous area.

b. Gas based fire suppression system calculations shall be submitted on Manufacturer's software as per hazard class.

c. All major equipment (Fire pump sets, valves, extinguishing system and its components etc.) shall be FM approved, UL listed or VDS approved.

d. Storage capacity of dedicated fire water tank for fire duration as per hazard class.

e. Firefighting system provision shall be as per Code and standards.

f. Submission of Technical specifications, Bill of quantities and design drawings for review and approval before commencement of installation works and procurement.

B- INSTALLATION

a. Preparation and submission of shop drawing (coordinated detail design drawings after coordination with all services) including installation details for approval.

b. Submission of equipment technical submittal as per approved calculation including selection sheet, manufacturer catalogues, certificates and pipe sample testing etc. All information must be in English. All procurement shall be made as per approved technical submittal only.

c. Pre-shipment inspection and performance testing shall be carried out for Fire pump set.

d. All relevant civil works including opening, cutting, patching, repairing, masonry and concrete works, foundations, vibration isolator for Fire Protection equipment foundation, drain arrangement in pump room, fire water tank is in scope of contract.

e. Dismantling, safe handling and reinstallation of false ceiling if required.

f. Protecting coats of paint and coating against corrosion for equipment and other components complete in all respect.

g. Provide all security and safety measures during installation phase and O&M period.

C- TESTING & COMMISSIONING

a. Hydrostatic test of MS seamless piping for water-based system during installation, pull out test of anchor bolts etc.

b. Air leakage test of MS seamless piping for gas based (FM-200/NOVEC/CO_2) system during installation, pull out test of anchor bolts,

c. Functional test, starting-up, initial operation, reliability test and performance test for Fire pumps by qualified personnel of the Contractor in the presence of the Employer or his representative.

d. Clearing of faults and damage during the Warranty Period,

e. All necessary spare parts, tools, devices, working and substitute material such as O-ring, bearings, mechanical seal, melts, air filter, fuel filter etc. for an uninterrupted, trouble-free operation.

f. As-built drawings marked-up, diagrams, schedules and lists, showing all variations from the original approved documents.

D- HANDING OVER/TAKING OVER

a. Complete instruction manuals including table of contents, description of all operating, control, indicating, switching, alarm and interlock functions and conditions, completed with schematic and detailed graphical presentations, as well as instructions and directions for setting, going, interruption of operation, supervision, effective and economical operation, arrangements for repair, error detection and determination, correction and elimination of errors and of defects servicing schedules, repair and maintenance guides.

b. Lists of provided spare parts, tools, consumables, substitute materials and working stock required to run the automatic fire protection system after taking over by the Employer/Employer's representative.

c. Detailed program for the training of the Employer's personnel and staff in the operation, service, repair and maintenance of the whole plants after final submission and approval of all above mentioned documents.

d. All systems and equipment forming part of the work shall be designed and constructed according to the latest relevant and international recognized codes and standards, as ASME, DIN, ASTM, NEMA, FM, UL, NFPA or as listed in the "NFPA STANDARDS", latest editions.

5. FIRE PROTECTION SYSTEM PROVISION

Provision of firefighting system shall be as follows:

Sr. No.	Description	Fire Protection/Suppression System				
		Hose Cabinet/ Standpipe System	Portable Fire Extinguishers / Trolleys	Automatic Sprinkler System	Yard/Outdoor Hydrants	Automatic Total Flooding Gas extinguishing System
1.	**Stations**					
1.1	Offices	•	•	•		
1.2	Shops	•	•	•		
1.3	Waiting Area	•	•	•		
1.4	Rest Area	•	•	•		
1.5	Storage Area	•	•	•		
1.6	Mechanical Room	•	•	•		
1.7	Lift Lobbies	•	•	•		
1.8	Fire Pump Room		•	•		
1.9	Command & Control room		•			•
1.10	IT/Server Rooms		•			•
1.11	Voltage/Main Distribution Room		•			•
1.12	Corridors	•	•	•		
2.	**Depot**					
2.1	Administration/Office Building		•	•	•	•
2.2	Command & Control Building	•	•	•	•	•
2.3	Spare parts & Store facility	•	•	•	•	
2.4	Washing facilities		•		•	
3.	**Sub-Station Buildings**		•		•	
3.1	Cable interlayer area		•		•	•

3.2	Rest of the building	•	•		•	

The system shall comply with all technical requirements specified herein, in addition to any supplementary technical requirements not explicitly detailed in this document.

6. MAJOR EQUIPMENT DESCRIPTION

6.1 FIRE PUMPS SET

Two (2) x 100% capacity fire pumps shall be provided. The duty pump shall be electric motor driven while the standby pump shall be diesel engine driven. Each pump shall have the capacity to supply the largest water demand as defined by the NFPA codes while maintaining the required residual pressure. The pressure in the fire main shall be maintained by jockey pump.

The pump set shall be FM approved and UL listed in compliance with NFPA 20 requirements. The pump coupled with motor shall be factory tested. The motor shall be totally enclosed forced cooling (TEFC) type with insulation Class-F and shall be tested in compliance with NEMA (National Electrical Manufacturer's Association) standard. Pre-shipment inspection shall be carried out in presence of Engineer's representative inside manufacturer's factory premises.

i) Control Panel

The controller shall have twin battery chargers meeting NFPA-20 requirements. The chargers shall auto detect the input voltage of either 120VAC or 220VAC and shall be able to be programmed for either 12VDC or 24VDC output. The controller shall be housed in a NEMA Type 2 (IP31); powder baked finish, free- standing enclosure. It shall have all features of operation and control as prescribed by NFPA-20.

ii) Spare Parts

Air filter, oil filter, fuel filter, mechanical seal, O-rings, bearings and belts shall be provided as spare parts as recommended by the Manufacturer.

6.2 Automatic Sprinkler Systems

Automatic sprinkler systems shall be provided in accordance with NFPA 13. Sprinklers shall be **FM approved & UL listed.**

The installation shall be a Wet Sprinkler System and the flow of water to the sprinkler pipe work shall be controlled by installation control valves. The system shall be charged with water under pressure up to the sprinkler heads so that when one or more of the sprinkler heads operates the wet alarm valve is actuated allowing water to flow from the open sprinkler heads. All sprinklers shall be one of the following types: - Concealed fast response type with chrome plated cover for areas with false ceiling. - Upright solder fusible link fast response type for areas without false ceiling.

6.3 VALVES AND ACCESSORIES

All valves shall be UL listed, FM approved and listed for fire service. Valves shall be rated not less

than 1.5 times the system working pressure. Valves shall have epoxy coating for corrosion resistance.

6.4 FIRE WATER PIPING NETWORK

All pipes used for firefighting water distribution shall be galvanized steel iron/Mil Steel seamless schedule 40 assembled with GI threaded fittings for pipe sizes 2" and smaller and with grooved mechanical fittings for pipe sizes 65 mm (2 ½ in.) and larger.

The firefighting water piping system shall be provided with valves on all mains and branches for sectionalizing the system for maintenance and operation. All valves used in the firefighting water piping system shall be of the rising stem type to clearly indicate whether the valve is in the open or closed position. Buried valves shall be provided with indicating posts. The valves shall conform in all other respects to the specifications given under valves.

A 50 mm (2 in.) drain valve of the globe type shall be provided at the base of every fire standpipe. Piping shall be sloped not less than 2% towards the drain valves.

Buried piping network (where applicable) shall be of High-Density Polyethylene.

The firefighting water pipes shall not be used in any way to supply water for other purposes

6.5 FIRE DEPARTMENT CONNECTION

It shall be with two B-couplings according to NFPA or another equivalent approved standard, (65 mm diameter) with ball valves, caps and union installed on galvanized sheet steel plate.

6.6 STANDPIPE SYSTEM

Wet Standpipe system (Class-III) shall be provided in each building where sprinkler system is not provided. The recess type/ wall mounted cabinet shall be of 18-gauge steel (1.2 mm). The cabinet shall have lock shield valve, 100 feet (30 meter) long synthetic, double jacket lined hose @ test pressure of 20 bars minimum, one triple-purpose brass nozzle and a landing valve.

6.7 GASEOUS EXTINGUISHING SYSTEMS

Gaseous extinguishing systems shall be designed for automatic operation and shall be provided with means to disable the automatic release of agent when personnel are within the protected space. Indicator lamps at each entrance to each protected space shall show the status of the extinguishing system.

CO2 systems shall meet the requirements of NFPA 12 while alternative gas systems shall meet the requirements of NFPA 2001. In addition to the safety features described above, safeguards

such as door interlocks and mechanical isolations shall be provided to ensure the safety of personnel entering CO2 protected areas.

System shall be FM approved & UL listed.

For CO2 systems, for surface fires, the design concentration shall be achieved within 1 minute. For deep-seated fires, the design concentration shall be achieved within 7 minutes but the rate shall be not less than that required to develop a concentration of 30 % in 2 minutes. The system pressure shall not be higher than 58.6 bar.

Alternative gas systems shall be, unless otherwise specified, designed to achieve a minimum concentration of 7 % at 5°C and a maximum of 9 % by volume at 38°C. Discharge of gas shall be substantially completed within ten seconds and following discharge the concentration of extinguishing agent shall develop throughout the protected compartment to achieve final extinguishment of fire within 60 seconds. The system pressure shall not be higher than 42 bar. Room integrity testing shall be conducted at site to ensure air tightness and the enclosure can hold the agent at the required concentration for the duration of 10 minutes as per NFPA 2001 recommendations.

The automatic gas extinguishing system shall be complete with gas storage cylinders, extinguishing agent, pipework, discharge heads, valves, control equipment and cables and all necessary accessories and fittings to form a complete system. Unless otherwise specified, automatic gas extinguishing systems shall be of the total flooding type with a high-pressure open-ended piping installation on the distribution side. The automatic gas release mechanism shall be operated by means of fire detection units at the protected compartment or manually by a pull handle or push button. Carbon dioxide, HFC227 as specified shall be used as extinguishing agent for total flooding systems.

PUNJAB MASSTRANSIT AUTHORITY

Minimum Qualification Requirement of Main Contractor/Firefighting Sub Contractor:

i. Registered with Pakistan Engineering Council in relevant category i.e. ME-02.

ii. Minimum experience as Contractor in the execution of at least five (05) projects of similar nature and complexity within last ten years; this experience should include supply, installation, testing and commissioning and operation & maintenance of firefighting system.

Minimum experience as Contractor in execution of at least three (03) multi storey's/ hospitals/ apartments building Firefighting system of same type and capacity.

PUNJAB MASSTRANSIT AUTHORITY

LIST OF RECOMMENDED MANUFACTURERS FOR ITEMS/ MATERIALS/EQUIPMENT OF FIRE FIGHTING WORKS

The Bidder should note that only Equipment/materials from the following approved manufacturers shall be allowed to be used on this Project provided their products meet the specified requirements.

SR. NO.	EQUIPMENT/ MATERIAL	APPROVED MANUFACTURER/ SUPPLIER	1. 2. COUNTRY(origin, manufacturing, assembly, testing & supply)
1.	Fire Fighting Pumps (FM Approved /UL Listed)	ITT PATTERSON READY BUFFALO PEARLESS NAFFCO SFFECO LIFECO WATERFALL PEREGRINE OR APPROVED EQUAL	USA/UAE/EUROPE/ TURKEY
2.	Pump Motors (UL Listed /NEMA)	ABB SIEMENS WEG NATIONAL MARATHON OR APPROVED EQUAL	UK/USA/EUROPE
3.	Diesel Engine (UL Listed /NEMA)	CLARKE BLACK STALLION FIRE DRIVER OR APPROVED EQUAL	USA/EUROPE/UAE
4.	Gas Suppression System	KIDDIE FIKE PEMALL SFFECO LIFECO OR APPROVED EQUAL	USA/EUROPE/UAE

5.	Valves, Pressure Reducing Valve, Pressure Relief valve, Drain Cocks, Air vents etc.	TYCO VIKING SHIELD LIFECO DUYAR PEREGRINE OR APPROVED EQUAL	JAPAN/USA/UK/ EUROPE/TURKEY
6.	MS Seamless Pipe	HUFFAZ LONTRIN BAOLAI OR APPROVED EQUAL	PAKISTAN/CHINA
7.	Hangers / Supports	FISCHER HILTI MUNGO INDEX NORM INKA OR APPROVED EQUAL	UK/EUROPE/CHINA
8.	Portable Fire Extinguishers	NAFFCO SFFECO LIFECO FIREX OR APPROVED EQUAL	UAE

NOTE 1: ALL EQUIPMENT/MATERIAL MUST BE SUPPLIED FROM AUTHORIZED/SOLE DISTRIBUTORS. MANUFACTURERS AUTHORIZATION CERTIFICATE IN ORIGINAL MUST BE PROVIDED.

NOTE 2: MINIMUM QUALIFICATION CRITERIA REQUIREMENT OF FIREFIGHTING EQUIPMENT MANUFACTURER

For all proposed equipment manufacturer shall meet the minimum following criteria:

- Minimum ten (10) years of international experience for same offered equipment.
- Minimum three (03) years national experience with local authorization representative and after sale service available in Pakistan.
- Compliance with international standards/codes of firefighting works applicable to relevant equipment.
- High ambient compatibility equipment.
- Most energy efficient equipment/model available in market and offered for the project.

- Testing facilities as per project requirement.
- Verifiable list of minimum five (05) projects in last five (05) years in Pakistan.
- All major parts used inside equipment like pumps, hydrants, valves etc. shall be supplied from the manufacturers' best source available in international market.
- International certificate of performance of proposed equipment/model available as per international standards.

NOTE: ALL EQUIPMENT/MATERIALS OTHER THAN STATED ABOVE SHALL BE SUBJECT TO PRIOR APPROVAL OF THE ENGINEER IN RESPECT OF MAKE & COUNTRY OF ORIGIN.

Initials of Signatory to Bid: _____

PUNJAB MASSTRANSIT AUTHORITY

ESTABLISHMENT OF TOURIST GLASS TRAIN FROM RAWALPINDI / ISLAMABAD TO MURREE

EMPLOYER'S REQUIREMENTS



ELEVATOR WORKS

December 2025

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ELEVATOR WORKS

1. GENERAL

All materials, components units and equipment of elevator systems shall be designed, furnished, installed, tested and commissioned in accordance with codes and standards given in this document as well as the requirements specified. The specifications state the minimum requirements for the equipment, which shall be valid.

2. ELEVATOR SCOPE OF WORKS IN GENERAL

The scope of work comprises designing, engineering, preparation of shop drawings, procurement, manufacture, testing, transport, erection, installation, obtaining approvals and completion of the elevator works including relevant electrical and civil works. The work covered by this part of the specification shall include but shall not be limited to the following items:

2.1. DESIGN

a. Submission of design/traffic analysis, elevator equipment selection and design drawings for installation etc for approval.

b. In detail design particularly consider Mass Transit system requirements as per CIBSE Guide D and equipment selection and design drawings for installation etc for approval.

c. Also, special measures shall be taken care off in order to match building aesthetic view.

d. All relevant electrical works from main LT Panel to downstream of elevator system including cabling, panels, conduits, breakers etc. All elevators shall also be electrically powered from emergency backup generators.

e. Design of elevator shaft air conditioners and ventilation system shall be considered.

f. Elevator shaft size, structural load, pit depth, overhead, electrical load, distribution board, connectivity with fire alarm system and connectivity with Building management system coordination shall be done by the designer with relevant services.

g. Submission of equipment schedule & Bill of quantities showing all types of elevator equipment and material along with capacities and design parameters.

2.2. INSTALLATION

a. All relevant civil works including elevator shaft, opening, cutting, patching, repairing, masonry and concrete works, foundations, vibration isolator for elevator equipment foundation, drain layout in elevator pit and Machine room etc. is in scope of contract.

b. Submission of equipment submittal as per approved calculation including selection sheet, manufacturer catalogues, certificates etc. All information must be in English. All procurement shall be made as per approved technical submittal only.

c. Preparation and submission of shop drawing (coordinated detail design drawings after coordination with all services) for approval.

d. Submission of installation drawings of each equipment and material for approval and reference at site.

e. The delivery and installation shall not be limited to the above-mentioned parts. All deliveries and installations not particularly specified shall be added to ensure fully functioning systems and to meet the latest technical experiences and standards.

f. Protecting coats of paint and coating against corrosion for equipment and other components complete in all respect.

g. Provision of all necessary documents for review and approval by the Employer/Engineer before starting up,

h. Provide all security and safety measures during installation phase and O&M period.

2.3. TESTING & COMMISSIONING

a. Setting, adjusting, and balancing of all elevator equipment and system.

b. Functional test, starting-up, initial operation, reliability test and performance test by qualified personnel of the Contractor in the presence of the Employer or his representative,

c. Clearing of faults and damage during the Warranty Period,

d. All necessary spare parts, tools, devices, working and substitute material such as guide shoes, lubrication oil, sliding wheels and grease, corrosion inhibitor, fusible link, etc. for an uninterrupted, trouble-free operation.

e. As-built drawings marked-up, (coloured), diagrams, schedules and lists, showing all variations from the original approved documents.

2.4. HANDING OVER/TAKING OVER

a. Complete instruction manuals including table of contents, description of all operating, control, indicating, switching, alarm and interlock functions and conditions, completed with schematically and detailed graphical presentations, as well as instructions and directions for setting, going, interruption of operation, supervision, effective and economical operation, arrangements for repair, error detection and determination, correction and elimination of errors and of defects servicing schedules, repair and maintenance guides, lubrication charts and lubricating instructions.

b. Provide operational staff (One operator for each shift) for each elevator, security and safety measures during installation phase and O&M period of two (02) years is mandatory.

c. Lists of provided spare parts, tools, special appliances, consumables, substitute materials and working stock required to run the complete elevator system for 2 years after taking over by the Employer/Employer’s representative.

d. Detailed program for the training of the Employer's personnel and staff in the operation, service, repair and maintenance of the whole system after final submission and approval of all above mentioned documents.

e. After the training of the Employer's personnel and staff has been completed satisfactorily, the Contractor shall submit all training minutes to the Employer/Employer’s representative,

signed by all trained persons in order to confirm and verify the success of his training efforts.

f. All systems and equipment forming part of the work shall be designed and constructed according to the latest relevant and international recognized codes and standards, as ASME, EN, IEC, NEPA, CSA, ASTM, NEMA, I.E.E, NFPA or as listed in the "EN 81", latest editions.

3. EQUIPMENT/MATERIAL SELECTION

For all proposed equipment manufacturer shall meet minimum following criteria:

- Thirty (30) years of international experience for same equipment /material.
- Minimum Five (05) years national experience with same brand and after sale services in Pakistan as authorized distributor.
- Full EN81 standards compliance statement for the proposed model from the Manufacturer and EU type examination certificates (As a whole) against proposed elevator model no. from authorized/verifiable companies like TUV, SGS, Liftinstituut etc.
- Most energy efficient equipment/model available in international market.
- Verifiable list of projects of last five (05) years in Pakistan.
- Further note that supply of complete elevator system from offered manufacturer is must. Only elevator electric/mechanical partial parts supply experience will not be entertained.
- Availability of elevator catalogue (including Model no./safety feature details) which are installed nationally as well internationally is required. Manufacturers proper web site, address and contact details are mandatory.

3.1. Codes and Standards Requirements

Following codes and standards shall be fully complied by Contractor and their offered equipment/material

a)	ASME	American Society of Mechanical Engineers
b)	ASTM	American Society for Testing & Materials
c)	EN	EUORPEON NORMS
d)	NFPA	National Fire Protection Association, USA
e)	I.E.E.	Institute of Electrical Engineers, London
f)	NEMA	National Electrical Manufacturers Association,
g)	P.S.	Pakistan Standards.

h)	B.S.	British Standards.
i)	B. C. P	Building Code of Pakistan
j)	NFPA	Life Safety Code 101

3.2. MAJOR EQUIPMENT DESCRIPTION

3.2.1. Elevator Schedule

Sr. No.	Description	Minimum Requirement
01	Type	Machine Room Less Type (MRL) heavy duty VVVF Passenger Elevator fully complied with EN 81-20, EN 81-50 and EN 81-70 standards. (Fire Elevator complied with EN 81-72 & ASME 17.1/CSA B44-If required)
02	Capacity	As per Traffic Analysis Results
03	Elevator Speed	1.0 – 2.5 m/sec (As per design)
04	Travel Height	As per Actual
05	No of Stops/Openings	As per Actual
06	Internal Car Sizes (w x d) x h	As Per Manufacturer
07	Machine Type	VVVF AC gearless drive
08	Car & Counterweight Guide Shoes	Sliding/Roller guide shoes
09	Drive Location	Machine Room Less (MRL Type)
10	Control System	Simplex control
11	Architraves	Full width of Stainless-Steel satin finish at all floors as approved by the Client/Employer at all floors.
12	Elevator Shaft Size (w x d)	(As per design)
13	Pit Depth	(As per design)
14	Head Room	(As per design)
15	Buffers	Oil buffers of spring return type (Energy Dissipation type) or as recommended by EN 81 Standards
16	Door Size	As per design

17	Door Operation & Type	VVVF control, Power operated, 2-Panel Side/Center opening stainless steel panel construction and fire rating of 2 hr.
18	Indicators	- Digital TFT/LED type car position indicator on each landing with directional arrows. - Digital TFT/LED type position indicator inside the car with directional arrows. - Two tone electronic voice announcing for arrival of car etc.
19	Landing Call Station	Push buttons type with stainless steel frame or as approved by the engineer with call acceptance illuminated indication
20	Car Operating Panel (COP) (02 Nos each elevator – One (01) for wheelchair users as per EN 81-70)	- Integral with the front return of the car and constructed of Stainless Steel/glass and recessed/flushed with wall. Including separate handicapped car operating panel push button type or as approved by the engineer - It shall include TFT/LED type display, alarm buttons, floor call buttons, door open/hold button, key-operated attendant switch, fan switch, intercom, all buttons shall be of push button type or as approved by the engineer (connection with building safety/security system is included in Contractor's scope).
21	Car Design	- Executive Finishes or Stainless-Steel Hairline at all floors as approved by the client/employer. - Front return and car door of executive finishes or stainless steel (hairline finish) construction as approved by the client/employer. - Full width half height mirror on rear wall or as per manufacturer design. - Ceiling removable type full extended poly carbonate diffuser with modular light fittings and access to ceiling trap door as approved by engineer - Ventilation Blower (Pre-Installed) - Handrails on two side - Executive Granite Floor - Inter Telecommunication system - Emergency exit/Trap Door - Load measuring device with overload buzzer and inter-lock till overload is removed. - LED Lighting - Seismic Sensor
22	Door Safety Devices	- Full height Light curtain protection (2D) - Door opening timing feature
23	Special Features	- Premium Motor - Attendant Control - Emergency Operation & Fireman Switch - Hard wired control connectivity of Elevator controller with building's Fire alarm system and operate

		automatically when received signal through Building Fire alarm system. - Emergency Lighting & Alarm Unit - Earthquake Control System - Voice Guidance System - Connected with Building Control system - Suitable 0 ~ 40°C Ambient Temperature - Phase Reversal Failure Indication & Interlock - Manufacturer Security Cameras for Surveillance (Connection with Building's Safety/Security is included in the scope of the Contractor) - ERD Device (Emergency Rescue Device Battery Backup) - Manual Brake Release Lever - Halogen Free Cables - RFID interface provision in elevator's controller capable to control the system for selection of floors by the passengers. - Access Control System (Biometric & Barcode Scanner)
24	Interior Finish	Superior/Highest/Executive quality as per approval of engineer on submitted samples.
25	Minimum Functions	- Direct Leveling - Optimum travel curve - Re-running automatically when elevator is re-powered - Car location adjusted automatically - Load compensating - Travel Counter - Over/Under voltage protection - Phase trip protection - Over current protection - Over heat protection - Encoder trip protection - Contact adhered protection - Bi-directional over speed protection - Unintended Car Movement Protection (UCMP) - Ascending Car Movement Protection (ACOP) - Reversal protection - Travel over time protection - Final terminal protection - Over load protection - Anti-door lock bridge - Automatic by-pass hall call while full load - Level for self-helping - Travel to next floor when open door trip - Emergency illumination in car - Emergency alarm - Automatic car fan

		- Automatic car lighting - Fire return feedback - Settable landing number - Automatic parking, parking floor - Car calls cancelable - Parking key switch, landing - Fire return (Phase I), Main landing - Hoist way lighting - Car door button
26	Trips/hour	240 minimum
27	Power Supply	- 3 Phase / 400V / 50 Hz. - 1Phase/230V/50 Hz. (for lighting)
28	Monitoring/Integration with BMS/ Building Controls	Communication module/Controller based on BACNet over IP for each Elevator to be provided for integration with Building Management system (BMS)/Building Controls. Any Software & Computer, if needed for integration with IBMS, shall also be provided by the Contractor.
29	Ambient Condition for Motor/control safeties for shafts etc.	0°C to 40°C
30	Inspection & Test Language	English
31	Elevator Mode	Two Mode: - Normal Mode: From the car or from the landing. - Maintenance Mode: Low speed (inspection running).
32	Design Life	25 Years

5.4. DOCUMENTS/INFORMATION REQUIRED FOR APPROVAL

The document for approval shall include minimum following;

a) Design calculations (Traffic Analysis) along with design drawings for all areas.

b) Technical submittal.

c) Testing protocols

d) EN 81 Compliance Certificates for Critical Parts

e) As built drawings

5.5. LIST OF RECOMMENDED MANUFACTURERS

SR. NO.	EQUIPMENT/ MATERIAL	RECOMMENDED MANUFACTURER/ SUPPLIER	COUNTRY (ORIGIN, MANUFACTURING, ASSEMBLY, TESTING & SUPPLY)
1.	Elevators	DOPPLER	WEST EUROPE
		HYUNDAI	KOREA, CHINA
		KONE	WEST EUROPE, CHINA
		MITSUBISHI	JAPAN/THAILAND
		ORONA	WEST EUROPE
		OTIS	WEST EUROPE, CHINA
		SIGMA	KOREA, CHINA
		SCHINDLER	WEST EUROPE, CHINA
		SHANGHAI MITSUBISHI	CHINA
		THYSSEN KRUPP	WEST EUROPE, CHINA
		Or Approved Equivalent*	

***NOTES**

1. All components/material shall be supplied through authorized distributors.
2. Manufacturer's authorization certificate shall be provided.
3. In case a Bidder offers an 'Approved Equivalent' Brand/Equipment, it shall be clearly stated in the Technical bid and all requisite data/documentation for qualification/evaluation of said brand/equipment shall be provided in the Technical bid in accordance with requirements provided in bidding documents.
   a) Compliance of equipment parts and their origin as mentioned in Technical Specifications.
   b) Compliance statement of Technical Specification/Standards through the equipment manufacturer.
   c) Full EN81 standards compliance statement for the proposed model from the Manufacturer and EU type examination certificates (As a whole) against proposed elevator model no. from authorized/verifiable companies like TUV, SGS, Liftinstituut etc.
   d) Successful experience of at least fifty (50) elevators of similar nature and complexity comparable to the works within the last five (05) years in Pakistan. This experience shall include supply, installation, testing, commissioning, operations & maintenance of elevator works.
   e) Successful experience of proposed brand's complete elevator manufacturing for minimum thirty (30) years in the international market.
   f) The bidder/supplier must have valid authorization certificate from Principal Manufacturer of offered equipment for at least last five (05) years in Pakistan.
   g) Further note that supply of complete elevator system from offered manufacturer is must. Only elevator electric parts supply experience will not be entertained.
   h) Availability of elevator catalogue (including Model no./safety feature details) which are installed nationally as well internationally is required. Manufacturers proper web site, address and contact details are mandatory.

ESTABLISHMENT OF TOURIST GLASS TRAIN FROM RAWALPINDI / ISLAMABAD TO MURREE

EMPLOYER'S REQUIREMENTS



ESCALATOR WORKS

December 2025

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ESCAATOR WORKS

1. GENERAL

All materials, components units and equipment of escalator systems shall be designed, furnished, installed, tested and commissioned in accordance with codes and standards given in this document as well as the requirements specified. The specifications state the minimum requirements for the equipment, which shall be valid.

2. ESCALATOR SCOPE OF WORKS IN GENERAL

The scope of work comprises designing, engineering, preparation of shop drawings, procurement, manufacture, testing, transport, erection, installation, obtaining approvals and completion of the escalator works including relevant electrical and civil works. The work covered by this part of the specification shall include but shall not be limited to the following items:

2.1. DESIGN

a. Submission of design/traffic analysis, escalator equipment selection and design drawings for installation etc for approval.

b. In detail design particularly consider Mass Transit system requirements as per CIBSE Guide D and equipment selection and design drawings for installation etc for approval.

c. Also, special measures shall be taken care off in order to match building aesthetic view.

d. All relevant electrical works from main LT Panel to downstream of escalator system including cabling, panels, conduits, breakers etc. All escalators shall also be electrically powered from emergency backup generators.

e. Design of escalator machine ventilation system shall be considered.

f. Escalator size, structural load, pit depth, electrical load, distribution board, connectivity with fire alarm system and connectivity with Building management system coordination shall be done by the designer with relevant services.

g. Submission of equipment schedule & Bill of quantities showing all types of escalator equipment and material along with capacities and design parameters.

2.2. INSTALLATION

a. All relevant civil works including escalator horizontal space, opening, cutting, patching, repairing, masonry and concrete works, foundations, vibration isolator for escalator equipment foundation, drain layout in escalator pit etc. is in scope of contract.

b. Submission of equipment submittal as per approved calculation including selection sheet, manufacturer catalogues, certificates etc. All information must be in English. All procurement shall be made as per approved technical submittal only.

c. Preparation and submission of shop drawing (coordinated detail design drawings after coordination with all services) for approval.

d. Submission of installation drawings of each equipment and material for approval and reference at site.

e. The delivery and installation shall not be limited to the above-mentioned parts. All deliveries and installations not particularly specified shall be added to ensure fully functioning systems and to meet the latest technical experiences and standards.

f. Protecting coats of paint and coating against corrosion for equipment and other components complete in all respect.

g. Provision of all necessary documents for review and approval by the Employer/Engineer before starting up,

h. Provide all security and safety measures during installation phase and O&M period.

2.3. TESTING & COMMISSIONING

a. Setting, adjusting, and balancing of all escalator equipment and system.

b. Functional test, starting-up, initial operation, reliability test and performance test by qualified personnel of the Contractor in the presence of the Employer or his representative,

c. Clearing of faults and damage during the Warranty Period,

d. All necessary spare parts, tools, devices, working and substitute material such as guide shoes, lubrication oil, sliding wheels and grease, corrosion inhibitor, fusible link, etc. for an uninterrupted, trouble-free operation.

e. As-built drawings marked-up, (coloured), diagrams, schedules and lists, showing all variations from the original approved documents.

2.4. HANDING OVER/TAKING OVER

a. Complete instruction manuals including table of contents, description of all operating, control, indicating, switching, alarm and interlock functions and conditions, completed with schematically and detailed graphical presentations, as well as instructions and directions for setting, going, interruption of operation, supervision, effective and economical operation, arrangements for repair, error detection and determination, correction and elimination of errors and of defects servicing schedules, repair and maintenance guides, lubrication charts and lubricating instructions.

b. Provide operational staff (One operator for each shift) for each station, security and safety measures during installation phase and O&M period of two (02) years is mandatory.

c. Lists of provided spare parts, tools, special appliances, consumables, substitute materials and working stock required to run the complete escalator system for 2 years after taking over by the Employer/Employer’s representative.

d. Detailed program for the training of the Employer's personnel and staff in the operation, service, repair and maintenance of the whole system after final submission and approval of all above mentioned documents.

e. After the training of the Employer's personnel and staff has been completed satisfactorily, the Contractor shall submit all training minutes to the Employer/Employer’s representative,

signed by all trained persons in order to confirm and verify the success of his training efforts.

f. All systems and equipment forming part of the work shall be designed and constructed according to the latest relevant and international recognized codes and standards, as ASME, EN, IEC, NEPA, CSA, ASTM, NEMA, I.E.E, NFPA or as listed in the "EN 81", latest editions.

3. EQUIPMENT/MATERIAL SELECTION

For all proposed equipment manufacturer shall meet minimum following criteria:

- Thirty (30) years of international experience for same equipment /material.
- Minimum Five (05) years national experience with same brand and after sale services in Pakistan as authorized distributor.
- Full EN115 standards compliance statement for the proposed model from the Manufacturer and EU type examination certificates (As a whole) against proposed escalator model no. from authorized/verifiable companies like TUV, SGS, Liftinstituut etc.
- Most energy efficient equipment/model available in international market.
- Verifiable list of projects of last five (05) years in Pakistan.
- Further note that supply of complete escalator system from offered manufacturer is must. Only escalator electric/mechanical partial parts supply experience will not be entertained.
- Availability of escalator catalogue (including Model no./safety feature details) which are installed nationally as well internationally is required. Manufacturers proper web site, address and contact details are mandatory.

3.1. Codes and Standards Requirements

Following codes and standards shall be fully complied by Contractor and their offered equipment/material

a)	ASME	American Society of Mechanical Engineers
b)	ASTM	American Society for Testing & Materials
c)	EN	EUORPEON NORMS
d)	NFPA	National Fire Protection Association, USA
e)	I.E.E.	Institute of Electrical Engineers, London
f)	NEMA	National Electrical Manufacturers Association,
g)	P.S.	Pakistan Standards.

h)	B.S.	British Standards.
i)	B. C. P	Building Code of Pakistan
j)	NFPA	Life Safety Code 101

3.2. MAJOR EQUIPMENT DESCRIPTION

3.3. TECHNICAL DATA

3.4. Escalator Schedule

Sr. No.	Description	Required
01	Type	Heavy duty, Public Building type for Commercial buildings, Indoor type, variable voltage variable frequency [VWF] slim tempered glass balustrade moving escalators. Fully complied with EN 115: 2008 A1: 2010 standards.
02	Design Life	Overall, 30 years
03	Use	Public Building
04	Hour of Operation	16 Hours/day, 6 days/ week, 365 days/ year
05	Rise	As per BOQ/SOP
06	Inclination	30º
07	Speed [Max] Maintenance speed.	0.5-0.65 m/sec (Max.) 0.13 m/sec
08	Step width	1000 mm
09	Capacity	6000 persons/ hour
10	Horizontal Step at Top	3 Nos.
11	Horizontal Step at Bottom	3 Nos.
12	Travel Direction	Reversible
13	Middle& End Support	As per manufacturer requirement. (included in scope of supplier)
14	Monitoring/Integration with BMS	- Communication module/Controller based on BACNet over IP for each Escalator to be provided for integration with Building Management system (BMS)/Building Controls. Any Software & Computer, if needed for integration with IBMS, shall also be provided by the Contractor.
15	Provision of Connectivity with Building Fire Alarm System	Hard wired control connectivity of escalators with building Fire Alarm system and act according to standards in case of Fire.
16	Installation	Indoor
17	Service Power Supply	400V/ 3 phase/ 50 Hz
18	Emergency Power Supply Connection	YES

19	Motion Sensors	YES (included)
20	Lubrication	Automatic type
21	Installation components	Suitable for commercial environment (Mass Transit System)
22	Vandalism expected	No
23	Ambient Temperature	40°C (All Escalator components)
24	Control Panel Location	Upper escalator side (Top)
25	Complete Electrical Works (Wiring, Earthing Connections, etc).	Yes (included)
26	Demarcation Lights on steps	Yes (included)
27	Skirt Lighting	Yes (included)
28	Emergency Stop button at Top, mid of inclined skirt panel & Bottom	Yes (included)
29	Earthing of Complete Escalator Components [Separate]	Yes (included)
30	Soft Starter / Y Delta	Yes (included)
31	Stop/Go operation and sinology to show operational status of escalator	Yes (included)
32	Drip Pan	Yes (included)
33	High Quality Stainless Steel [SS 304] Cladding	Yes (included)
34	Safety Sign at both ends	Yes (included)
35	LED Traffic Direction Light	Yes(included)
36	Balustrade type	Slim Tempered Glass Type (12mm)
37	Balustrade material	Tempered Glass (12mm)
38	Roller	Step inside roller heavy duty 75-100 mm.

Other Features

1	Stop button	Yes
2	Key switch	Yes
3	Handrail entrance contact	Yes
4	Step-chain broken contact	Yes
5	Step sag contact	Yes
6	Phase monitor	Yes
7	Steel flying wheel cover	Yes
8	Reversing fences	Yes
9	Motor overload	Yes
10	Motor overheat protection	Yes
11	Comb contact	Yes
12	Maintenance interlock	Yes
13	Alarm buzzer	Yes
14	Over speed and unintended reversal monitor	Yes
15	Handrail anti-static roller	Yes

16	Step anti-static brush	Yes
17	Service brake release contact	Yes
18	Soft stop	Yes
19	Handrail speed monitor	Yes
20	Driver-chain broken contact	Yes
21	Switchboard box	Yes
22	Landing plate/Floor Cover switch	Yes
23	Alarm for stop distance over run	Yes
24	Step missing contact	Yes
25	Earth leakage circuit – breaker	Yes
26	Auto lubrication system with oil collector	Yes
27	Skirting contact	Yes
28	Step gap illumination	Yes
29	Step up-thrust contact	Yes
30	Safety brake on main driver shaft	Yes
31	Fire interface	Yes
32	TFT/LCD fault display	Yes
33	LED traffic light [one at top and one at bottom]	Yes
34	Float switch at lower machine room	Yes
35	Oil water separator	Yes
36	Auto lubrication system [with oil collector]	Yes
37	Zinc steel drive chain cover	Yes
38	Chain protection: Zinced	Yes
39	Cooling fan in control box	Yes
40	Cooling fan in machine room	Yes
41	Comb heater	Yes

Service Life of Main Parts

Name	Life	Basic Requirements of Lift Cycle
Truss	≥ 30 years	1. Galvanized layer basically intact.
		2. No deformation, crack etc.
Escalator driver	≥ 25 years	1. Reducer diver wheel can work properly, tooth surface without excessive wear or broken teeth, no informal working noise.
		2. Motor can work properly, stator insulation resistance in line with standard requirements.
		3. Reducer and motor bearings work properly.
		4. Brake work properly.
Step	≥ 20 years	1. No deformation, cracks etc.
		2. No fracture
		3. No other problems to be replaced.
Step chain	≥ 20 years	1. Elongation should not exceed 1.5 mm / step distance, can be engaged with the chain wheel.
		2. The gap between steps shall not be greater than the standard.
		3. No other problems to be replaced.
Driving chain	≥ 8 years	1. Elongation should not exceed 1.5%.
		2. Be engaged with the chain wheel.

		3.	No other problems to be replaced.
Handrail chain	≥ 8 years	1.	Elongation should not exceed 1.5%.
		2.	Be engaged with the chain wheel.
		3.	No other problem to be replaced.
Drive spindle	≥ 20 years	1.	No serious wear of sprocket.
		2.	Spindle without deformation or crack.
		3.	No other problem to be replaced.
Chain tension device	≥ 20 years	1.	No serious wear of sprocket.
		2.	Spindle without deformation or crack.
		3.	No other problem to be replaced.
Guide rail	≥ 20 years	1.	Working face wear marks depth should not be greater than 1 mm.
		2.	Without deformation or crack
		3.	No other problem to be replaced.
Bracket of guide rail	≥ 20 years	1.	Galvanized layer basically intact.
		2.	Without deformation or crack.
		3.	No other problems to be replaced.
Handrail drive unit	≥ 20 years	1.	No serious wear of sprocket.
		2.	No other problems to be replaced.
Handrail	≥ 05 years	1.	The distance between handrail opening and rail clearance is not greater than 8 mm.
		2.	No surface crack or peel material inside and outside layer material or severe surface wear.
		3.	No other problems to be replaced.
Step chain wheel and step wheel	≥ 12 years	1.	Outer ring wear shall not be greater than 1 mm.
		2.	Bearing should be able to work properly.
		3.	No other problems to be replaced.
Cable	≥ 12 years	1.	Insulation performance to meet the relevant standards.
		2.	Surface does not appear aging.
		3.	No other problems to be replaced
Electrical board	≥ 10 years	Should be able to work properly.	
Inverter	≥ 10 years	Should be able to work properly.	

5.4. DOCUMENTS/INFORMATION REQUIRED FOR APPROVAL

The document for approval shall include minimum following;

a) Design calculations (Traffic Analysis) along with design drawings for all areas.

b) Technical submittal.

c) Testing protocols

d) EN 115 Compliance Certificates for Critical Parts

e) As built drawings

5.5. LIST OF RECOMMENDED MANUFACTURERS

SR. NO.	EQUIPMENT/ MATERIAL	RECOMMENDED MANUFACTURER/ SUPPLIER	COUNTRY (ORIGIN, MANUFACTURING, ASSEMBLY, TESTING & SUPPLY)
1.	Escalators	HYUNDAI	KOREA, CHINA
		KONE	EUROPE, CHINA
		MITSUBISHI	JAPAN/THAILAND
		OTIS	EUROPE, CHINA
		SIGMA	KOREA, CHINA
		SCHINDLER	EUROPE, CHINA
		SHANGHAI MITSUBISHI	CHINA
		THYSSEN KRUPP	EUROPE, CHINA
		Or Approved Equivalent*	

***NOTES**

1. All components/material shall be supplied through authorized distributors.
2. Manufacturer's authorization certificate shall be provided.
3. In case a Bidder offers an 'Approved Equivalent' Brand/Equipment, it shall be clearly stated in the technical bid and all requisite data/documentation for qualification/evaluation of said brand/equipment shall be provided in the technical bid in accordance with requirements provided in bidding documents.
   a) Compliance of equipment parts and their origin as mentioned in Technical Specifications.
   b) Compliance statement of Technical Specification/Standards through the equipment manufacturer.
   c) Full EN115 standards compliance statement for the proposed model from the Manufacturer and EU type examination certificates (As a whole) against proposed escalator model no. from authorized/verifiable companies like TUV, SGS, Liftinstituut etc.
   d) Successful experience of at least fifty (50) escalators of similar nature and complexity comparable to the works within the last five (05) years in Pakistan. This experience shall include supply, installation, testing, commissioning, operations & maintenance of escalator works.
   e) Successful experience of proposed brand's complete escalator manufacturing for minimum thirty (30) years in the international market.
   f) The bidder/supplier must have valid authorization certificate from Principal Manufacturer of offered equipment for at least last five (05) years in Pakistan.

g) Further note that supply of complete escalator system from offered manufacturer is must. Only escalator electric parts supply experience will not be entertained.

h) Availability of escalator catalogue (including Model no./safety feature details) which are installed nationally as well internationally is required. Manufacturers proper web site, address and contact details are mandatory.

PUNJAB MASSTRANSIT AUTHORITY

ESTABLISHMENT OF TOURIST GLASS TRAIN FROM RAWALPINDI / ISLAMABAD TO MURREE

EMPLOYER'S REQUIREMENTS



General Technical Provisions

December 2025

National Engineering Services Pakistan (Pvt.) Limited
1-C, Block-N, Model Town Extension, Lahore 54700, Pakistan
PABX: +92-42-99090000
Fax: +92-42-99231950
Email: info@nespak.com.pk Website: www.nespak.com.pk

Clearance Code:		Document No:		Revision No:	

TECHNICAL PROVISIONS -

SCOPE OF WORK AND SPECIFICATIONS

Broad Scope of Work

The work involves Engineering, Procurement, and Construction in accordance with the Feasibility Study, drawings and specification/scope of work. It is clarified that the attached drawings (Schedule M-1) are deemed to be appropriate and applicable for the project. Technical scope of work is summarized as under;

A. General

1. Prior to the submission of the tender, the Contractor is required and deemed to have visited the Site to fully acquaint himself as to the nature of work, extent and practicality of the excavation, underpinning works, earthworks or associated temporary and permanent works of the project.

2. The tender documentation/specifications may seem at times restrictive. While certain clauses prescribe specific values, characteristics or solutions to be conformed to by the Contractor, it is understood that these specific requirements represent the current state-of-the-art adopted by the industry and should be read as a reference. Alternate verifiable standards and codes of equivalent or better standing may be acceptable subject to Employer's approval. In addition, the scope of work shall remain unchanged. It is further clarified that preference of the Employer is to ensure compliance to all technical provisions and standards as originally detailed in this section. In addition, wherever the Employer has not prescribed any Technical standards/specifications for workmanship, material and equipment, the Contractor shall ensure compliance to the highest standards of quality and specifications and after approval of the Employer. Furthermore, wherever the specifications/standards of workmanship, material and equipment are governed/affected by the laws of Pakistan, or regulations/standards/requirements of any of its agencies, the Contractor shall comply accordingly.

3. The contractor shall bring a design consultant and build its cost in the bid.

4. The contract bid value is fixed and final for the given scope of work and not subject to price escalation and variation in quantities; except if and when a variation is required by the Employer.

5. The detailed drawings shall be prepared based on the reference drawings attached with the RFP.

6. The bid value shall be for all civil works and systems required for the project compliant with the attached specifications. It must include design cost, equipment, erection, testing and commissioning cost, installation cost, training cost, documentation cost, maintenance and special tools costs, and services costs.

7. The life of equipment shall be as per criteria mentioned in the detailed design specifications.

8. The design shall involve fresh surveys along the proposed route to adjust for any design changes needed at required locations.

9. If any conflict exists in the specification then the Employer's decision regarding clarification would be binding upon contractor.

B. Design

The Contractor shall submit all deliverables pertaining to the design of the project including the final design report within first six months of signing of the contract. The contractor shall submit the design deliverables to the Employer or his representative for approval in at least three stages.

1. The Contractor shall be responsible for providing complete engineering and design services (Final Design) for the project based on the design criteria and specifications provided in this RFP package.

2. The Contractor shall also provide design services as necessary during construction, testing and commissioning stage in case if design variations are needed.

3. The design includes straddle monorail elevated structure, stations, station entrances, high voltage substations, depot buildings, station concourses/platforms, station architecture, civil/building structure and design of system such as Communications-Based Control System (CBTC), Traction, Power Supply, Communication/telecom System, miscellaneous equipment, Depot, Stabling Yard, Rolling stock, Operation control centre, Automated fare collection, Platform screen door/gates, Elevators/escalators, E & M Building services, Firefighting, HVAC, Executive Rooms etc.

4. The contractor shall seek and obtain approval of the Employer / PMC of all documents and reports including drawings, BOQs, Schedule of Prices, Project Milestones, Payment Milestones. etc, and for any deviation from the design codes and standards mentioned in the attached specifications, prior to adopting the same. Furthermore, the contractor shall also seek and obtain approval of the Employer of design principles, preliminary and reference drawings, design plans, BOQs, Schedule of Prices, Project Milestones, Payment Milestones, Equipment/Systems/sub-systems etc., and for any deviation from the design codes and standards mentioned in the attached specifications, prior to adopting the same. It is however clarified that preference of the Employer is to ensure compliance to all technical provisions and standards as originally detailed in this section.

5. The contractor shall submit electronic copies of all reports/design/drawings (AutoCAD, Word, Excel) with calculation notes, codes and standards.

C. Construction/Procurement

1. The detailed scope of work for construction works shall be as per attached specifications. The activities mentioned in Construction Technical Specifications shall be applicable to all works, if not mentioned specifically in one section.

2. Contractor shall hire all labors, and procure all materials, and equipment etc. required for the project.

3. Contractor shall carry out construction of all works of the project including but not limited to straddle monorail elevated structure, stations, station entrances, high voltage substations, depot buildings, station concourses/platforms, station architecture, civil/building structure and design of system such as Communications-Based Control System (CBTC), Traction, Power Supply,

Communication/telecom System, miscellaneous equipment, Depot, Stabling Yard, Rolling stock, Operation control centre, Automated fare collection, Platform screen door/gates, Elevators/escalators, E & M Building services, Firefighting, HVAC, Executive Rooms etc.Contractor shall conduct procurement of systems e.g. Communications-Based Control System (CBTC), Traction (third rail), Power Supply, Communication/telecom System, equipment, Depot, Rolling stock, Operation control centre, Automated fare collection, Platform screen door/gates, Elevator/escalator, E & M Building services etc.

4. Contractor shall carry out construction work as per approved drawings.

5. Contractor shall provide 10 copies of approved construction drawings to the Employer or its representative.

6. The As-Built Drawings shall be produced by the Contractor on completion of the work.

7. The contractor shall pay for lease/rent of construction yard/working yard.

8. The Contractor shall assist and pay for all required NOCs required for construction of the project.

9. The Contractor shall arrange and pay for all the utilities required for construction of works including but not limited to water, electricity, internet etc.

D. Land Acquisition

The Contractor shall submit detailed land acquisition plan for Depot, Stabling Yard or anywhere else along the corridor showing the proposed areas for acquisition, for Employer's approval and execution. The Employer shall arrange for land acquisition for the project at his own cost.

E. Utilities Relocation

The contractor shall conduct survey for identification of utilities in conflict with the project's Civil Works Structures and/or systems. The Employer shall bear the cost of relocation of utilities. Contractor shall identify the need for land acquisition and relocation of conflicting utilities. Employer shall be responsible for land acquisition and relocation of conflicting utilities at its own cost.

Within 60 days of signing of the Commercial contract, the Contractor shall inform the Employer of the needs for acquisition of right of way and foreseen relocation of conflicting utilities. Relocation of unforeseen utilities and land acquisition requirements forced by detailed design, if any, shall be brought to the notice of the Employer by the Contractor as soon as identified and the time for relocation of the said utilities and said land acquisition shall be agreed upon between the Employer and the Contractor through mutual consultation.

F. Environmental Management plan

The Contractor shall implement the provisions as outlined in the Environment Management Plan and shall do so in accordance with EPA requirements. The responsibility of ensuring compliance with EPA requirements shall rest with the Contractor.

G. Summary Scope of Work

1. Environmental Management and Mitigation Measures

2. All surveys and background data collection required for detailed design including sub-soil investigations, topographic surveys etc

3. Planning, Preparation and coordination for relocation of all conflicting underground, at

grade and overhead Utilities along the corridor through concerned agencies

4. Planning for Land Acquisition along the corridor through concerned agencies.
5. Preparation of Detailed Design Documents, and BOQs for approval of the Employer.
6. Preparation of Schedule of Prices, Project Milestones, and Payment Milestones.
7. Construction Works detailed as follows:
   - Elevated Structure for Straddle Mono-Rail
   - Construction of 04 Nos. Stations
   - Firefighting Works
   - PSD Doors
   - Ticket Counters
   - Escalators
   - Elevators
   - HVAC Works.
   - Construction of 01 Depot adjacent to Lake City Station with park and ride facility and 16 bays for mon-rail.
   - Construction of 03 (132 KV) substations.
   - Signalling & Telecommunication Works
   - Procurement of Rolling Stock – Mono Rail (08 Sets) Panoramic Glass Type 04 Cars in each Set (36 + 105 + 105 + 105)
8. Security Services prior to commissioning
9. Compliance to Service Levels requirements for all services prior to commissioning
10. Provision of warranties of all equipment installed in the project.
11. Commissioning of the complete mono-rail operations Proper training of the Operator staff prior to handing over and commissioning of the mono-rail operations

    Any other design, construction or maintenance requirements for successful commissioning of the project whether directly or indirectly mentioned in the attached design criteria and design specifications.

Punjab MASSTRANSIT AUTHORITY (PMA)



TOURIST GLASS TRAIN FROM ISLAMABAD TO MURREE (LAKE VIEW TO MURREE)

December - 2025

BIDDING DOCUMENTS – VOLUME IV

– Referenced Drawings

National Engineering Services Pakistan (Pvt.) Limited
Construction Manamgement Division, NESPAK House,
1-C, Block N, Model Town Extension, Lahore

Clearance Code	4768/13/BD/1225	Doc. No.	4768 – 04	Rev No.	00

PUNJAB MASSTRANSIT AUTHORITY

FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE

(ALIGNMENT DRAWINGS)

Reference Only

NATIONAL ENGINEERING SERVICES
PAKISTAN (PVT) LTD.

HEAD OFFICE: NESPAK HOUSE, 1-C, BLOCK N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

LIST OF DRAWINGS

SR	DRAWINGS TITLE	DRAWING NO.
	GERNERAL DRAWINGS	
1	GENERAL NOTES	SA593/PMA/MGT/GN-000
2	SYMBOLS & ABBREVATIONS	SA593/PMA/MGT/GS-000
3	LOCATION KEY PLAN	SA593/PMA/MGT/KP-000
4	PROJECT LOCATION PLAN	SA593/PMA/MGT/LP-000
	TYPICAL CROSS SECTIONS & LAYOUT PLAN	
1	LAYOUT PLAN	SA593/PMA/MGT/XS-000-012
2	TYPICAL CROSS SECTION	SA593/PMA/MGTXS-013
	ALIGNMENT LAYOUT PLAN	
1	ALIGNMENT LAYOUT PLAN	SA593/PMA/MGT/PP-000-025
	ROADS SETTINGOUT DATA	
2	ROADS SETTINGOUT DATA	SA593/PMA/MGTSOD-000-002

Reference Only

CLIENT
PUNJAB MASSTRANSIT AUTHORITY

CONSULTANT
NESPAK
NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.
HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	AS
SUBMITTED	AA
RECOMMENDED	
CHD./VER.	MZ
APPROVED	JF

PROJECT
FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE

LIST OF DRAWINGS

DATE: APRIL, 2025
DRAWING No.: SA593/PMA/MGT/LD-000
SCALE: **N.T.S**
REV.: 0

GENERAL DRAWINGS

Reference Only

GENERAL NOTES

1. **These drawings are issued for planning and feasibility purposes only and are not for construction.**
2. **All dimensions are in metric units (SI) unless otherwise noted.**
3. **Alignment has been prepared based on satellite imagery, topographic surveys, reconnaissance data, and preliminary geotechnical investigations.**
4. **The horizontal alignment is shown with chainages at 100m intervals; curves are indicated with radius, deflection angle, and transition lengths.**
5. **Elevations are referenced to Mean Sea Level (MSL) or specified project benchmarks.**
6. **Track centerline, curve data, and structure locations (stations etc.) are preliminary and subject to modification after detailed surveys and investigations.**
7. **The drawings shall be read in conjunction with the Route Selection Report, Geotechnical and Geological Report.**
8. **Any discrepancies or ambiguities shall be referred to the Engineer/Consultant for clarification.**
9. **Safety clearances, right-of-way limits, and environmental considerations shall be confirmed during the detailed design phase.**

Reference Only

CLIENT	PUNJAB MASSTRANSIT AUTHORITY	CONSULTANT	NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.	HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	

REV.	DATE	DESCRIPTION	APPROVED		
04				DRAWN	AS
03				SUBMITTED	AA
02				RECOMMENDED	
01				CHD./VER.	MZ
				APPROVED	JF

PROJECT	GENERAL NOTES	SCALE	
FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE		**N.T.S**	
	DATE	DRAWING No.	REV.
	APRIL, 2025	SA593/PMA/MGT/GN-000	0

SYMBOLS

- Geodetic Control Point
- Spot Level
- Electric Poles
- Transmission Poles
- Trees
- Manhole
- Mosque
- Divider
- FootPath
- Transmission Line
- Road
- Runway
- Pylon
- Air Craft Ramp
- Air Safari Lahore
- Civil Avaition Staff Mess
- Footpath / Green Belt
- Hybrid Avaition (PVT) LTD
- Lahore Flying Club
- Open / Barren Area
- PAF Falcon Complex Society
- Bab-e-Pakistan Baradari
- Builtup
- Cultivation Area
- Fountain
- Graveyard
- Nullah
- Nursery
- Ramp
- Structures
- Water Pond
- Check Post
- CBD Walton Boundary
- BRIDGE
- FLYOVER
- BOX CULVERT
- PIPE CULVERT
- OPTIC FIBER CABLE (OFC)
- GUARD RAIL
- DYKES AND CHUTES
- UTILITY DUCT FOR PTCL
- UTILITY DUCT FOR WAPDA
- BOUNDARY

ABBREVIATIONS

A	AREA
ALIG.	ALIGNMENT
B	BRIDGE
BD	SUFFIX USED FOR CONTROL POINTS OF DASKA BYPASS
BC	BOX CULVERT
B.M	BENCH MARK
B.N	BOLT & NUT
BOP	BEGINNING OF PROJECT
C	CHORD LENGTH
C.B.R	CALIFORNIA BEARING RATIO
C/C	CENTER TO CENTER
CD	CULVERT OVER DRAIN
CHD.	CHECKED
C/L, LC	CENTER LINE
CM/cm	CENTIMETER
CONC.	CONCRETE
CONST/JT	CONSTRUCTION JOINT
CS	CURVE TO SPIRAL
CUL	CULVERT
Cu.m	CUBIC METER
CURVE LEN	VERTICAL CURVE LENGTH
D	DEPTH
Da	DEGREE OF CURVE (BY ARC)
Dc	DEGREE OF CURVE (BY CHORD)
DEG	DEGREE
DIA.	DIAMETER
DIM.	DIMENSION
D/S	DOWNSTREAM
D.S.T	DOUBLE SURFACE TREATMENT
DRG.	DRAWING
E	EASTING , EAST , EXTERNAL DISTANCE (SHIFT)
ELEV./EL	ELEVATION
EOP	END OF PROJECT
EXP/JT	EXPANSION JOINT
G.I	GALVANIZED IRON
H/HOR.	HORIZONTAL
H.T/L.T	HIGH TENSION/LOW TENSION
HF	HEIGHT OF FILL
HFL	HIGH FLOOD LEVEL
HR	SUFFIX USED FOR CONTROL POINTS OF REALIGNED MOTORWAY.
I	DEFLECTION ANGLE (HORIZONTAL CURVE)
Ic	CIRCULAR DEFLECTION ANGLE
I.L	INVERT LEVEL
IS	SPIRAL DEFLECTION ANGLE
K	REFERRED TO STRAIGHT END OF SPIRAL
Kg.	KILOGRAM
KM/Km	ABSCISSA OF PC OF SHIFTED CIRCULAR CURVE KILOMETER
L	LENGTH OF HORIZONTAL CURVE/SPIRAL
LIN.M	LINEAR METER
LHS.	LEFT HAND SIDE
LS	SUFFIX USED FOR CONTROL POINTS OF MAIN MOTORWAY
LT.	LEFT
LT	LONG TANGENT
M/m	METER
M	MIDDLE ORDINATE
MAX.	MAXIMUM
M.H	MAN HOLE
MIN.	MINIMUM
MM/mm	MILLIMETER
0°09'49"	ANGULAR DIMENSION (0 deg, 9 min 49 sec)

LWC	LINED WATER COURSE
N.S.L	NATURAL SURFACE LEVEL (E.G.L)
N	NORTHING, NORTH
NB	NORTH BOUND
NO.	NUMBER
N.T.S	NOT TO SCALE
P	OFFSET OF TANGENT LINE TO PC OF SHIFTED CIRCLE CURVE
PC	POINT OF HORIZONTAL CURVATURE (START OF HORIZONTAL CURVE)
P.C.	REINFORCED CONCRETE PIPE CULVERT
PGL	PROFILE GRADE LINE
P.I.	PLASTICITY INDEX
PI	POINT OF HORIZONTAL INTERSECTION
PL	PLATE
PR	POINT OF ROTATION
PT	POINT OF HORIZONTAL TANGENCY (END OF HORIZONTAL CURVE)
R	RADIUS OF HORIZONTAL CURVE
R.C	REINFORCED CONCRETE
REINF.	REINFORCEMENT
REV.	REVISION
RHS.	RIGHT HAND SIDE
R.O.W.	RIGHT OF WAY
PUP	PEDESTRIAN UNDERPASS
UP-1	UNDERPASS WITH CLEARANCE 5.1m
U-XX	U-TURN
RT.	RIGHT
R/W	RETAINING WALL
RWC	RELOCATED WATER COURSE
S.O.L	SETTINGOUT LINE
S.B.P	SHOULDER BREAK POINT
SVC RD	SERVICE ROAD
SB	SOUTH BOUND
S	SHOULDER
Sq.m	SQUARE METER
S.T.	SHORT TANGENT
ST	SPIRAL TO TANGENT
STA./STA	STATION (CHAINAGE)
STRUCT	STRUCTURE
SUPEREL.	SUPERELEVATION
S'WALK	SIDE WALK
SW	SUBWAY
T	TANGENT LENGTH OF HORIZONTAL CURVE
TS	TANGENT TO SPIRAL
T.S.T	TRIPPLE SURFACE TREATMENT
TAN.	TANGENT
TH	THICKNESS
TR	TRANSITION
TYP.	TYPICAL
U/S	UPSTREAM
V	VERTICAL
VAR.	VARIABLE
VER.	VERIFIED
VPC	VERTICAL POINT OF CURVATURE (START OF VERTICAL CURVE)
VPI	VERTICAL POINT OF INTERSECTION OF PROFILE GRADE.
VPT	VERTICAL POINT OF TANGENCY (END OF VERTICAL CURVE)
W.R	WALTON ROAD
WFS	WIDTH OF FILL SLOPE
W.B.M	WATER BOUND MACADAM
WC	WATER COURSE
WCC	WATER COURSE CULVERT
WS	SUFFIX USED FOR CONTROL

Reference Only

CLIENT

PUNJAB MASSTRANSIT AUTHORITY

CONSULTANT

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.

HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	AS
SUBMITTED	AA
RECOMMENDED	
CHD./VER.	MZ
APPROVED	JF

PROJECT

FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE

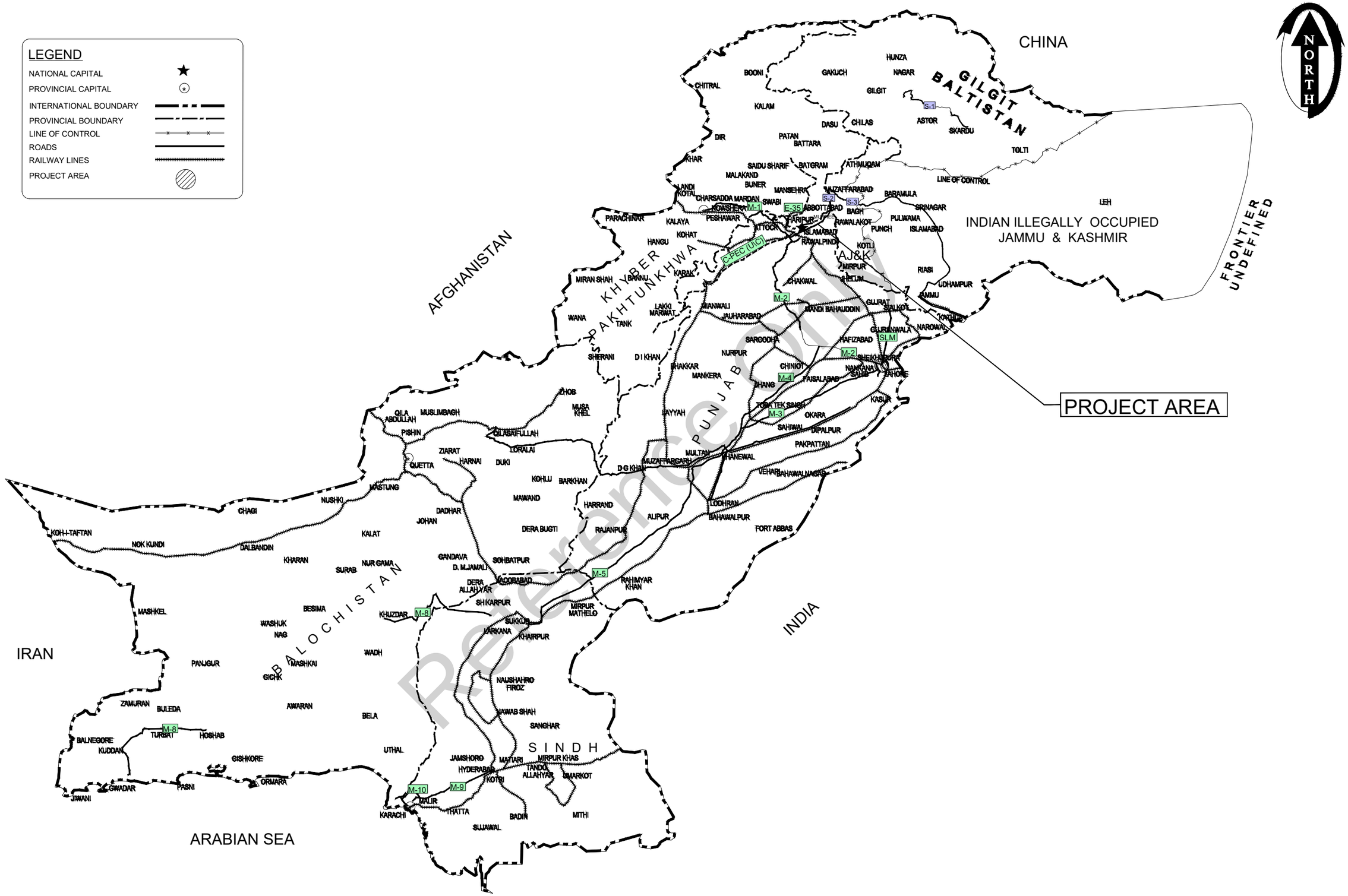
SYMBOLS & ABREVIATIONS

SCALE **N.T.S**

DATE APRIL, 2025

DRAWING No. SA593/PMA/MGT/GS-000

REV. 0



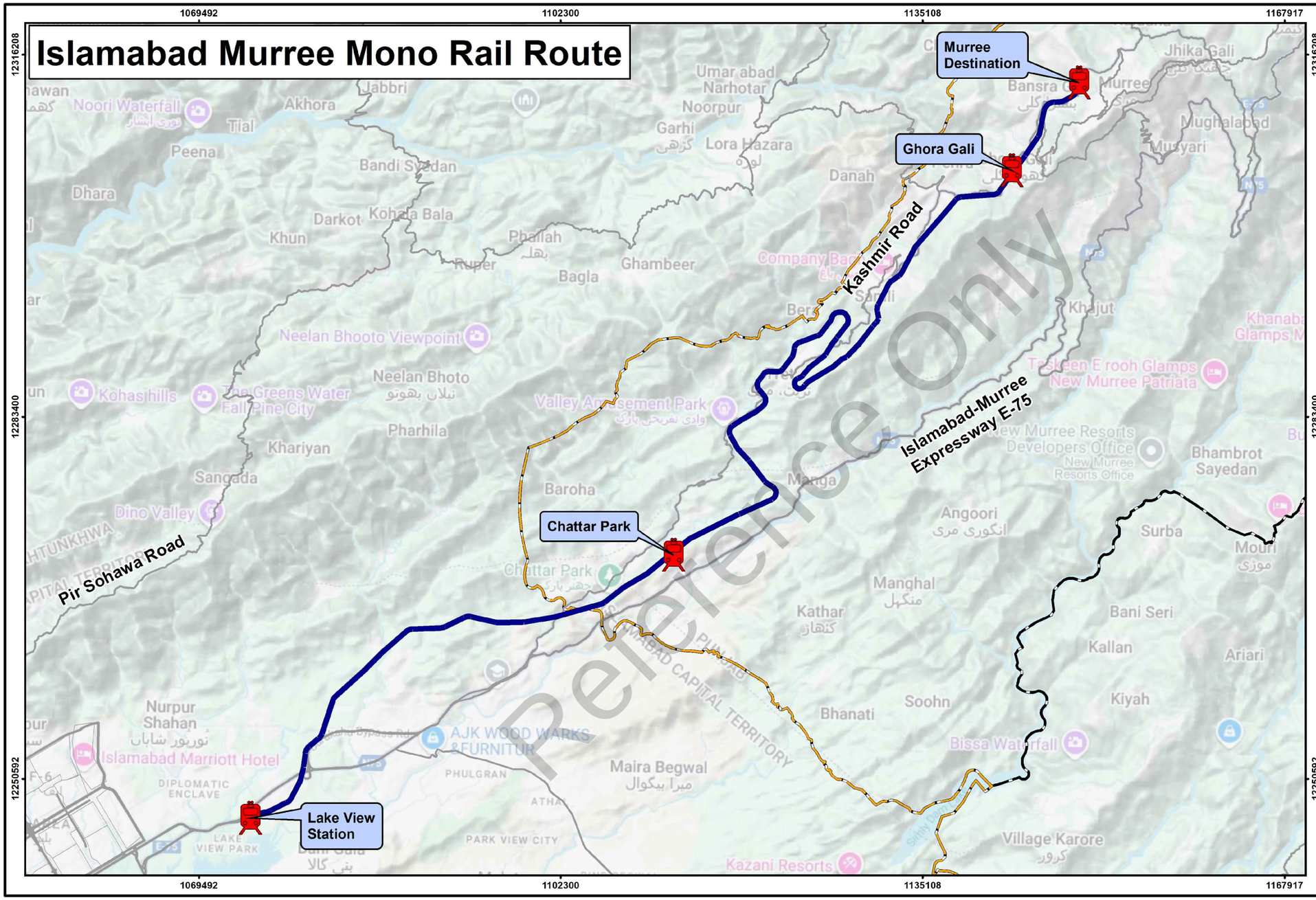
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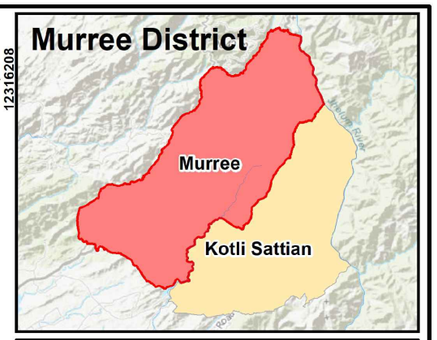
CLIENT: PUNJAB MASSTRANSIT AUTHORITY	CONSULTANT: NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	PROJECT: FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE	LOCATION KEY PLAN	SCALE: N.T.S	

REV.	DATE	DESCRIPTION	APPROVED		
04				DRAWN	AS
03				SUBMITTED	AA
02				RECOMMENDED	
01				CHD./VER.	MZ
				APPROVED	JF

DATE	DRAWING No.	REV.
APRIL, 2025	SA593/PMA/MGT/KP-000	0

Islamabad Murree Mono Rail Route





Legend

- Monorail Stations
- Islamabad Murree Mono Rail Route
- Railway Line
- Road Network
- Tehsil Boundary
- District Boundary

SCALE 1:110,000

0 1.5 3 4.5 Kilometers

Coordinate Reference System

Projection: UTM Zone-43 N

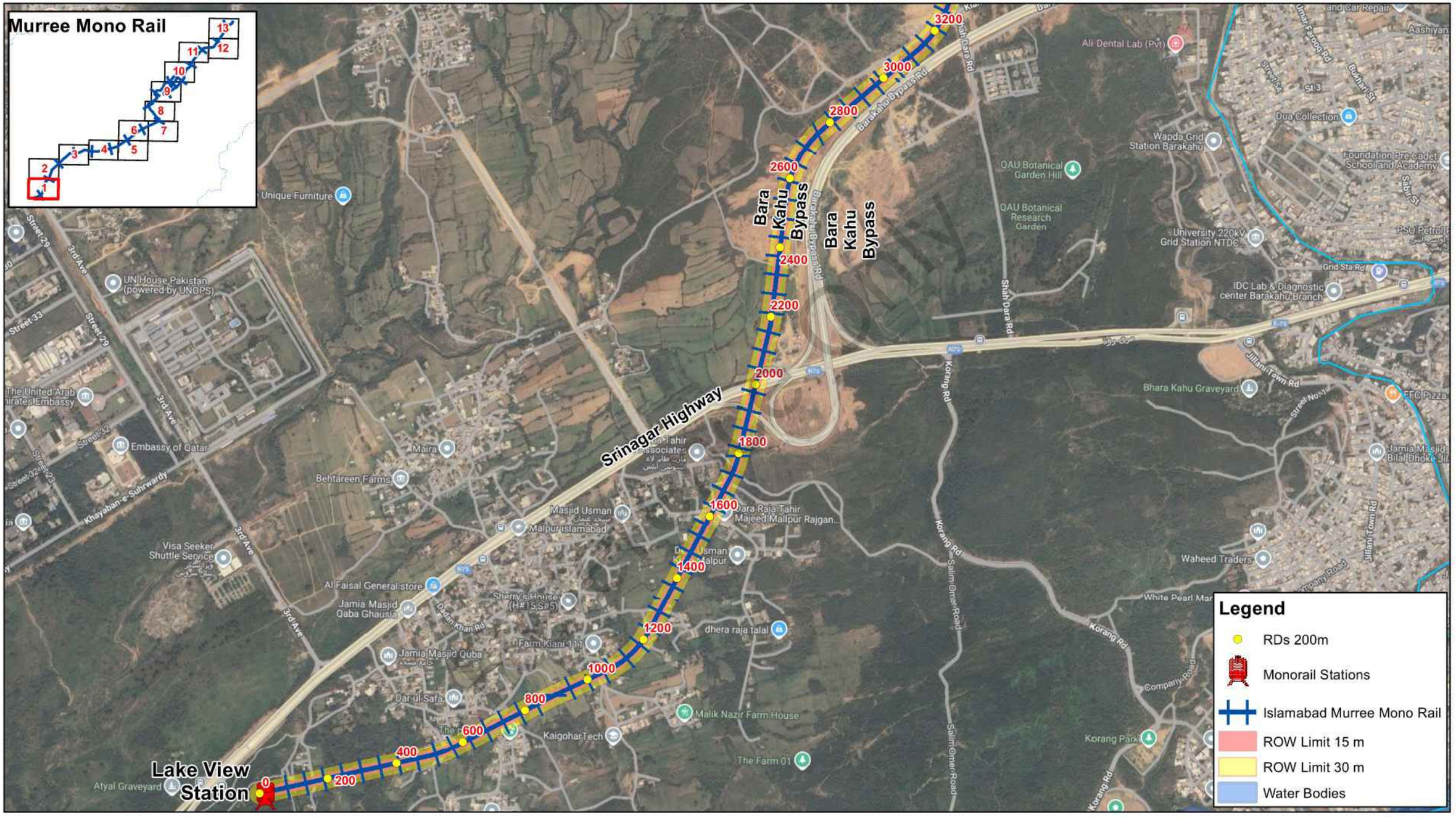
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CLIENT	PUNJAB MASSTRANSIT AUTHORITY	CONSULTANT	NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	PROJECT	FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE
				PROJECT LOCATION KEY PLAN	SCALE N.T.S
				DATE APRIL, 2025	DRAWING No. SA593/PMA/MGT/LP-000
					REV. 0

REV.	DATE	DESCRIPTION	APPROVED		
04				DRAWN	AS
03				SUBMITTED	AA
02				RECOMMENDED	
01				CHD./VER.	MZ
				APPROVED	JF

TYPICAL CROSS SECTIONS & LAYOUT PLAN

Reference Only



For Study Only

CLIENT	PUNJAB MASSTRANSIT AUTHORITY		
CONSULTANT	NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.		
PROJECT	FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE		
TYPICAL CROSS SECTIONS & LAYOUT PLAN			
DATE	APRIL, 2025		
DRAWING No.	SA593/PMA/MGT/XS-000		
SCALE	N.T.S		
REV.	0		

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	AS
SUBMITTED	AA
RECOMMENDED	
CHD./VER.	MZ
APPROVED	JF



For Reference Only

CLIENT	PUNJAB MASSTRANSIT AUTHORITY		
CONSULTANT	NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.		
PROJECT	FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE		
TYPICAL CROSS SECTIONS & LAYOUT PLAN			
SCALE	N.T.S		
DATE	APRIL, 2025		
DRAWING No.	SA593/PMA/MGT/XS-001		
REV.	0		

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	AS
SUBMITTED	AA
RECOMMENDED	
CHD./VER.	MZ
APPROVED	JF



For Review Only

CLIENT

PUNJAB MASSTRANSIT AUTHORITY

CONSULTANT

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.

HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	AS
SUBMITTED	AA
RECOMMENDED	
CHD./VER.	MZ
APPROVED	JF

PROJECT

FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE

TYPICAL CROSS SECTIONS & LAYOUT PLAN

SCALE: N.T.S

DATE: APRIL, 2025

DRAWING No.: SA593/PMA/MGT/XS-002

REV.: 0



Reference Only

CLIENT	PUNJAB MASSTRANSIT AUTHORITY	CONSULTANT	NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.	04				DRAWN	AS	PROJECT: FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE
			HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	03				SUBMITTED	AA	
				02				RECOMMENDED		
				01				CHD./VER.	MZ	
				REV.	DATE	DESCRIPTION	APPROVED	APPROVED	JF	

TYPICAL CROSS SECTIONS & LAYOUT PLAN		SCALE: N.T.S
DATE: APRIL, 2025	DRAWING No.: SA593/PMA/MGT/XS-003	REV.: 0



Preliminary

CLIENT: PUNJAB MASSTRANSIT AUTHORITY	CONSULTANT: NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	04 / 03 / 02 / 01	REV. / DATE / DESCRIPTION	APPROVED	DRAWN AS; SUBMITTED AA; RECOMMENDED; CHD./VER. MZ; APPROVED JF	PROJECT: FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE

TYPICAL CROSS SECTIONS & LAYOUT PLAN			SCALE: N.T.S
DATE: APRIL, 2025	DRAWING No.: SA593/PMA/MGT/XS-004		REV.: 0



CLIENT: PUNJAB MASSTRANSIT AUTHORITY	CONSULTANT: NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	04 / 03 / 02 / 01	DRAWN: AS; SUBMITTED: AA; RECOMMENDED: ; CHD./VER.: MZ; APPROVED: JF	PROJECT: FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE	TYPICAL CROSS SECTIONS & LAYOUT PLAN	SCALE: N.T.S
		REV. / DATE / DESCRIPTION / APPROVED			DATE: APRIL, 2025 — DRAWING No.: SA593/PMA/MGT/XS-005	REV.: 0

Reference Only



For reference Only

CLIENT

PUNJAB MASSTRANSIT AUTHORITY

CONSULTANT

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.

HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	AS
SUBMITTED	AA
RECOMMENDED	
CHD./VER.	MZ
APPROVED	JF

PROJECT

FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE

TYPICAL CROSS SECTIONS & LAYOUT PLAN

SCALE: N.T.S

DATE: APRIL, 2025

DRAWING No.: SA593/PMA/MGT/XS-006

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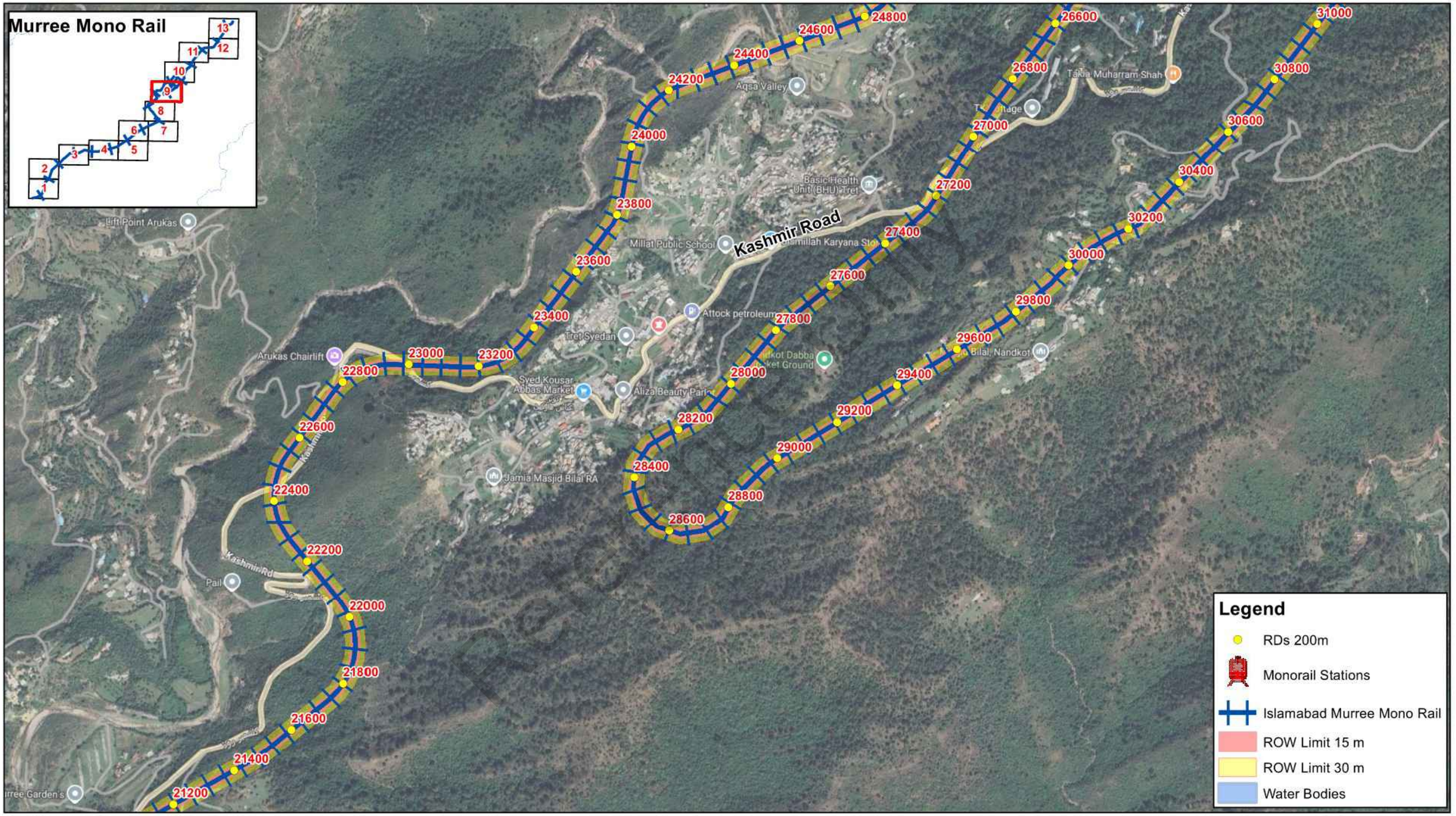


Reference Only

CLIENT	PUNJAB MASSTRANSIT AUTHORITY	CONSULTANT	NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	PROJECT	FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE	TYPICAL CROSS SECTIONS & LAYOUT PLAN
						DATE: APRIL, 2025
						DRAWING No.: SA593/PMA/MGT/XS-007
						SCALE: N.T.S
						REV.: 0

REV.	DATE	DESCRIPTION	APPROVED
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03			
02			
01			

DRAWN	AS
SUBMITTED	AA
RECOMMENDED	
CHD./VER.	MZ
APPROVED	JF



CLIENT

PUNJAB MASSTRANSIT AUTHORITY

CONSULTANT

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.

HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	AS
SUBMITTED	AA
RECOMMENDED	
CHD./VER.	MZ
APPROVED	JF

PROJECT

FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE

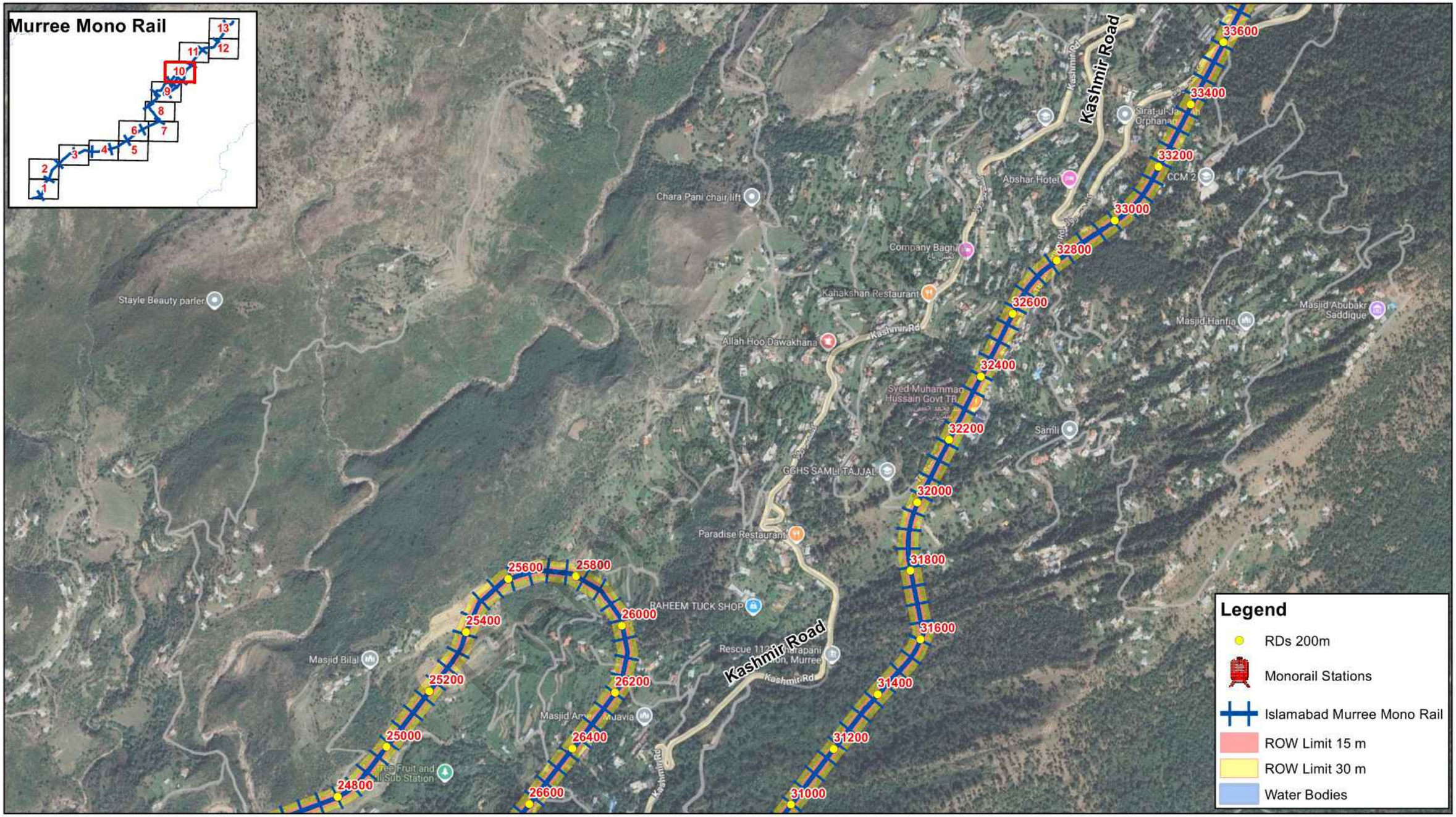
TYPICAL CROSS SECTIONS & LAYOUT PLAN

DATE: APRIL, 2025

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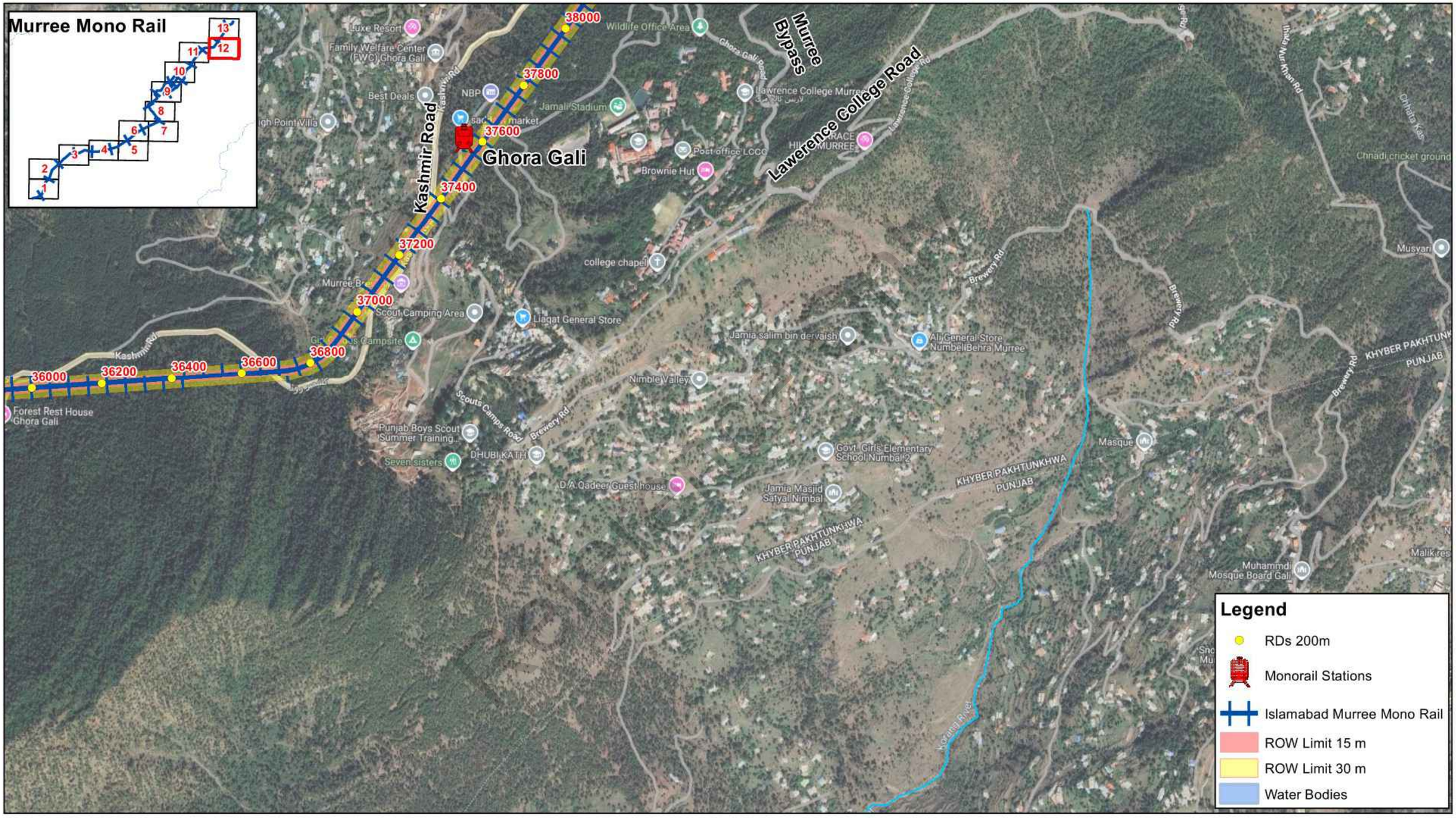
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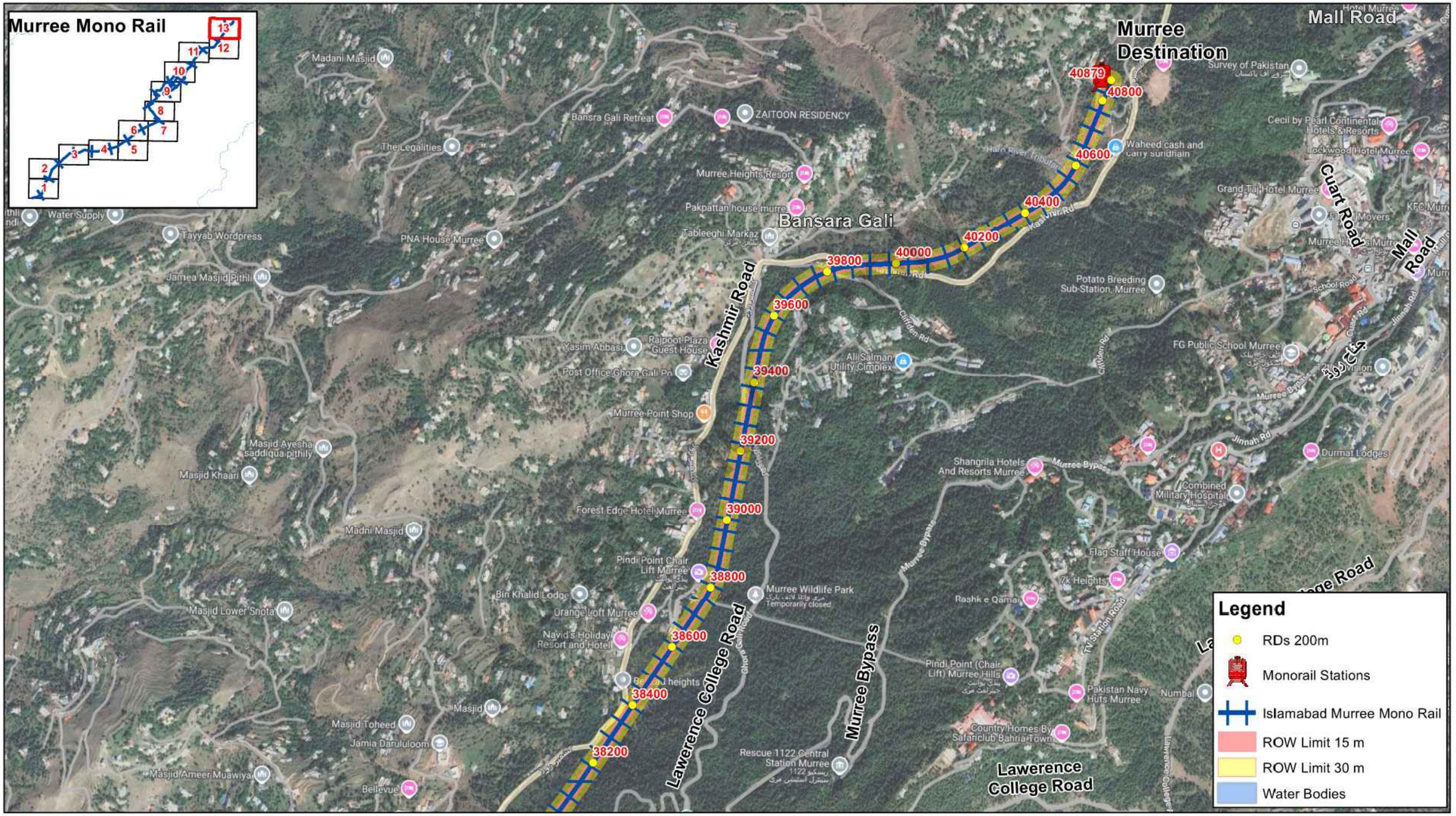
CLIENT: PUNJAB MASSTRANSIT AUTHORITY	CONSULTANT: NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	REV. / DATE / DESCRIPTION: 04, 03, 02, 01	APPROVED	DRAWN: AS; SUBMITTED: AA; RECOMMENDED: ; CHD./VER.: MZ; APPROVED: JF	PROJECT: FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE	TYPICAL CROSS SECTIONS & LAYOUT PLAN; DATE: APRIL, 2025; DRAWING No.: SA593/PMA/MGT/XS-009	SCALE: N.T.S; REV.: 0



CLIENT	PUNJAB MASSTRANSIT AUTHORITY	CONSULTANT	NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.	04				DRAWN	AS	PROJECT	FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE	TYPICAL CROSS SECTIONS & LAYOUT PLAN	SCALE N.T.S
			HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	03				SUBMITTED	AA				
				02				RECOMMENDED				DATE APRIL, 2025	DRAWING No. SA593/PMA/MGT/XS-010
				01				CHD./VER.	MZ				REV. 0
				REV.	DATE	DESCRIPTION	APPROVED	APPROVED	JF				



CLIENT: PUNJAB MASSTRANSIT AUTHORITY	CONSULTANT: NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	04 / 03 / 02 / 01	REV. / DATE / DESCRIPTION / APPROVED	DRAWN AS; SUBMITTED AA; RECOMMENDED; CHD./VER. MZ; APPROVED JF	PROJECT: FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE	TYPICAL CROSS SECTIONS & LAYOUT PLAN; DATE: APRIL, 2025; DRAWING No.: SA593/PMA/MGT/XS-011	SCALE: N.T.S; REV.: 0

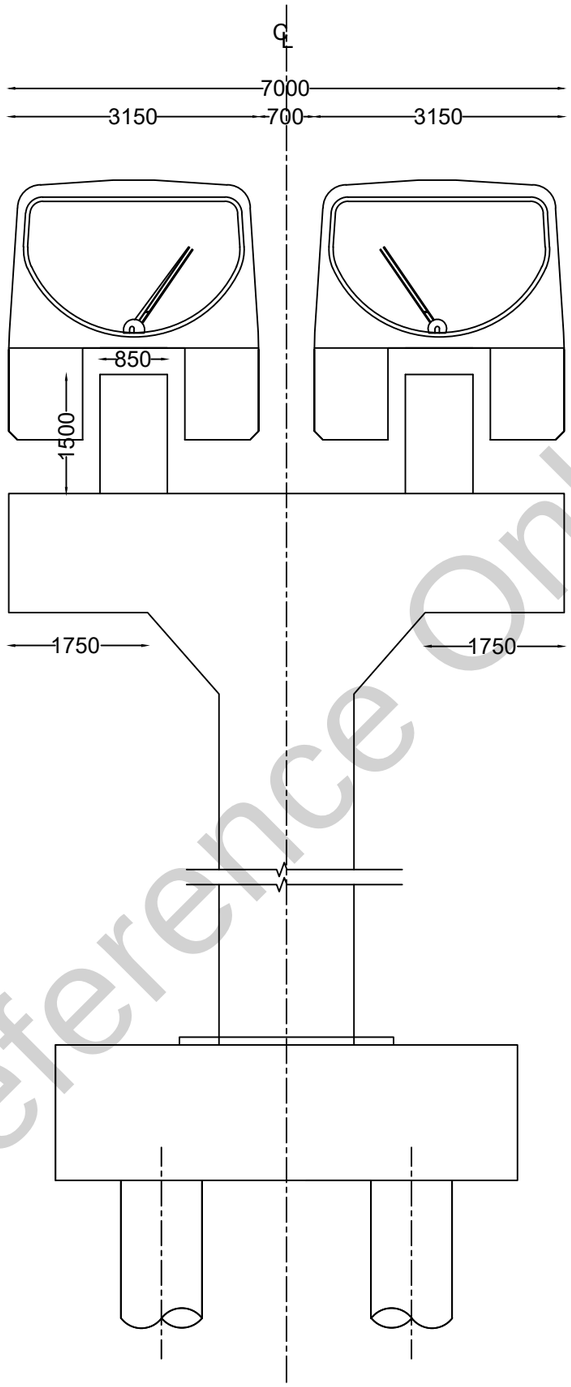


CLIENT: PUNJAB MASSTRANSIT AUTHORITY	CONSULTANT: NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	04			DRAWN	AS
		03			SUBMITTED	AA
		02			RECOMMENDED	
		01			CHD./VER.	MZ
		REV.	DATE	DESCRIPTION / APPROVED	APPROVED	JF

PROJECT: **FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE**

TYPICAL CROSS SECTIONS & LAYOUT PLAN

DATE: APRIL, 2025 | DRAWING No.: SA593/PMA/MGT/XS-012 | SCALE: N.T.S | REV.: 0



Reference Only

TYPICAL CROSS SECTION MONO RAIL

Notes:

1. **All dimensions shown on the cross section are in millimeter otherwise noted.**

CLIENT	PUNJAB MASSTRANSIT AUTHORITY	CONSULTANT	NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
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03			
02			
01			

DRAWN	AS
SUBMITTED	AA
RECOMMENDED	
CHD./VER.	MZ
APPROVED	JF

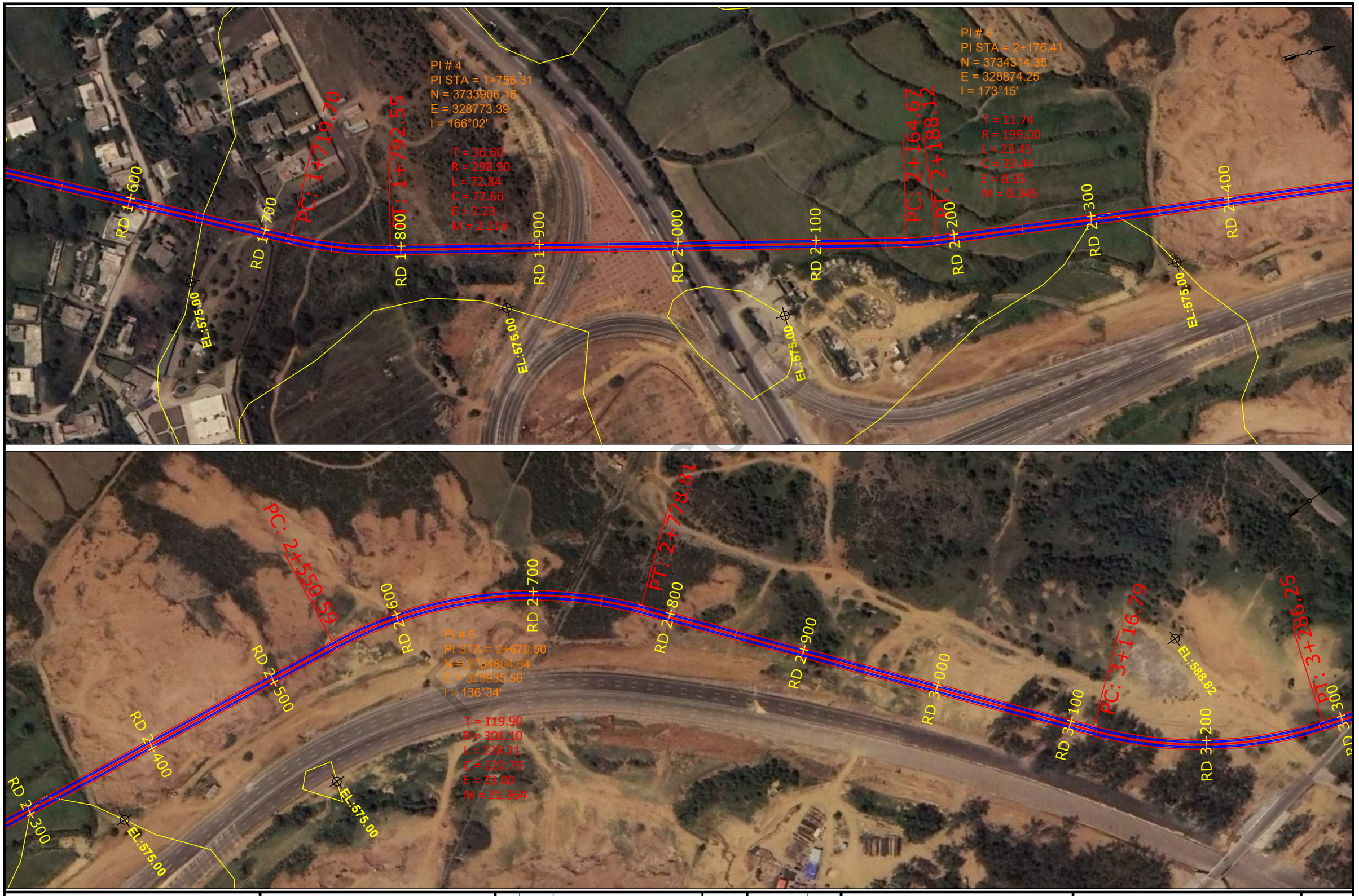
PROJECT	FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE	TYPICAL CROSS SECTIONS & LAYOUT PLAN	SCALE N.T.S
		DATE APRIL, 2025 / DRAWING No. SA593/PMA/MGT/XS-013	REV. 0

ALIGNMENT LAYOUT PLAN

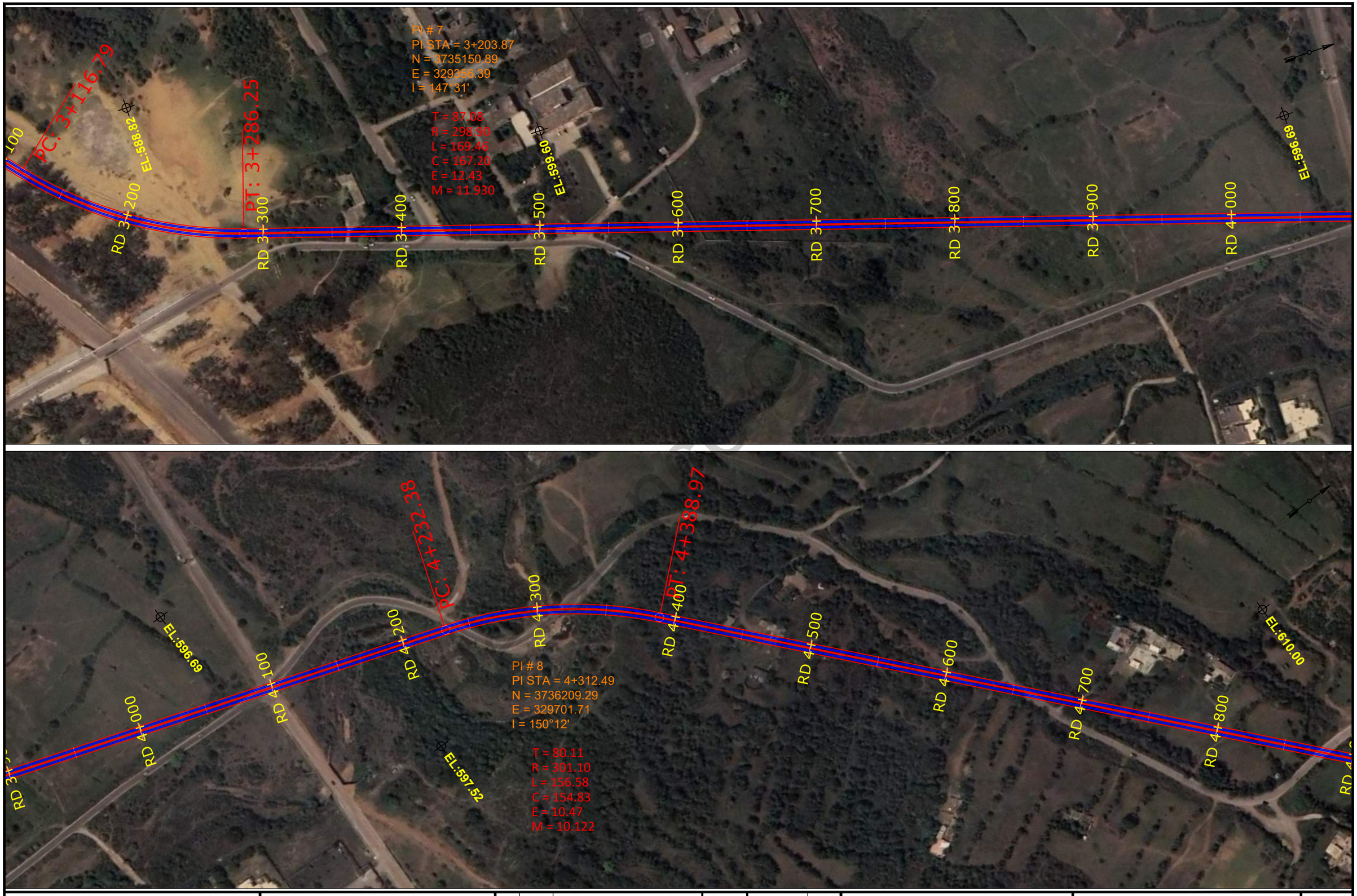
Reference Only



CLIENT	CONSULTANT					PROJECT	SCALE
PUNJAB MASSTRANSIT AUTHORITY	NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.	04			DRAWN AS	FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE	1:2500
	HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	03			SUBMITTED AA	ALIGNMENT LAYOUT PLAN (RD-0+000 - 1+600)	
		02			RECOMMENDED		
		01			CHD./VER. MZ	DATE: APRIL, 2025	DRAWING No.: SA593/PMA/MGT/PP-000
		REV.	DATE	DESCRIPTION	APPROVED APPROVED JF		REV.: 0



CLIENT: PUNJAB MASSTRANSIT AUTHORITY	CONSULTANT: NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	04 / 03 / 02 / 01	DRAWN: AS; SUBMITTED: AA; RECOMMENDED: ; CHD./VER.: MZ; APPROVED: JF	PROJECT: FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE	ALIGNMENT LAYOUT PLAN (RD-1+600 - 3+200)	SCALE: 1:2500
		REV. / DATE / DESCRIPTION / APPROVED			DATE: APRIL, 2025	DRAWING No.: SA593/PMA/MGT/PP-001	REV.: 0



CLIENT	PUNJAB MASSTRANSIT AUTHORITY	CONSULTANT	NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	04				DRAWN AS
				03				SUBMITTED AA
				02				RECOMMENDED
				01				CHD./VER. MZ
				REV.	DATE	DESCRIPTION	APPROVED	APPROVED JF

PROJECT	**FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE**	**ALIGNMENT LAYOUT PLAN (RD-3+200 - 4+800)**	SCALE **1:2500**
		DATE APRIL, 2025	DRAWING No. SA593/PMA/MGT/PP-002
			REV. 0



CLIENT: PUNJAB MASSTRANSIT AUTHORITY	CONSULTANT: NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	04 / 03 / 02 / 01	REV. / DATE / DESCRIPTION	APPROVED	DRAWN AS; SUBMITTED AA; RECOMMENDED; CHD./VER. MZ; APPROVED JF	PROJECT: FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE

ALIGNMENT LAYOUT PLAN (RD-4+800 - 6+400)		SCALE	1:2500
DATE: APRIL, 2025	DRAWING No.: SA593/PMA/MGT/PP-003	REV.	0



CLIENT	PUNJAB MASSTRANSIT AUTHORITY	
CONSULTANT	NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	
PROJECT	FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE	
ALIGNMENT LAYOUT PLAN (RD-6+400 - 8+000)		
SCALE	1:2500	
DATE	APRIL, 2025	
DRAWING No.	SA593/PMA/MGT/PP-004	
REV.	0	

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	AS
SUBMITTED	AA
RECOMMENDED	
CHD./VER.	MZ
APPROVED	JF



CLIENT

PUNJAB MASSTRANSIT AUTHORITY

CONSULTANT

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.

HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	AS
SUBMITTED	AA
RECOMMENDED	
CHD./VER.	MZ
APPROVED	JF

PROJECT

FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE

ALIGNMENT LAYOUT PLAN (RD-8+000 - 9+600)

SCALE 1:2500

DATE APRIL, 2025

DRAWING No. SA593/PMA/MGT/PP-005

REV. 0



CLIENT

PUNJAB MASSTRANSIT AUTHORITY

CONSULTANT

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.

HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	AS
SUBMITTED	AA
RECOMMENDED	
CHD./VER.	MZ
APPROVED	JF

PROJECT

FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE

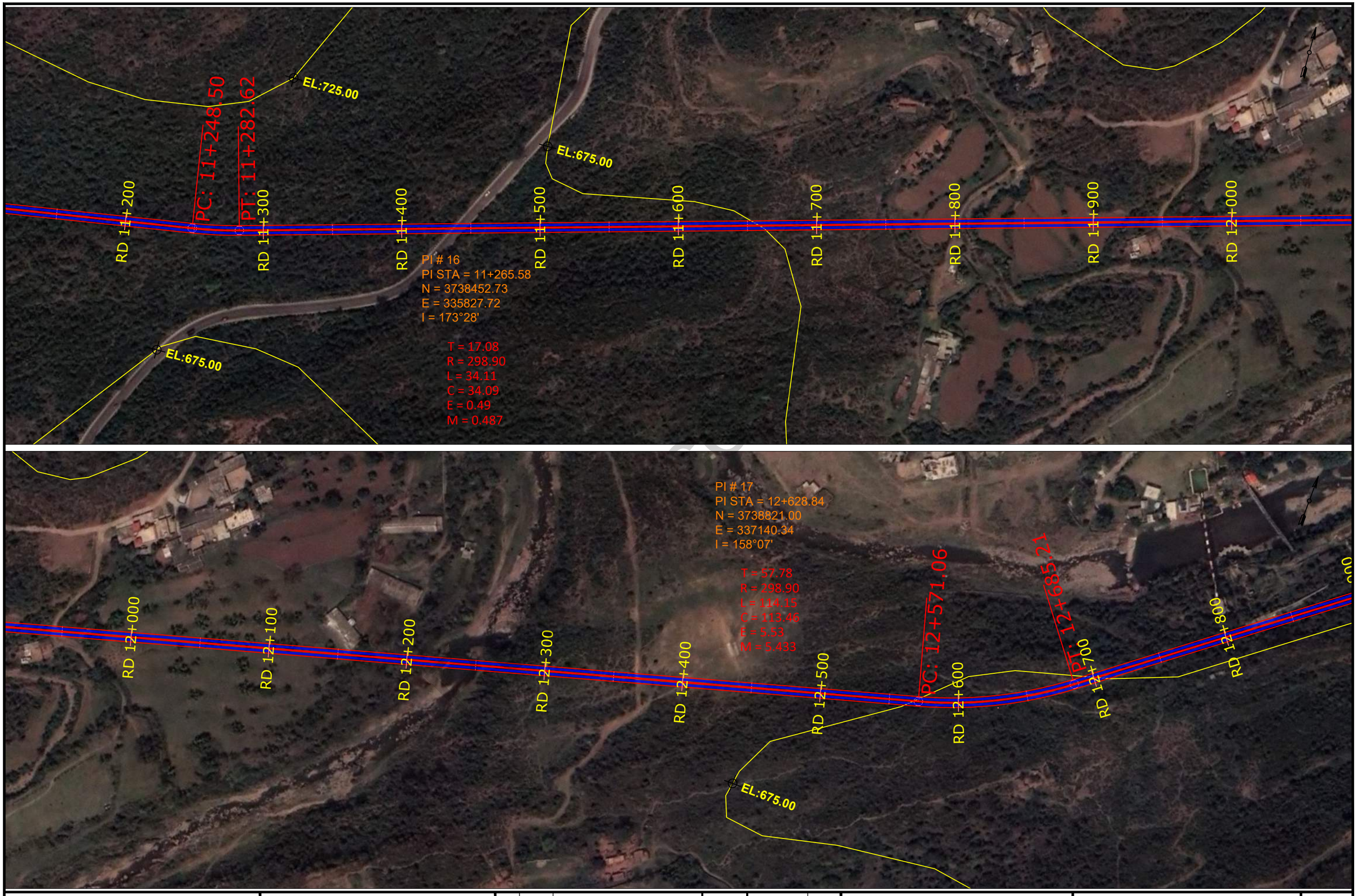
ALIGNMENT LAYOUT PLAN (RD-9+600 - 11+200)

SCALE: 1:2500

DATE: APRIL, 2025

DRAWING No.: SA593/PMA/MGT/PP-006

REV.: 0



CLIENT

PUNJAB MASSTRANSIT AUTHORITY

CONSULTANT

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.

HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	AS
SUBMITTED	AA
RECOMMENDED	
CHD./VER.	MZ
APPROVED	JF

PROJECT

FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE

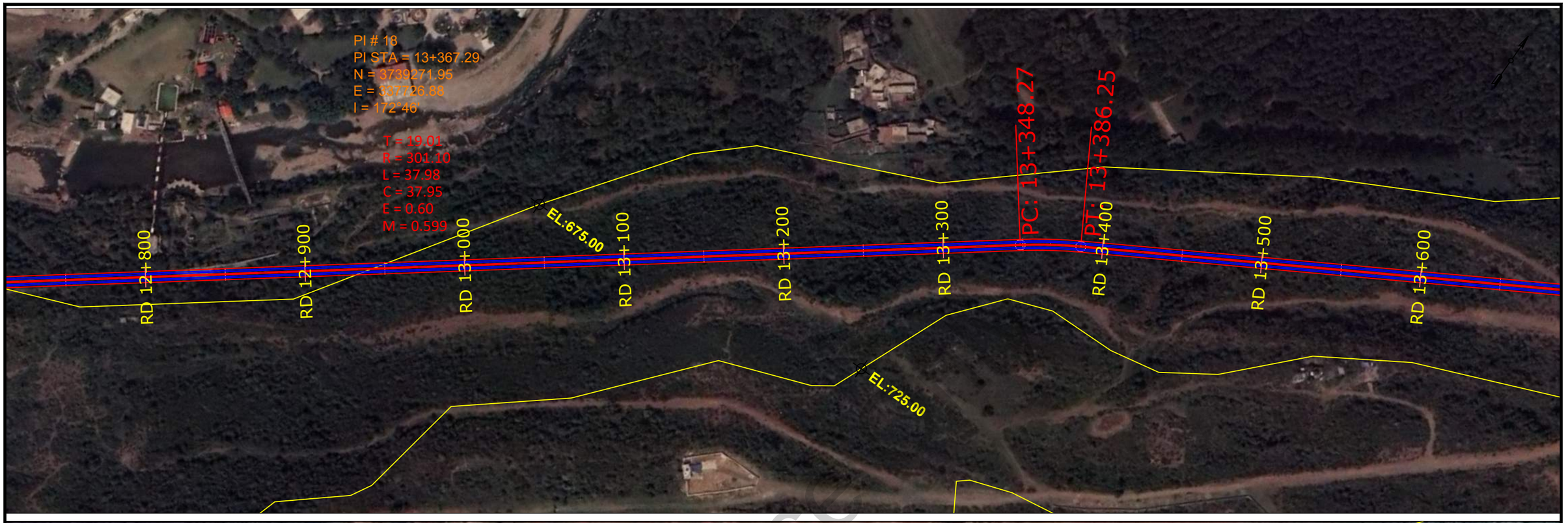
ALIGNMENT LAYOUT PLAN (RD-11+200 - 12+800)

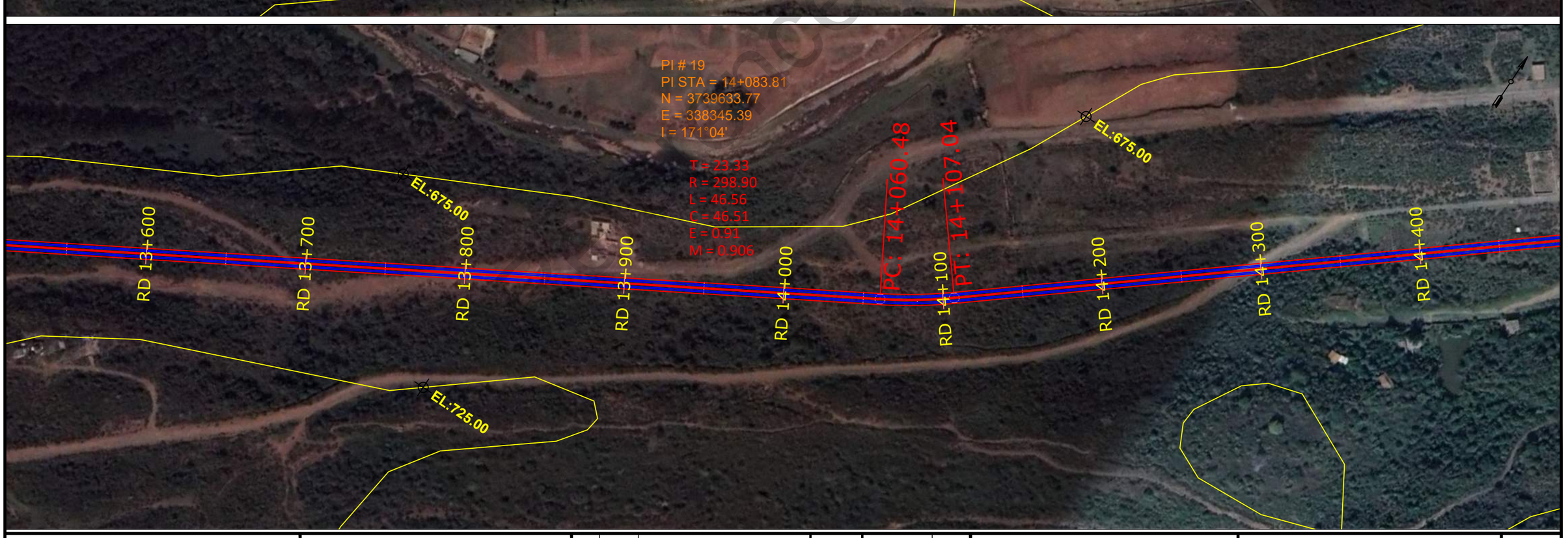
SCALE: 1:2500

DATE: APRIL, 2025

DRAWING No.: SA593/PMA/MGT/PP-007

REV.: 0





CLIENT

PUNJAB MASSTRANSIT AUTHORITY

CONSULTANT

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.

HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	AS
SUBMITTED	AA
RECOMMENDED	
CHD./VER.	MZ
APPROVED	JF

PROJECT

FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE

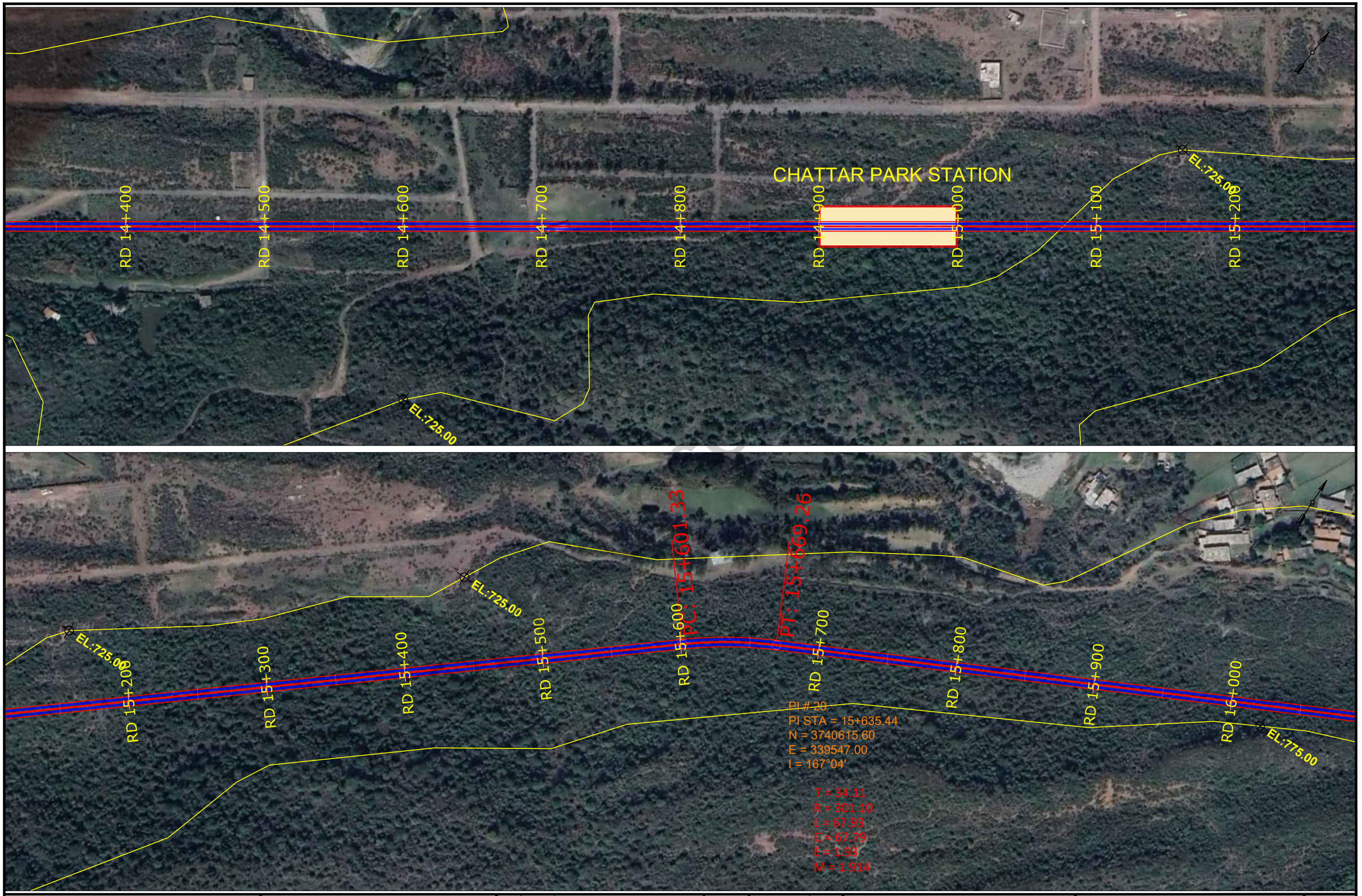
ALIGNMENT LAYOUT PLAN (RD-12+800 - 14+400)

SCALE **1:2500**

DATE APRIL, 2025

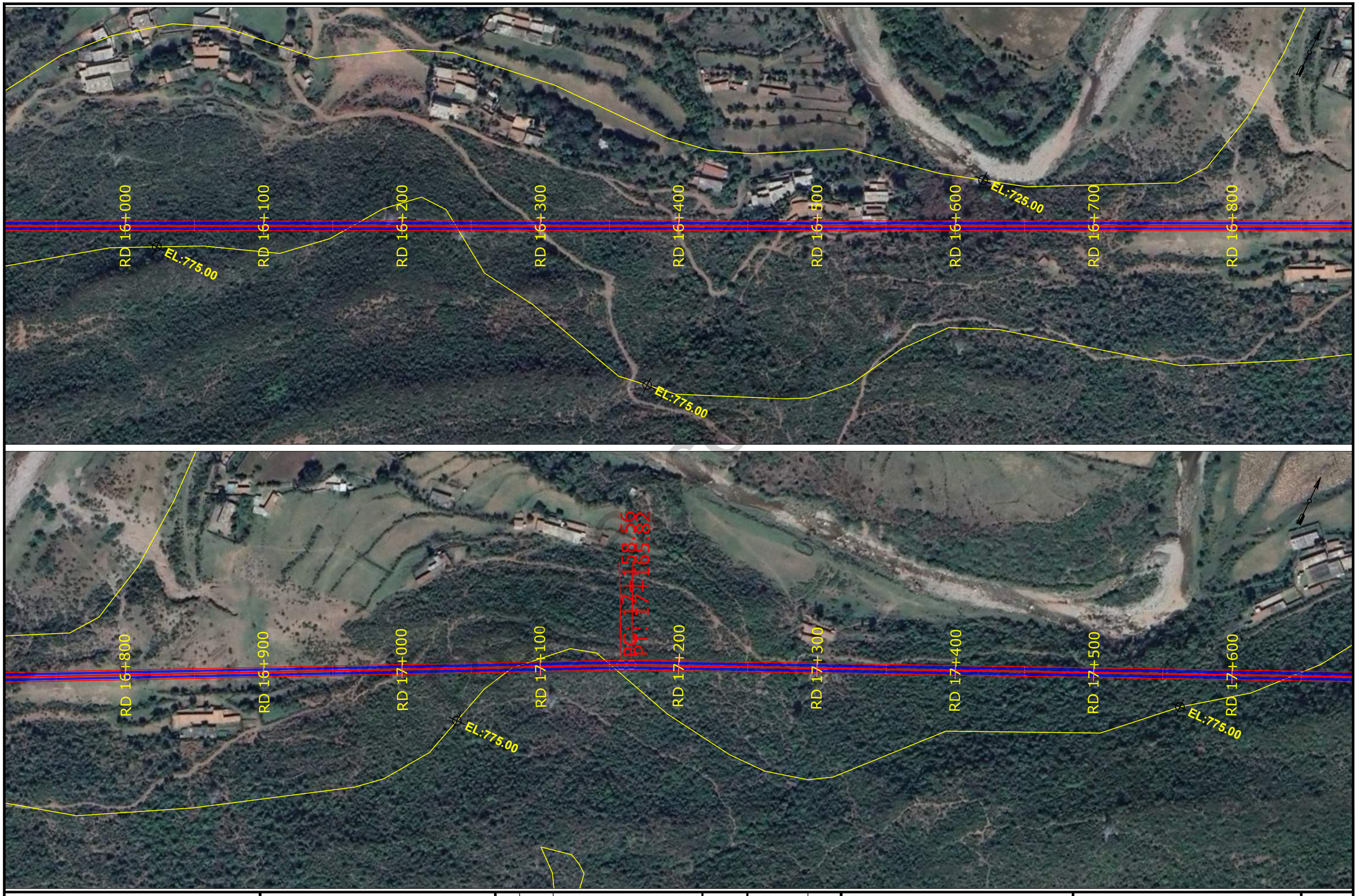
DRAWING No. SA593/PMA/MGT/PP-008

REV. 0



CLIENT: PUNJAB MASSTRANSIT AUTHORITY	CONSULTANT: NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	04 / 03 / 02 / 01	REV. / DATE / DESCRIPTION	APPROVED	DRAWN AS; SUBMITTED AA; RECOMMENDED; CHD./VER. MZ; APPROVED JF	PROJECT: FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE

ALIGNMENT LAYOUT PLAN (RD-14+400 - 16+000)		SCALE	1:2500
DATE: APRIL, 2025	DRAWING No.: SA593/PMA/MGT/PP-009	REV.	0



CLIENT

PUNJAB MASSTRANSIT AUTHORITY

CONSULTANT

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.

HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	AS
SUBMITTED	AA
RECOMMENDED	
CHD./VER.	MZ
APPROVED	JF

PROJECT

FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE

ALIGNMENT LAYOUT PLAN (RD-16+000 - 17+600)

SCALE: **1:2500**

DATE: APRIL, 2025

DRAWING No.: SA593/PMA/MGT/PP-010

REV.: 0

RD 17+500
RD 17+600
RD 17+700
RD 17+800
RD 17+900
RD 18+000
RD 18+100
RD 18+200
RD 18+300
RD 18+400
RD 18+500
EL:775.00
EL:775.00
EL:775.00
EL:775.00
PC: 18+152.61
PT: 18+576.79
PC: 18+768.39
PT: 18+837.42
RD 18+300
RD 18+400
RD 18+500
RD 18+600
RD 18+700
RD 18+800
RD 18+900
RD 19+000
RD 19+100
RD 19+200
EL:775.00
EL:775.00
EL:775.00
EL:775.00

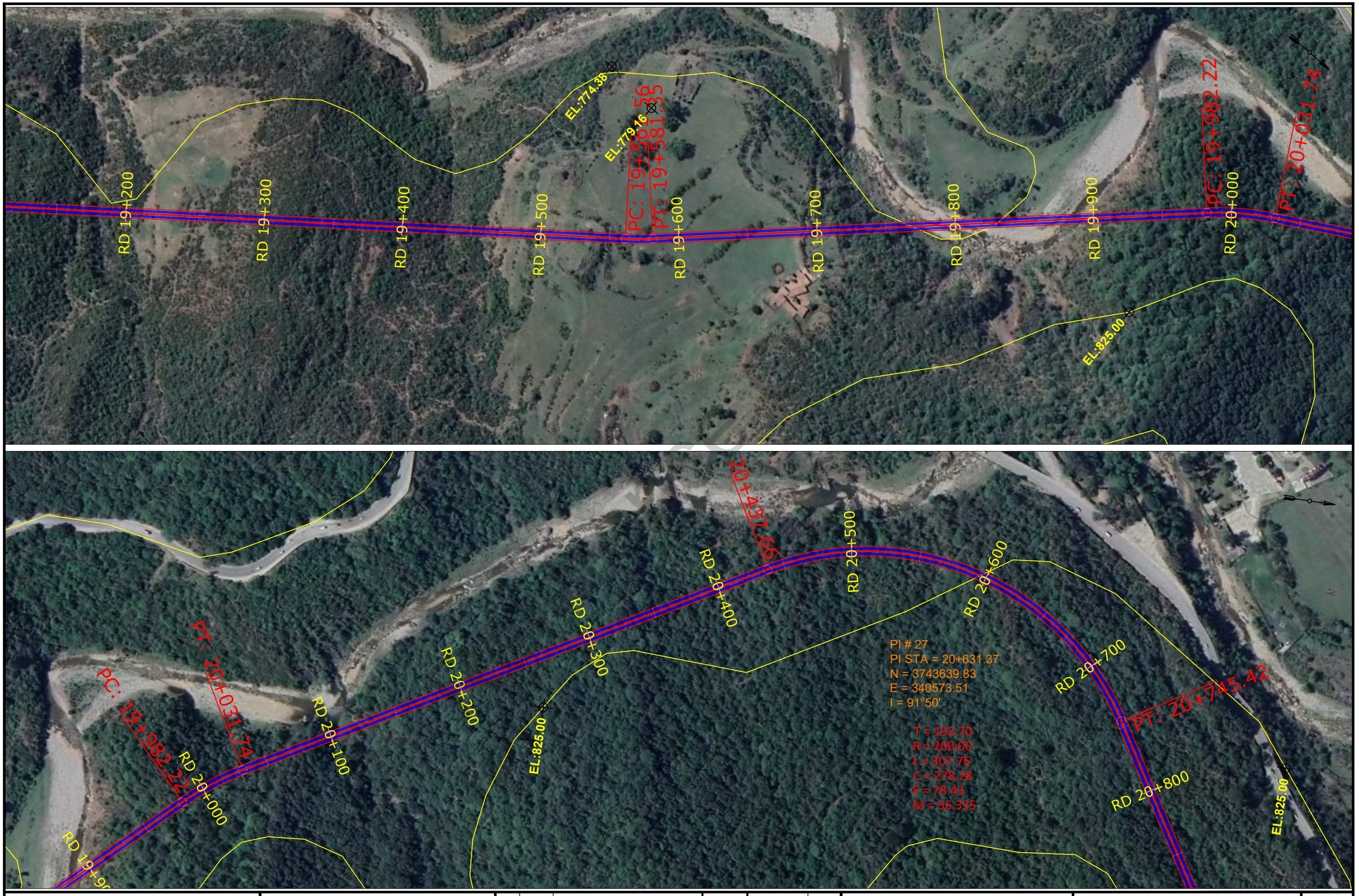
PI # 24
PI STA = 18+803.25
N = 3742169.71
E = 341647.67
I = 160°13'

T = 34.86
R = 200.00
L = 69.08
C = 68.69
E = 3.02
M = 2.971

CLIENT	PUNJAB MASSTRANSIT AUTHORITY	
CONSULTANT	NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	
PROJECT	FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE	
ALIGNMENT LAYOUT PLAN (RD-17+600 - 19+200)		
SCALE	1:2500	
DATE	APRIL, 2025	
DRAWING No.	SA593/PMA/MGT/PP-011	
REV.	0	

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	AS
SUBMITTED	AA
RECOMMENDED	
CHD./VER.	MZ
APPROVED	JF



CLIENT

PUNJAB MASSTRANSIT AUTHORITY

CONSULTANT

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.

HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	AS
SUBMITTED	AA
RECOMMENDED	
CHD./VER.	MZ
APPROVED	JF

PROJECT

FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE

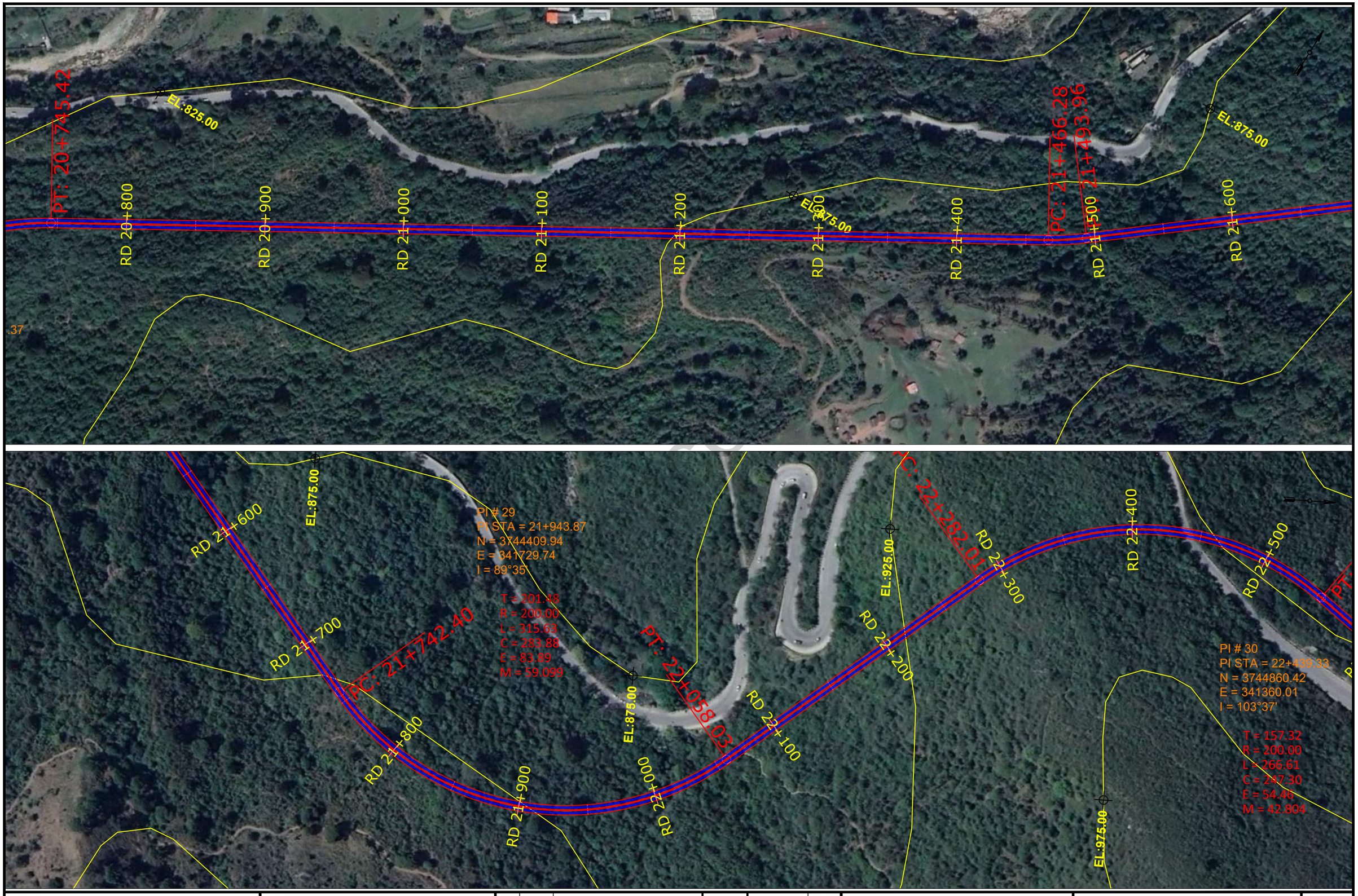
ALIGNMENT LAYOUT PLAN (RD-19+200 - 20+800)

SCALE **1:2500**

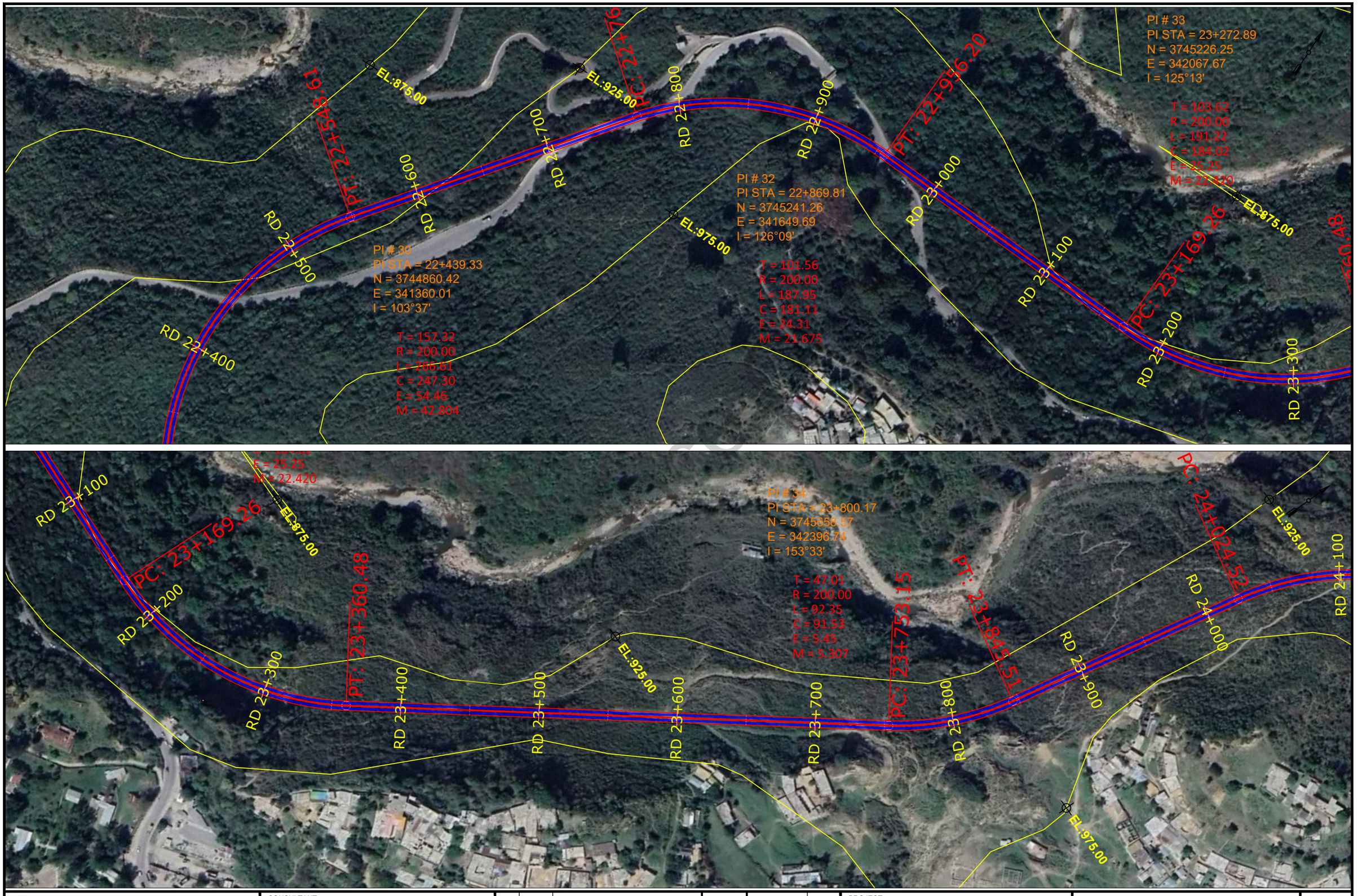
DATE: APRIL, 2025

DRAWING No.: SA593/PMA/MGT/PP-012

REV.: 0



CLIENT: PUNJAB MASSTRANSIT AUTHORITY	CONSULTANT: NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	04 / 03 / 02 / 01 / REV. / DATE / DESCRIPTION	APPROVED	DRAWN AS; SUBMITTED AA; RECOMMENDED; CHD./VER. MZ; APPROVED JF	PROJECT: FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE	ALIGNMENT LAYOUT PLAN (RD-20+800 - 22+400)	SCALE: 1:2500
						DATE: APRIL, 2025 / DRAWING No.: SA593/PMA/MGT/PP-013	REV.: 0



CLIENT: PUNJAB MASSTRANSIT AUTHORITY	CONSULTANT: NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	04 / 03 / 02 / 01	REV. / DATE / DESCRIPTION	APPROVED	DRAWN AS; SUBMITTED AA; RECOMMENDED; CHD./VER. MZ; APPROVED JF	PROJECT: FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE

ALIGNMENT LAYOUT PLAN (RD-22+400 - 24+000)			SCALE: 1:2500
DATE: APRIL, 2025	DRAWING No.: SA593/PMA/MGT/PP-014		REV.: 0

PC: 24+024.52
RD 24+000
RD 24+100
EL:925.00
RD 24+200
PT: 24+229.73
RD 24+300
RD 24+400
RD 24+500
RD 24+600
RD 24+700
EL:975.00
PC: 24+785.96
RD 24+800
PT: 24+898.15
RD 24+900

PI # 35
PI STA = 24+137.18
N = 3745991.24
E = 342460.33
I = 121°13'

T = 112.67
R = 200.00
L = 205.21
C = 196.32
E = 29.55
M = 25.747

EL:975.00

PI # 36
PI STA = 24+843.57
N = 3746244.38
E = 343141.32
I = 147°52'

T = 57.61
R = 200.00
L = 112.19
C = 110.73
E = 8.13
M = 7.815

PI # 37
PI STA = 25+355.06
N = 3746652.75
E = 343454.31
I = 155°03'

T = 44.25
R = 200.00
L = 87.09
C = 86.40
E = 4.84
M = 4.722

EL:1025.00
PC: 25+310.82
PRC: 25+397.91
RD 24+700
EL:975.00
RD 24+800
PT: 24+898.15
RD 24+900
RD 25+000
RD 25+100
EL:975.00
RD 25+200
RD 25+300
RD 25+400
RD 25+500
RD 25+600
EL:1025.00

PI # 38
PI STA = 25+719.19

CLIENT	PUNJAB MASSTRANSIT AUTHORITY	
CONSULTANT	NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	AS
SUBMITTED	AA
RECOMMENDED	
CHD./VER.	MZ
APPROVED	JF

PROJECT
FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE

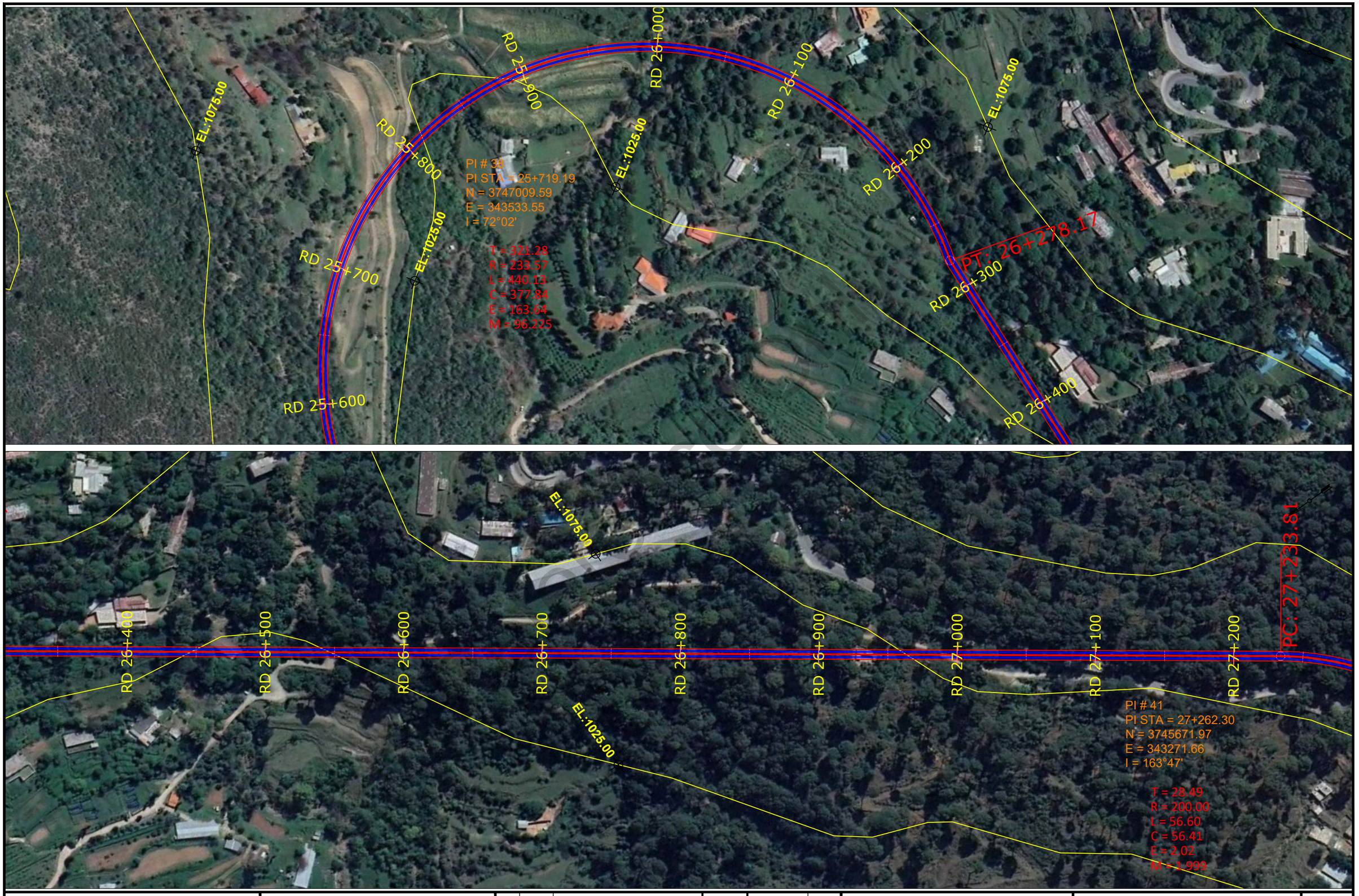
ALIGNMENT LAYOUT PLAN (RD-24+000 - 25+600)

SCALE: 1:2500

DATE: APRIL, 2025

DRAWING No.: SA593/PMA/MGT/PP-015

REV.: 0



CLIENT

PUNJAB MASSTRANSIT AUTHORITY

CONSULTANT

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.

HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	AS
SUBMITTED	AA
RECOMMENDED	
CHD./VER.	MZ
APPROVED	JF

PROJECT

FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE

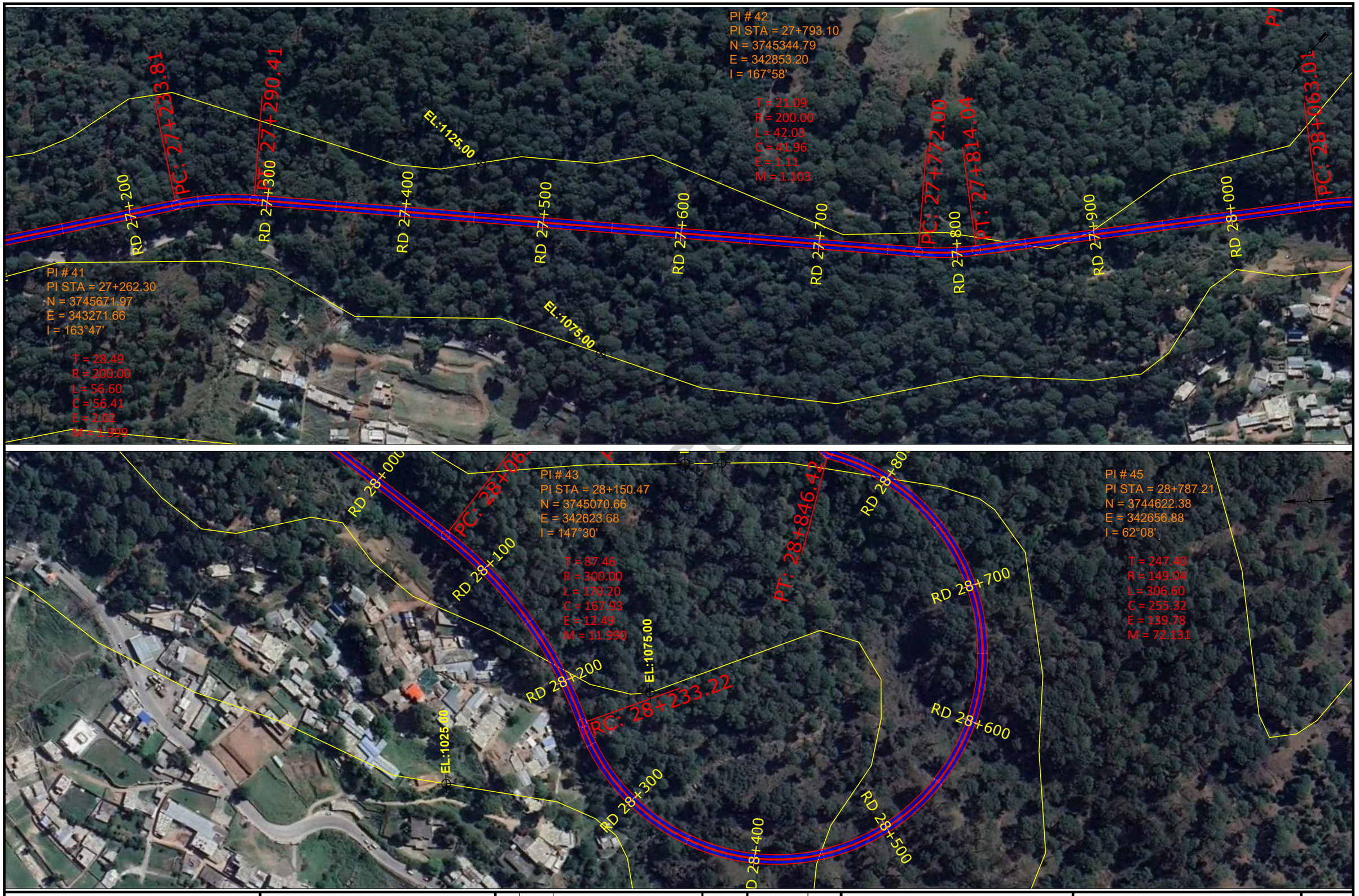
ALIGNMENT LAYOUT PLAN (RD-25+600 - 27+200)

SCALE: **1:2500**

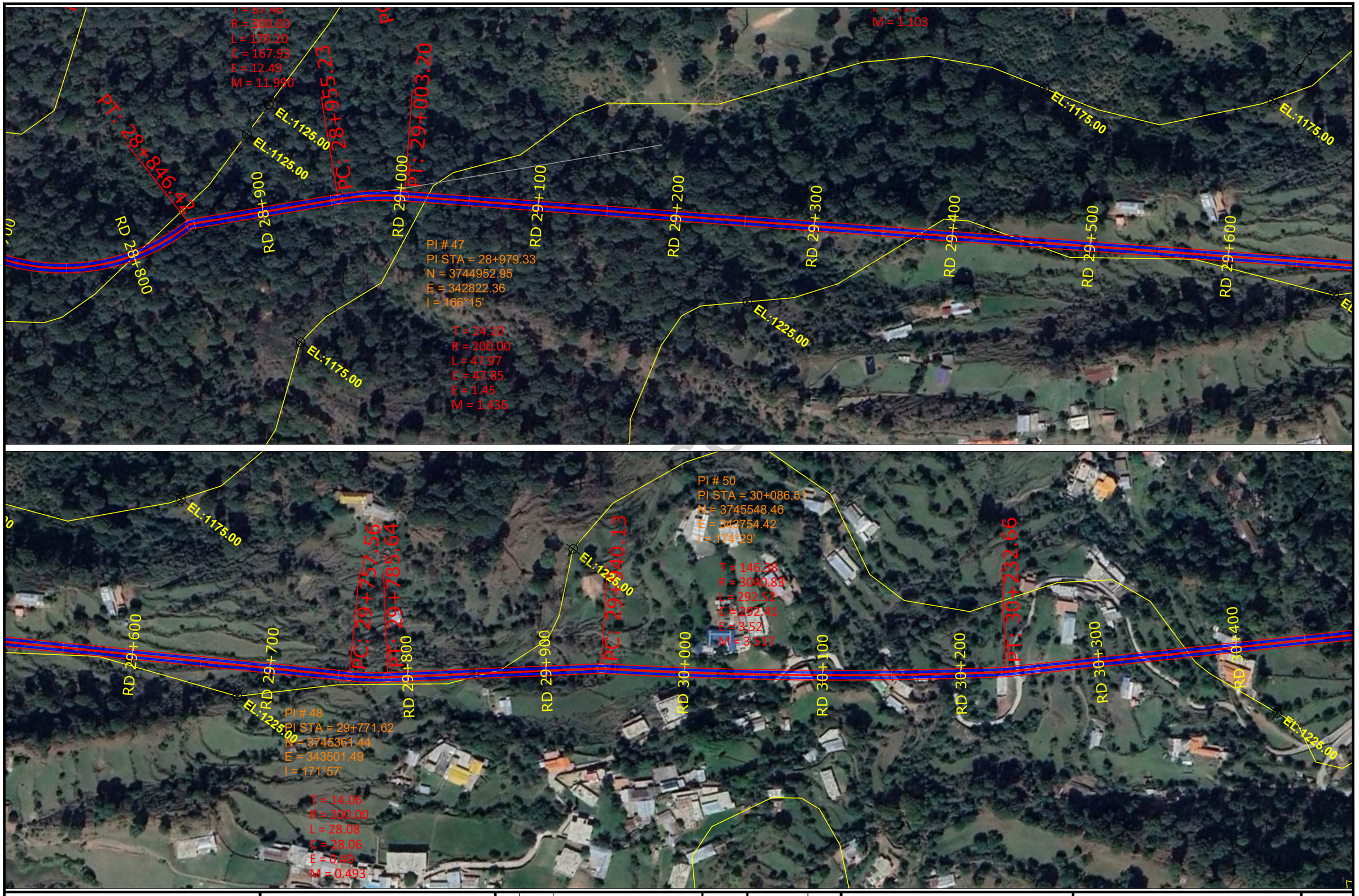
DATE: APRIL, 2025

DRAWING No.: SA593/PMA/MGT/PP-016

REV.: 0



CLIENT: PUNJAB MASSTRANSIT AUTHORITY	CONSULTANT: NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	04 / 03 / 02 / 01 / REV. / DATE / DESCRIPTION / APPROVED	DRAWN AS; SUBMITTED AA; RECOMMENDED; CHD./VER. MZ; APPROVED JF	PROJECT: FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE	ALIGNMENT LAYOUT PLAN (RD-27+200 - 28+800)	SCALE 1:2500
					DATE: APRIL, 2025	DRAWING No. SA593/PMA/MGT/PP-017
						REV. 0



CLIENT: PUNJAB MASSTRANSIT AUTHORITY	CONSULTANT: NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	04 / 03 / 02 / 01	REV. / DATE / DESCRIPTION	APPROVED	DRAWN AS; SUBMITTED AA; RECOMMENDED; CHD./VER. MZ; APPROVED JF	PROJECT: FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE

ALIGNMENT LAYOUT PLAN (RD-28+800 - 30+400)			SCALE: 1:2500
DATE: APRIL, 2025	DRAWING No.: SA593/PMA/MGT/PP-018		REV.: 0

PI # 52
PI STA = 30+648.35
N = 3745923.00
E = 344173.19
I = 170°25'

T = 16.75
R = 200.00
L = 33.41
C = 33.39
E = 0.70
M = 0.696

PC: 30+631.60
PT: 30+665.02

RD 30+400
RD 30+500
RD 30+600
RD 30+700
RD 30+800
RD 30+900
RD 31+000
RD 31+100
RD 31+200

EL:1225.00
EL:1225.00
EL:1275.00
EL:1275.00

PI # 53
PI STA = 31+354.75
N = 3746482.53
E = 344604.52
I = 175°41'

T = 7.50
R = 199.00
L = 14.99
C = 14.99
E = 0.14
M = 0.141

PC: 31+347.25
PT: 31+362.24

PI # 55
PI STA = 31+557.50
N = 3746628.69
E = 344744.75
I = 153°23'

T = 70.73
R = 299.00
L = 138.90
C = 137.66
E = 8.25
M = 8.030

PC: 31+486.77
PT: 31+625.67

PC: 31+823.34
PT: 32+017.

PI # 57
PI STA = 31+923.96
N = 3746987.60
E = 344712.51
I = 142°03'

T = 100.62
R = 292.58
L = 193.82
C = 190.30
E = 16.82
M = 15.904

RD 31+100
RD 31+200
RD 31+300
RD 31+400
RD 31+500
RD 31+600
RD 31+700
RD 31+800
RD 31+900
RD 32+000
RD 32+100

EL:1225.00
EL:1225.00
EL:1225.00
EL:1225.00
EL:1225.00

CLIENT
PUNJAB MASSTRANSIT AUTHORITY

CONSULTANT
NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.
HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	AS
SUBMITTED	AA
RECOMMENDED	
CHD./VER.	MZ
APPROVED	JF

PROJECT
FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE

ALIGNMENT LAYOUT PLAN (RD-30+400 - 32+000)

SCALE 1:2500

DATE APRIL, 2025

DRAWING No. SA593/PMA/MGT/PP-019

REV. 0

PI # 58
PI STA = 32+718.33
N = 3747702.67
E = 345075.17
I = 151°54'

T = 75.08
R = 300.00
L = 147.15
C = 145.68
E = 9.25
M = 8.977

PC : 32+643.24
PT : 32+017.16
PT : 32+790.39

EL:1325.00
EL:1375.00
EL:1425.00

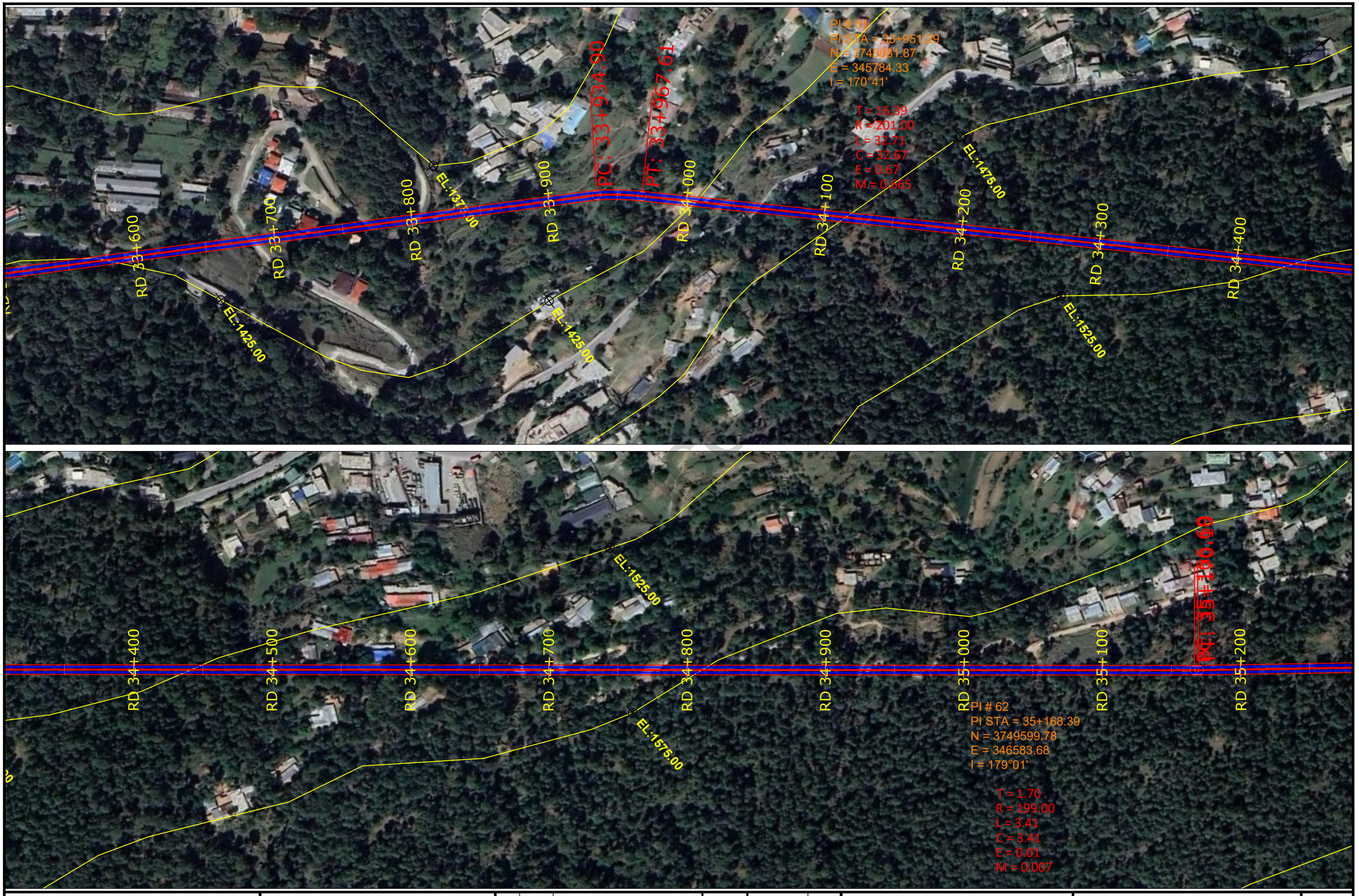
RD 32+000
RD 32+100
RD 32+200
RD 32+300
RD 32+400
RD 32+500
RD 32+600
RD 32+700
RD 32+800
RD 32+900
RD 33+000
RD 33+100
RD 33+200
RD 33+300
RD 33+400
RD 33+500
RD 33+600

PC : 33+020.41
PT : 33+164.01

PI # 59
PI STA = 33+093.62
N = 3747919.68
E = 345386.05
I = 152°34'

T = 73.21
R = 300.00
L = 143.61
C = 142.24
E = 8.80
M = 8.552

CLIENT: PUNJAB MASSTRANSIT AUTHORITY	CONSULTANT: NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	04 / 03 / 02 / 01		DRAWN: AS; SUBMITTED: AA; RECOMMENDED: ; CHD./VER.: MZ; APPROVED: JF	PROJECT: FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE	ALIGNMENT LAYOUT PLAN (RD-32+000 - 33+600)
		REV. / DATE / DESCRIPTION	APPROVED			DATE: APRIL, 2025 · DRAWING No.: SA593/PMA/MGT/PP-020 · REV.: 0 · SCALE: 1:2500



CLIENT

PUNJAB MASSTRANSIT AUTHORITY

CONSULTANT

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.

HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	AS
SUBMITTED	AA
RECOMMENDED	
CHD./VER.	MZ
APPROVED	JF

PROJECT

FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE

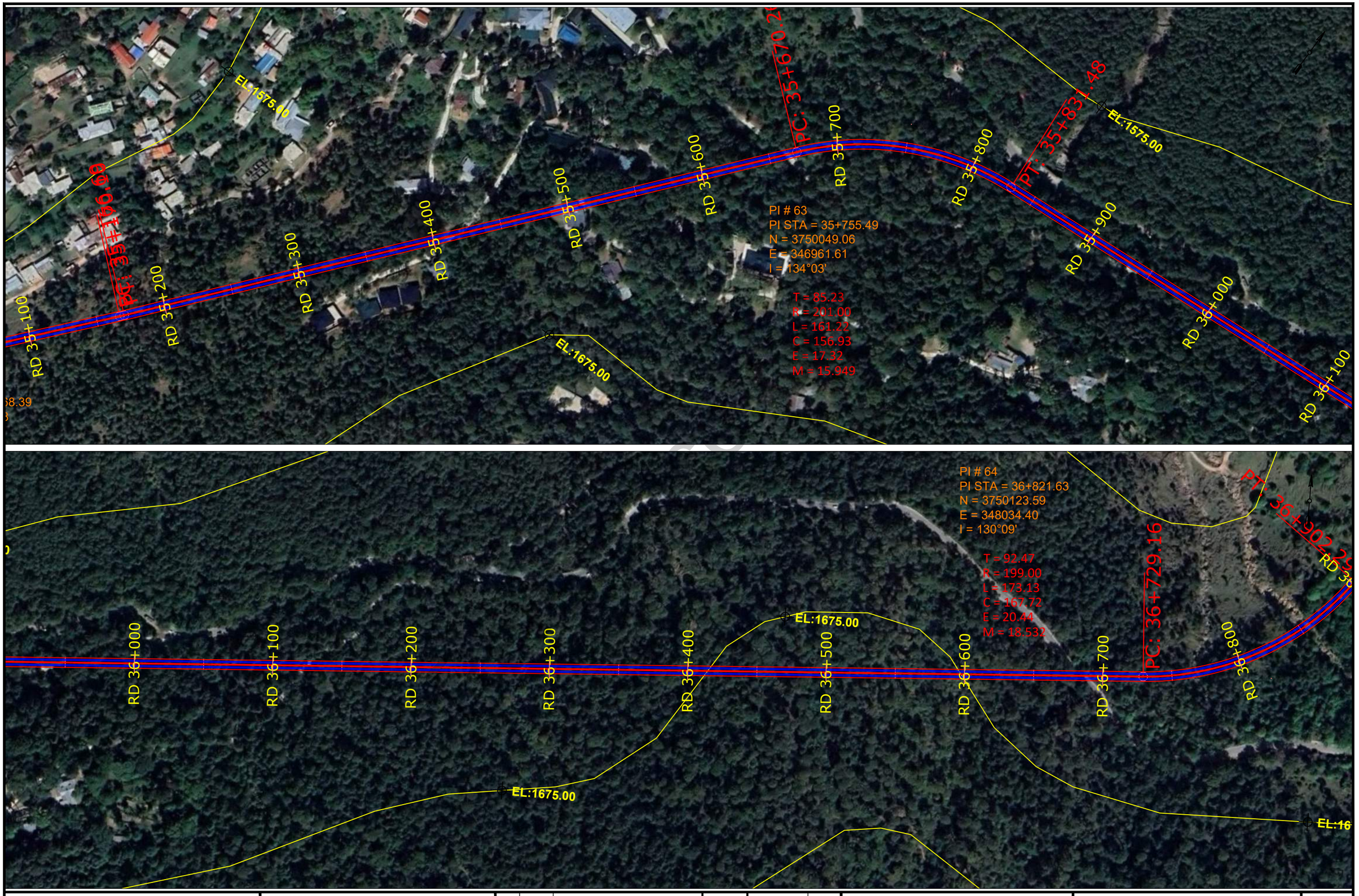
ALIGNMENT LAYOUT PLAN (RD-33+600 - 35+200)

SCALE: **1:2500**

DATE: APRIL, 2025

DRAWING No.: SA593/PMA/MGT/PP-021

REV.: 0



CLIENT: PUNJAB MASSTRANSIT AUTHORITY	CONSULTANT: NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	04 / 03 / 02 / 01 / REV. / DATE / DESCRIPTION	APPROVED	DRAWN AS; SUBMITTED AA; RECOMMENDED; CHD./VER. MZ; APPROVED JF	PROJECT: FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE	ALIGNMENT LAYOUT PLAN (RD-35+200 - 36+800) DATE: APRIL, 2025 DRAWING No.: SA593/PMA/MGT/PP-022	SCALE: 1:2500 REV.: 0

L = 173.13
C = 167.72
E = 20.44
M = 18.532

PC: 36+729.16

PI: 36+902.29

PI # 65
PI STA = 37+547.97
N = 3750779.40
E = 348470.15
I = 179°52'

T = 0.24
R = 201.00
L = 0.49
C = 0.49
E = 0.00
M = 0.000

PC: 37+548.21

GHORA GA

RD 36+700
RD 36+800
RD 36+900
RD 37+000
RD 37+100
RD 37+200
RD 37+300
RD 37+400
RD 37+500
RD 37+600

EL:1575.00
EL:1675.00
EL:1725.00
EL:1775.00

PC: 37+548.21

GHORA GALI

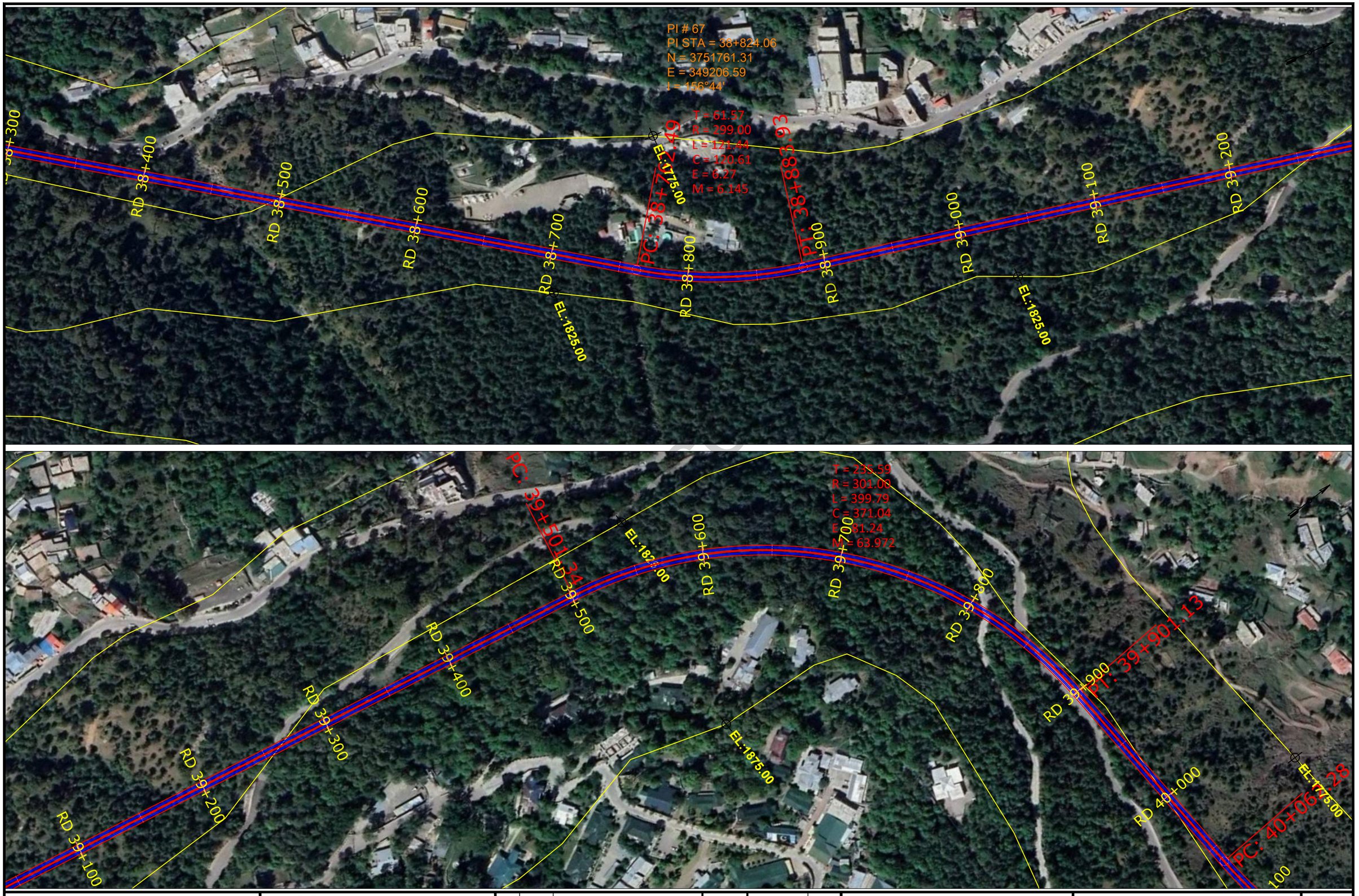
RD 37+600
RD 37+700
RD 37+800
RD 37+900
RD 38+000
RD 38+100
RD 38+200
RD 38+300
RD 38+400

EL:1725.00
EL:1775.00
EL:1825.00

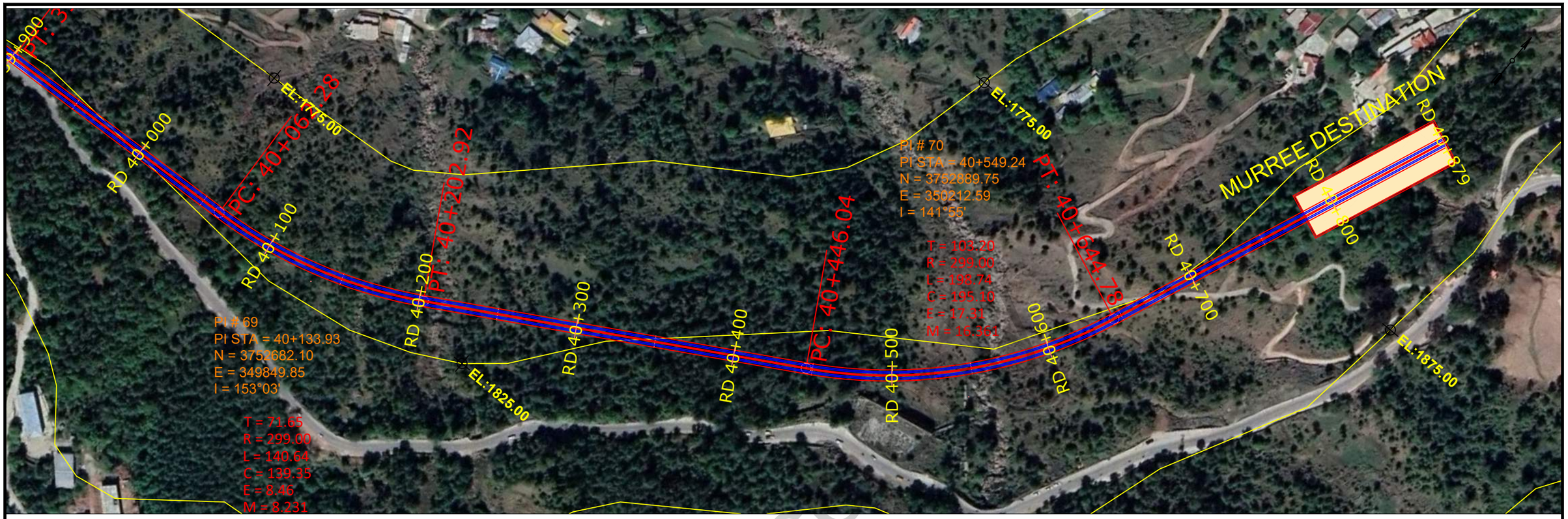
PT: 38+146.40

CLIENT	PUNJAB MASSTRANSIT AUTHORITY	CONSULTANT	NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.	PROJECT	FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE	ALIGNMENT LAYOUT PLAN (RD-36+800 - 38+400)
		HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.				SCALE 1:2500
						DATE APRIL, 2025
						DRAWING No. SA593/PMA/MGT/PP-023
						REV. 0

REV.	DATE	DESCRIPTION	APPROVED	
04				DRAWN AS
03				SUBMITTED AA
02				RECOMMENDED
01				CHD./VER. MZ
				APPROVED JF



CLIENT: PUNJAB MASSTRANSIT AUTHORITY	CONSULTANT: NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	04 / 03 / 02 / 01 / REV. / DATE / DESCRIPTION	APPROVED	DRAWN AS; SUBMITTED AA; RECOMMENDED; CHD./VER. MZ; APPROVED JF	PROJECT: FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE	ALIGNMENT LAYOUT PLAN (RD-38+400 - 40+000)	SCALE: 1:2500
						DATE: APRIL, 2025 / DRAWING No.: SA593/PMA/MGT/PP-024	REV.: 0



Reference

CLIENT	PUNJAB MASSTRANSIT AUTHORITY	CONSULTANT	NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	04			DRAWN	AS	PROJECT: FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE
				03			SUBMITTED	AA	
				02			RECOMMENDED		
				01			CHD./VER.	MZ	
				REV.	DATE	DESCRIPTION	APPROVED	APPROVED	JF

ALIGNMENT LAYOUT PLAN (RD-40+400 - 40+879)

DATE: APRIL, 2025 | DRAWING No.: SA593/PMA/MGT/PP-025 | SCALE: 1:2500 | REV.: 0

SETTINGOUT DATA

Reference Only

Station	Northing	Easting	Tangential Direction
0+000.00	3,732,975.2301m	327,413.0675m	N77° 33' 34"E
0+100.00	3,732,996.7726m	327,510.7196m	N77° 33' 34"E
0+200.00	3,733,018.3151m	327,608.3716m	N77° 33' 34"E
0+300.00	3,733,039.8576m	327,706.0236m	N77° 33' 34"E
0+400.00	3,733,061.4002m	327,803.6757m	N77° 33' 34"E
0+500.00	3,733,083.0765m	327,901.2968m	N75° 49' 21"E
0+600.00	3,733,121.7080m	327,993.2202m	N62° 44' 54"E
0+700.00	3,733,167.4978m	328,082.1207m	N62° 44' 54"E
0+800.00	3,733,213.2876m	328,171.0212m	N62° 44' 54"E
0+900.00	3,733,258.9877m	328,259.9666m	N64° 33' 30"E
1+000.00	3,733,300.6172m	328,350.8894m	N65° 24' 43"E
1+100.00	3,733,346.3381m	328,439.6392m	N55° 17' 44"E
1+200.00	3,733,415.8404m	328,510.8888m	N36° 07' 36"E
1+300.00	3,733,502.6742m	328,560.2805m	N27° 50' 33"E
1+400.00	3,733,591.0978m	328,606.9847m	N27° 50' 33"E
1+500.00	3,733,679.5213m	328,653.6888m	N27° 50' 33"E
1+600.00	3,733,767.9449m	328,700.3930m	N27° 50' 33"E
1+700.00	3,733,856.3684m	328,747.0971m	N27° 50' 33"E
1+800.00	3,733,948.9267m	328,783.9622m	N13° 52' 44"E
1+900.00	3,734,046.0071m	328,807.9493m	N13° 52' 44"E
2+000.00	3,734,143.0876m	328,831.9365m	N13° 52' 44"E
2+100.00	3,734,240.1681m	328,855.9237m	N13° 52' 44"E
2+200.00	3,734,337.7819m	328,877.1828m	N7° 07' 39"E
2+300.00	3,734,437.0091m	328,889.5904m	N7° 07' 39"E
2+400.00	3,734,536.2364m	328,901.9980m	N7° 07' 39"E
2+500.00	3,734,635.4637m	328,914.4057m	N7° 07' 39"E
2+600.00	3,734,733.9694m	328,930.7989m	N16° 31' 44"E
2+700.00	3,734,823.4034m	328,974.5023m	N35° 33' 28"E
2+800.00	3,734,894.2878m	329,044.5168m	N50° 33' 14"E
2+900.00	3,734,957.8231m	329,121.7390m	N50° 33' 14"E
3+000.00	3,735,021.3585m	329,198.9611m	N50° 33' 14"E
3+100.00	3,735,084.8939m	329,276.1832m	N50° 33' 14"E
3+200.00	3,735,156.6354m	329,345.2673m	N34° 36' 13"E
3+300.00	3,735,246.7366m	329,387.6642m	N18° 04' 10"E
3+400.00	3,735,341.8047m	329,418.6814m	N18° 04' 10"E
3+500.00	3,735,436.8727m	329,449.6985m	N18° 04' 10"E
3+600.00	3,735,531.9408m	329,480.7157m	N18° 04' 10"E
3+700.00	3,735,627.0089m	329,511.7328m	N18° 04' 10"E
3+800.00	3,735,722.0769m	329,542.7500m	N18° 04' 10"E
3+900.00	3,735,817.1450m	329,573.7672m	N18° 04' 10"E
4+000.00	3,735,912.2130m	329,604.7843m	N18° 04' 10"E
4+100.00	3,736,007.2811m	329,635.8015m	N18° 04' 10"E
4+200.00	3,736,102.3492m	329,666.8186m	N18° 04' 10"E
4+300.00	3,736,194.5332m	329,704.8477m	N30° 56' 11"E
4+400.00	3,736,270.4318m	329,769.2957m	N47° 51' 56"E
4+500.00	3,736,337.5188m	329,843.4531m	N47° 51' 56"E
4+600.00	3,736,404.6059m	329,917.6105m	N47° 51' 56"E
4+700.00	3,736,471.6930m	329,991.7680m	N47° 51' 56"E
4+800.00	3,736,538.7801m	330,065.9254m	N47° 51' 56"E
4+900.00	3,736,605.8671m	330,140.0828m	N47° 51' 56"E
5+000.00	3,736,672.9542m	330,214.2403m	N47° 51' 56"E
5+100.00	3,736,740.0413m	330,288.3977m	N47° 51' 56"E
5+200.00	3,736,807.1284m	330,362.5551m	N47° 51' 56"E
5+300.00	3,736,874.2154m	330,436.7125m	N47° 51' 56"E
5+400.00	3,736,941.3025m	330,510.8700m	N47° 51' 56"E
5+500.00	3,737,008.3896m	330,585.0274m	N47° 51' 56"E
5+600.00	3,737,077.7791m	330,656.9992m	N45° 00' 12"E
5+700.00	3,737,148.4857m	330,727.7140m	N45° 00' 12"E
5+800.00	3,737,219.1923m	330,798.4288m	N45° 00' 12"E
5+900.00	3,737,289.8988m	330,869.1436m	N45° 00' 12"E
6+000.00	3,737,360.6054m	330,939.8584m	N45° 00' 12"E
6+100.00	3,737,431.3119m	331,010.5732m	N45° 00' 12"E
6+200.00	3,737,502.0185m	331,081.2880m	N45° 00' 12"E
6+300.00	3,737,569.1757m	331,155.3182m	N49° 02' 15"E
6+400.00	3,737,634.7323m	331,230.8320m	N49° 02' 15"E
6+500.00	3,737,700.2888m	331,306.3459m	N49° 02' 15"E
6+600.00	3,737,765.8453m	331,381.8597m	N49° 02' 15"E
6+700.00	3,737,831.4019m	331,457.3735m	N49° 02' 15"E
6+800.00	3,737,896.9584m	331,532.8874m	N49° 02' 15"E
6+900.00	3,737,962.5150m	331,608.4012m	N49° 02' 15"E
7+000.00	3,738,028.0715m	331,683.9151m	N49° 02' 15"E
7+100.00	3,738,085.7833m	331,765.1513m	N63° 36' 06"E
7+200.00	3,738,114.6935m	331,860.4016m	N82° 37' 49"E
7+300.00	3,738,120.2088m	331,960.2252m	N87° 26' 49"E
7+400.00	3,738,124.6631m	332,060.1259m	N87° 26' 49"E
7+500.00	3,738,129.1174m	332,160.0267m	N87° 26' 49"E
7+600.00	3,738,133.5718m	332,259.9274m	N87° 26' 49"E
7+700.00	3,738,138.0261m	332,359.8282m	N87° 26' 49"E
7+800.00	3,738,142.4805m	332,459.7289m	N87° 26' 49"E
7+900.00	3,738,146.9348m	332,559.6297m	N87° 26' 49"E
8+000.00	3,738,151.3891m	332,659.5304m	N87° 26' 49"E
8+100.00	3,738,171.0687m	332,757.1039m	N69° 01' 37"E
8+200.00	3,738,213.6559m	332,847.5552m	N64° 10' 24"E
8+300.00	3,738,257.2211m	332,937.5667m	N64° 10' 24"E
8+400.00	3,738,300.7863m	333,027.5782m	N64° 10' 24"E
8+500.00	3,738,344.3515m	333,117.5897m	N64° 10' 24"E
8+600.00	3,738,387.9167m	333,207.6012m	N64° 10' 24"E
8+700.00	3,738,431.4819m	333,297.6127m	N64° 10' 24"E
8+800.00	3,738,463.5372m	333,391.8975m	N80° 33' 14"E
8+900.00	3,738,463.4185m	333,491.4385m	S80° 25' 02"E
9+000.00	3,738,441.8736m	333,589.0827m	S77° 18' 08"E
9+100.00	3,738,419.8929m	333,686.6371m	S77° 18' 08"E
9+200.00	3,738,397.9122m	333,784.1914m	S77° 18' 08"E
9+300.00	3,738,375.9314m	333,881.7457m	S77° 18' 08"E
9+400.00	3,738,353.9507m	333,979.3001m	S77° 18' 08"E
9+500.00	3,738,331.9700m	334,076.8544m	S77° 18' 08"E
9+600.00	3,738,309.9893m	334,174.4087m	S77° 18' 08"E
9+700.00	3,738,299.6427m	334,273.4977m	N89° 02' 35"E
9+800.00	3,738,301.3126m	334,373.4838m	N89° 02' 35"E
9+900.00	3,738,302.9826m	334,473.4698m	N89° 02' 35"E
10+000.00	3,738,304.6525m	334,573.4559m	N89° 02' 35"E
10+100.00	3,738,306.3224m	334,673.4419m	N89° 02' 35"E
10+200.00	3,738,307.9923m	334,773.4280m	N89° 02' 35"E
10+300.00	3,738,309.6622m	334,873.4140m	N89° 02' 35"E
10+400.00	3,738,315.3368m	334,973.1192m	N80° 52' 01"E
10+500.00	3,738,331.2098m	335,071.8514m	N80° 52' 01"E
10+600.00	3,738,347.0827m	335,170.5836m	N80° 52' 01"E
10+700.00	3,738,362.9557m	335,269.3158m	N80° 52' 01"E
10+800.00	3,738,378.8286m	335,368.0480m	N80° 52' 01"E
10+900.00	3,738,394.7016m	335,466.7802m	N80° 52' 01"E
11+000.00	3,738,410.5745m	335,565.5125m	N80° 52' 01"E
11+100.00	3,738,426.4475m	335,664.2447m	N80° 52' 01"E
11+200.00	3,738,442.3205m	335,762.9769m	N80° 52' 01"E
11+300.00	3,738,462.0381m	335,860.9015m	N74° 19' 40"E
11+400.00	3,738,489.0516m	335,957.1837m	N74° 19' 40"E
11+500.00	3,738,516.0650m	336,053.4660m	N74° 19' 40"E
11+600.00	3,738,543.0785m	336,149.7482m	N74° 19' 40"E
11+700.00	3,738,570.0920m	336,246.0305m	N74° 19' 40"E
11+800.00	3,738,597.1054m	336,342.3128m	N74° 19' 40"E
11+900.00	3,738,624.1189m	336,438.5950m	N74° 19' 40"E
12+000.00	3,738,651.1324m	336,534.8773m	N74° 19' 40"E
12+100.00	3,738,678.1458m	336,631.1595m	N74° 19' 40"E
12+200.00	3,738,705.1593m	336,727.4418m	N74° 19' 40"E
12+300.00	3,738,732.1727m	336,823.7240m	N74° 19' 40"E
12+400.00	3,738,759.1862m	336,920.0063m	N74° 19' 40"E
12+500.00	3,738,786.1997m	337,016.2885m	N74° 19' 40"E
12+600.00	3,738,814.5488m	337,112.1491m	N68° 46' 49"E
12+700.00	3,738,865.2346m	337,197.8691m	N52° 26' 46"E
12+800.00	3,738,926.1853m	337,277.1471m	N52° 26' 46"E
12+900.00	3,738,987.1360m	337,356.4252m	N52° 26' 46"E
13+000.00	3,739,048.0867m	337,435.7032m	N52° 26' 46"E
13+100.00	3,739,109.0374m	337,514.9813m	N52° 26' 46"E
13+200.00	3,739,169.9881m	337,594.2594m	N52° 26' 46"E
13+300.00	3,739,230.9388m	337,673.5374m	N52° 26' 46"E
13+400.00	3,739,288.4943m	337,755.1611m	N59° 40' 23"E
13+500.00	3,739,338.9877m	337,841.4769m	N59° 40' 23"E
13+600.00	3,739,389.4811m	337,927.7928m	N59° 40' 23"E
13+700.00	3,739,439.9744m	338,014.1086m	N59° 40' 23"E
13+800.00	3,739,490.4678m	338,100.4244m	N59° 40' 23"E
13+900.00	3,739,540.9612m	338,186.7402m	N59° 40' 23"E

Reference Only

CLIENT

PUNJAB MASSTRANSIT AUTHORITY

CONSULTANT

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.

HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	AS
SUBMITTED	AA
RECOMMENDED	
CHD./VER.	MZ
APPROVED	JF

PROJECT

FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE

SETTINGOUT DATA

DATE: APRIL, 2025

DRAWING No.: SA593/PMA/MGT/SOD-000

SCALE: N.T.S

REV.: 0

14+000.00	3,739,591.4545m	338,273.0560m	N59° 40' 23"E
14+100.00	3,739,644.1417m	338,357.9552m	N52° 05' 51"E
14+200.00	3,739,707.3503m	338,435.4442m	N50° 44' 53"E
14+300.00	3,739,770.6235m	338,512.8813m	N50° 44' 53"E
14+400.00	3,739,833.8967m	338,590.3184m	N50° 44' 53"E
14+500.00	3,739,897.1700m	338,667.7555m	N50° 44' 53"E
14+600.00	3,739,960.4432m	338,745.1925m	N50° 44' 53"E
14+700.00	3,740,023.7164m	338,822.6296m	N50° 44' 53"E
14+800.00	3,740,086.9896m	338,900.0667m	N50° 44' 53"E
14+900.00	3,740,150.2628m	338,977.5038m	N50° 44' 53"E
15+000.00	3,740,213.5360m	339,054.9409m	N50° 44' 53"E
15+100.00	3,740,276.8092m	339,132.3779m	N50° 44' 53"E
15+200.00	3,740,340.0824m	339,209.8150m	N50° 44' 53"E
15+300.00	3,740,403.3556m	339,287.2521m	N50° 44' 53"E
15+400.00	3,740,466.6288m	339,364.6892m	N50° 44' 53"E
15+500.00	3,740,529.9020m	339,442.1263m	N50° 44' 53"E
15+600.00	3,740,593.1752m	339,519.5634m	N50° 44' 53"E
15+700.00	3,740,644.3573m	339,605.1315m	N63° 40' 28"E
15+800.00	3,740,688.7043m	339,694.7605m	N63° 40' 28"E
15+900.00	3,740,733.0513m	339,784.3894m	N63° 40' 28"E
16+000.00	3,740,777.3983m	339,874.0183m	N63° 40' 28"E
16+100.00	3,740,821.7453m	339,963.6472m	N63° 40' 28"E
16+200.00	3,740,866.0923m	340,053.2761m	N63° 40' 28"E
16+300.00	3,740,910.4393m	340,142.9051m	N63° 40' 28"E
16+400.00	3,740,954.7863m	340,232.5340m	N63° 40' 28"E
16+500.00	3,740,999.1334m	340,322.1629m	N63° 40' 28"E
16+600.00	3,741,043.4804m	340,411.7918m	N63° 40' 28"E
16+700.00	3,741,087.8274m	340,501.4207m	N63° 40' 28"E
16+800.00	3,741,132.1744m	340,591.0497m	N63° 40' 28"E
16+900.00	3,741,176.5214m	340,680.6786m	N63° 40' 28"E
17+000.00	3,741,220.8684m	340,770.3075m	N63° 40' 28"E
17+100.00	3,741,265.2154m	340,859.9364m	N63° 40' 28"E
17+200.00	3,741,308.3227m	340,950.1519m	N65° 45' 10"E
17+300.00	3,741,349.3901m	341,041.3301m	N65° 45' 10"E
17+400.00	3,741,390.4576m	341,132.5083m	N65° 45' 10"E
17+500.00	3,741,431.5250m	341,223.6865m	N65° 45' 10"E
17+600.00	3,741,472.5924m	341,314.8647m	N65° 45' 10"E
17+700.00	3,741,513.6599m	341,406.0429m	N65° 45' 10"E
17+800.00	3,741,554.7273m	341,497.2211m	N65° 45' 10"E
17+900.00	3,741,595.7947m	341,588.3993m	N65° 45' 10"E
18+000.00	3,741,636.8622m	341,679.5775m	N65° 45' 10"E
18+100.00	3,741,677.9296m	341,770.7557m	N65° 45' 10"E
18+200.00	3,741,725.1171m	341,858.4850m	N50° 27' 16"E
18+300.00	3,741,805.0459m	341,916.8355m	N21° 48' 24"E
18+400.00	3,741,903.1648m	341,929.7229m	N6° 50' 28"W
18+500.00	3,741,995.4508m	341,893.9921m	N35° 29' 21"W
18+600.00	3,742,060.4715m	341,819.0702m	N57° 29' 16"W
18+700.00	3,742,114.2196m	341,734.7426m	N57° 29' 16"W
18+800.00	3,742,169.9994m	341,651.8659m	N48° 25' 53"W
18+900.00	3,742,246.8019m	341,588.0691m	N37° 42' 43"W
19+000.00	3,742,325.9116m	341,526.9001m	N37° 42' 43"W
19+100.00	3,742,405.0213m	341,465.7310m	N37° 42' 43"W
19+200.00	3,742,484.1310m	341,404.5620m	N37° 42' 43"W
19+300.00	3,742,563.2408m	341,343.3930m	N37° 42' 43"W
19+400.00	3,742,642.3505m	341,282.2239m	N37° 42' 43"W
19+500.00	3,742,721.4602m	341,221.0549m	N37° 42' 43"W
19+600.00	3,742,798.7473m	341,157.7304m	N43° 22' 49"W
19+700.00	3,742,871.4284m	341,089.0467m	N43° 22' 49"W
19+800.00	3,742,944.1095m	341,020.3629m	N43° 22' 49"W
19+900.00	3,743,016.7906m	340,951.6791m	N43° 22' 49"W
20+000.00	3,743,089.9972m	340,883.5856m	N38° 17' 10"W
20+100.00	3,743,175.9532m	340,832.6810m	N29° 11' 35"W
20+200.00	3,743,263.2513m	340,783.9056m	N29° 11' 35"W
20+300.00	3,743,350.5494m	340,735.1301m	N29° 11' 35"W
20+400.00	3,743,437.8475m	340,686.3547m	N29° 11' 35"W
20+500.00	3,743,528.9475m	340,646.4235m	N11° 23' 31"W
20+600.00	3,743,627.7796m	340,651.4853m	N17° 15' 21"E
20+700.00	3,743,712.0861m	340,703.3100m	N45° 54' 13"E
20+800.00	3,743,770.0907m	340,784.5856m	N56° 24' 35"E
20+900.00	3,743,825.4158m	340,867.8870m	N56° 24' 35"E
21+000.00	3,743,880.7410m	340,951.1884m	N56° 24' 35"E
21+100.00	3,743,931.7970m	341,037.1056m	N60° 45' 55"E
21+200.00	3,743,980.6357m	341,124.3683m	N60° 45' 55"E
21+300.00	3,744,029.4744m	341,211.6310m	N60° 45' 55"E
21+400.00	3,744,078.3131m	341,298.8937m	N60° 45' 55"E
21+500.00	3,744,130.4276m	341,384.0372m	N51° 02' 35"E
21+600.00	3,744,193.3012m	341,461.7991m	N51° 02' 35"E
21+700.00	3,744,256.1748m	341,539.5610m	N51° 02' 35"E
21+800.00	3,744,324.8206m	341,611.6724m	N34° 44' 27"E
21+900.00	3,744,417.5653m	341,646.1949m	N6° 05' 34"E
22+000.00	3,744,515.5075m	341,632.0270m	N22° 33' 18"W
22+100.00	3,744,597.5861m	341,575.7327m	N39° 22' 41"W
22+200.00	3,744,674.8838m	341,512.2893m	N39° 22' 41"W
22+300.00	3,744,752.6389m	341,449.4372m	N34° 25' 23"W
22+400.00	3,744,845.5736m	341,415.4293m	N5° 46' 31"W
22+500.00	3,744,943.4358m	341,430.1399m	N22° 52' 21"E
22+600.00	3,745,026.5420m	341,485.1904m	N36° 59' 58"E
22+700.00	3,745,106.4060m	341,545.3713m	N36° 59' 58"E
22+800.00	3,745,184.2819m	341,607.8872m	N47° 06' 38"E
22+900.00	3,745,231.6017m	341,694.8023m	N75° 45' 30"E
23+000.00	3,745,236.0721m	341,794.2626m	S87° 56' 35"E
23+100.00	3,745,232.4827m	341,894.1982m	S87° 56' 35"E
23+200.00	3,745,231.1475m	341,994.1018m	N83° 27' 05"E
23+300.00	3,745,266.4065m	342,086.5691m	N54° 48' 13"E
23+400.00	3,745,339.5989m	342,153.9490m	N37° 16' 39"E
23+500.00	3,745,419.1700m	342,214.5167m	N37° 16' 39"E
23+600.00	3,745,498.7411m	342,275.0843m	N37° 16' 39"E
23+700.00	3,745,578.3122m	342,335.6520m	N37° 16' 39"E
23+800.00	3,745,660.7688m	342,391.7545m	N24° 03' 25"E
23+900.00	3,745,757.5907m	342,415.6698m	N10° 49' 15"E
24+000.00	3,745,855.8126m	342,434.4435m	N10° 49' 15"E
24+100.00	3,745,949.7402m	342,466.4666m	N32° 14' 43"E
24+200.00	3,746,017.7742m	342,538.3329m	N60° 53' 35"E
24+300.00	3,746,054.7412m	342,631.1519m	N69° 36' 31"E
24+400.00	3,746,089.5843m	342,724.8853m	N69° 36' 31"E
24+500.00	3,746,124.4274m	342,818.6187m	N69° 36' 31"E
24+600.00	3,746,159.2705m	342,912.3522m	N69° 36' 31"E
24+700.00	3,746,194.1136m	343,006.0856m	N69° 36' 31"E
24+800.00	3,746,229.3702m	343,099.6548m	N65° 47' 11"E
24+900.00	3,746,291.0240m	343,177.0652m	N37° 28' 07"E
25+000.00	3,746,370.3928m	343,237.8977m	N37° 28' 07"E
25+100.00	3,746,449.7616m	343,298.7302m	N37° 28' 07"E
25+200.00	3,746,529.1304m	343,359.5627m	N37° 28' 07"E
25+300.00	3,746,608.4991m	343,420.3953m	N37° 28' 07"E
25+400.00	3,746,697.3119m	343,464.2130m	N12° 51' 43"E
25+500.00	3,746,787.1588m	343,506.3523m	N37° 23' 32"E
25+600.00	3,746,851.4011m	343,581.9903m	N61° 55' 21"E
25+700.00	3,746,878.4420m	343,677.4732m	N86° 27' 11"E
25+800.00	3,746,863.4002m	343,775.5646m	S69° 01' 00"E
25+900.00	3,746,808.9909m	343,858.5574m	S44° 29' 11"E
26+000.00	3,746,725.0360m	343,911.4702m	S19° 57' 22"E
26+100.00	3,746,626.6907m	343,924.7511m	S4° 34' 27"W
26+200.00	3,746,531.7080m	343,896.0029m	S29° 06' 16"W
26+300.00	3,746,453.8417m	343,833.8597m	S37° 54' 19"W
26+400.00	3,746,374.9389m	343,772.4240m	S37° 54' 19"W
26+500.00	3,746,296.0361m	343,710.9883m	S37° 54' 19"W
26+600.00	3,746,217.1333m	343,649.5526m	S37° 54' 19"W
26+700.00	3,746,137.9616m	343,588.4661m	S37° 16' 11"W
26+800.00	3,746,058.3822m	343,527.9094m	S37° 16' 11"W
26+900.00	3,745,978.3756m	343,467.9486m	S32° 21' 47"W
27+000.00	3,745,893.7907m	343,414.6064m	S32° 14' 12"W
27+100.00	3,745,809.2055m	343,361.2646m	S32° 14' 12"W
27+200.00	3,745,724.6203m	343,307.9227m	S32° 14' 12"W
27+300.00	3,745,649.5748m	343,243.0123m	S51° 58' 45"W
27+400.00	3,745,587.9801m	343,164.2335m	S51° 58' 45"W
27+500.00	3,745,526.3854m	343,085.4547m	S51° 58' 45"W
27+600.00	3,745,464.7907m	343,006.6760m	S51° 58' 45"W
27+700.00	3,745,403.1960m	342,927.8972m	S51° 58' 45"W
27+800.00	3,745,340.2899m	342,850.2397m	S44° 27' 05"W
27+900.00	3,745,264.0264m	342,785.5790m	S39° 56' 16"W
28+000.00	3,745,187.3522m	342,721.3835m	S39° 56' 16"W

Reference Only

CLIENT

PUNJAB MASSTRANSIT AUTHORITY

CONSULTANT

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.

HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	AS
SUBMITTED	AA
RECOMMENDED	
CHD./VER.	MZ
APPROVED	JF

PROJECT

FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE

SETTINGOUT DATA

DATE: APRIL, 2025

DRAWING No.: SA593/PMA/MGT/SOD-001

SCALE: N.T.S

REV.: 0

28+100.00	3,745,112.0695m	342,655.6524m	S46° 40' 25"W
28+200.00	3,745,056.7302m	342,572.9160m	S65° 46' 20"W
28+300.00	3,745,011.9438m	342,484.4298m	S47° 25' 52"W
28+400.00	3,744,925.4648m	342,438.0423m	S8° 59' 14"W
28+500.00	3,744,828.8916m	342,455.4790m	S29° 27' 24"E
28+600.00	3,744,764.0950m	342,529.1799m	S67° 54' 02"E
28+700.00	3,744,759.1685m	342,627.1908m	N73° 39' 20"E
28+800.00	3,744,816.2481m	342,707.0178m	N35° 12' 42"E
28+900.00	3,744,895.8648m	342,764.8179m	N45° 13' 52"E
29+000.00	3,744,962.7802m	342,838.8274m	N57° 33' 46"E
29+100.00	3,745,014.3762m	342,924.4882m	N58° 58' 23"E
29+200.00	3,745,065.9205m	343,010.1806m	N58° 58' 23"E
29+300.00	3,745,117.4648m	343,095.8729m	N58° 58' 23"E
29+400.00	3,745,169.0091m	343,181.5653m	N58° 58' 23"E
29+500.00	3,745,220.5534m	343,267.2577m	N58° 58' 23"E
29+600.00	3,745,272.0977m	343,352.9501m	N58° 58' 23"E
29+700.00	3,745,323.6420m	343,438.6425m	N58° 58' 23"E
29+800.00	3,745,378.2774m	343,522.2228m	N50° 55' 42"E
29+900.00	3,745,441.3065m	343,599.8587m	N50° 55' 42"E
30+000.00	3,745,509.2362m	343,672.9956m	N47° 11' 28"E
30+100.00	3,745,570.6669m	343,751.7507m	N56° 53' 56"E
30+200.00	3,745,617.9378m	343,839.7368m	N66° 36' 25"E
30+300.00	3,745,675.1287m	343,919.1129m	N44° 19' 52"E
30+400.00	3,745,746.6600m	343,988.9933m	N44° 19' 52"E
30+500.00	3,745,818.1914m	344,058.8737m	N44° 19' 52"E
30+600.00	3,745,889.7227m	344,128.7540m	N44° 19' 52"E
30+700.00	3,745,961.2541m	344,198.6344m	N44° 19' 52"E
30+800.00	3,746,038.3711m	344,262.1252m	N37° 37' 41"E
30+900.00	3,746,117.5702m	344,323.1785m	N37° 37' 41"E
31+000.00	3,746,196.7693m	344,384.2318m	N37° 37' 41"E
31+100.00	3,746,275.9684m	344,445.2850m	N37° 37' 41"E
31+200.00	3,746,355.1675m	344,506.3383m	N37° 37' 41"E
31+300.00	3,746,434.3666m	344,567.3915m	N37° 37' 41"E
31+400.00	3,746,511.6819m	344,630.7180m	N41° 56' 42"E
31+500.00	3,746,585.6524m	344,697.9780m	N45° 56' 03"E
31+600.00	3,746,665.8158m	344,756.9777m	N26° 46' 18"E
31+700.00	3,746,761.8501m	344,756.6449m	N11° 03' 47"W
31+800.00	3,746,859.9918m	344,737.4560m	N11° 03' 47"W
31+900.00	3,746,959.0895m	344,726.7166m	N2° 45' 43"E
32+000.00	3,747,056.2246m	344,748.3456m	N22° 20' 40"E
32+100.00	3,747,145.8050m	344,792.7451m	N26° 53' 34"E
32+200.00	3,747,234.9905m	344,837.9773m	N26° 53' 34"E
32+300.00	3,747,324.1760m	344,883.2095m	N26° 53' 34"E
32+400.00	3,747,413.3614m	344,928.4417m	N26° 53' 34"E
32+500.00	3,747,502.5469m	344,973.6740m	N26° 53' 34"E
32+600.00	3,747,591.7323m	345,018.9062m	N26° 53' 34"E
32+700.00	3,747,678.7701m	345,067.8404m	N36° 34' 29"E
32+800.00	3,747,747.7768m	345,139.5794m	N54° 59' 44"E
32+900.00	3,747,805.1407m	345,221.4903m	N54° 59' 44"E
33+000.00	3,747,862.5046m	345,303.4011m	N54° 59' 44"E
33+100.00	3,747,926.7910m	345,379.5679m	N40° 57' 11"E
33+200.00	3,748,011.1020m	345,432.7782m	N27° 34' 09"E
33+300.00	3,748,099.7474m	345,479.0599m	N27° 34' 09"E
33+400.00	3,748,188.3927m	345,525.3417m	N27° 34' 09"E
33+500.00	3,748,277.0381m	345,571.6235m	N27° 34' 09"E
33+600.00	3,748,365.6834m	345,617.9052m	N27° 34' 09"E
33+700.00	3,748,454.3288m	345,664.1870m	N27° 34' 09"E
33+800.00	3,748,542.9741m	345,710.4688m	N27° 34' 09"E
33+900.00	3,748,631.6195m	345,756.7505m	N27° 34' 09"E
34+000.00	3,748,714.0876m	345,812.3834m	N41° 03' 03"E
34+100.00	3,748,789.5002m	345,878.0563m	N41° 03' 03"E
34+200.00	3,748,864.9128m	345,943.7293m	N41° 03' 03"E
34+300.00	3,748,940.3255m	346,009.4022m	N41° 03' 03"E
34+400.00	3,749,015.7381m	346,075.0751m	N41° 03' 03"E
34+500.00	3,749,091.1508m	346,140.7481m	N41° 03' 03"E
34+600.00	3,749,166.5634m	346,206.4210m	N41° 03' 03"E
34+700.00	3,749,241.9760m	346,272.0939m	N41° 03' 03"E
34+800.00	3,749,317.3887m	346,337.7668m	N41° 03' 03"E
34+900.00	3,749,392.8013m	346,403.4398m	N41° 03' 03"E
35+000.00	3,749,468.2140m	346,469.1127m	N41° 03' 03"E
35+100.00	3,749,543.6266m	346,534.7856m	N41° 03' 03"E
35+200.00	3,749,619.3238m	346,600.1262m	N40° 04' 10"E
35+300.00	3,749,695.8503m	346,664.4978m	N40° 04' 10"E
35+400.00	3,749,772.3767m	346,728.8694m	N40° 04' 10"E
35+500.00	3,749,848.9032m	346,793.2410m	N40° 04' 10"E
35+600.00	3,749,925.4296m	346,857.6126m	N40° 04' 10"E
35+700.00	3,750,001.0173m	346,923.0152m	N46° 49' 09"E
35+800.00	3,750,048.8911m	347,009.6381m	N75° 19' 29"E
35+900.00	3,750,059.2937m	347,108.9380m	N86° 01' 34"E
36+000.00	3,750,066.2241m	347,208.6976m	N86° 01' 34"E
36+100.00	3,750,073.1545m	347,308.4571m	N86° 01' 34"E
36+200.00	3,750,080.0849m	347,408.2167m	N86° 01' 34"E
36+300.00	3,750,087.0153m	347,507.9762m	N86° 01' 34"E
36+400.00	3,750,093.9457m	347,607.7358m	N86° 01' 34"E
36+500.00	3,750,100.8761m	347,707.4954m	N86° 01' 34"E
36+600.00	3,750,107.8065m	347,807.2549m	N86° 01' 34"E
36+700.00	3,750,114.7370m	347,907.0145m	N86° 01' 34"E
36+800.00	3,750,132.0123m	348,004.9149m	N67° 22' 35"E
36+900.00	3,750,191.5894m	348,083.9206m	N38° 35' 05"E
37+000.00	3,750,272.2011m	348,143.0924m	N36° 10' 46"E
37+100.00	3,750,352.9182m	348,202.1241m	N36° 10' 46"E
37+200.00	3,750,433.6353m	348,261.1559m	N36° 10' 46"E
37+300.00	3,750,514.3525m	348,320.1876m	N36° 10' 46"E
37+400.00	3,750,595.0696m	348,379.2193m	N36° 10' 46"E
37+500.00	3,750,675.7867m	348,438.2510m	N36° 10' 46"E
37+600.00	3,750,756.4378m	348,497.3729m	N36° 19' 08"E
37+700.00	3,750,837.0111m	348,556.6008m	N36° 19' 08"E
37+800.00	3,750,917.5844m	348,615.8287m	N36° 19' 08"E
37+900.00	3,750,998.1577m	348,675.0565m	N36° 19' 08"E
38+000.00	3,751,078.7310m	348,734.2844m	N36° 19' 08"E
38+100.00	3,751,159.3043m	348,793.5123m	N36° 19' 08"E
38+200.00	3,751,240.9668m	348,851.2046m	N34° 19' 55"E
38+300.00	3,751,323.5453m	348,907.6031m	N34° 19' 55"E
38+400.00	3,751,406.1238m	348,964.0016m	N34° 19' 55"E
38+500.00	3,751,488.7023m	349,020.4001m	N34° 19' 55"E
38+600.00	3,751,571.2808m	349,076.7986m	N34° 19' 55"E
38+700.00	3,751,653.8593m	349,133.1971m	N34° 19' 55"E
38+800.00	3,751,737.3217m	349,188.1986m	N28° 18' 21"E
38+900.00	3,751,831.5578m	349,220.3159m	N11° 03' 37"E
39+000.00	3,751,929.7004m	349,239.5002m	N11° 03' 37"E
39+100.00	3,752,027.8430m	349,258.6845m	N11° 03' 37"E
39+200.00	3,752,125.9855m	349,277.8688m	N11° 03' 37"E
39+300.00	3,752,224.1281m	349,297.0531m	N11° 03' 37"E
39+400.00	3,752,322.2707m	349,316.2374m	N11° 03' 37"E
39+500.00	3,752,420.4132m	349,335.4217m	N11° 03' 37"E
39+600.00	3,752,514.4185m	349,368.1950m	N28° 41' 10"E
39+700.00	3,752,592.6394m	349,429.7567m	N47° 43' 16"E
39+800.00	3,752,646.5049m	349,513.4637m	N66° 45' 23"E
39+900.00	3,752,670.1241m	349,610.1616m	N85° 47' 29"E
40+000.00	3,752,675.1629m	349,710.0340m	N87° 09' 40"E
40+100.00	3,752,681.7852m	349,809.7693m	N81° 05' 41"E
40+200.00	3,752,713.3460m	349,904.1676m	N61° 55' 56"E
40+300.00	3,752,762.9098m	349,991.0191m	N60° 12' 37"E
40+400.00	3,752,812.5915m	350,077.8046m	N60° 12' 37"E
40+500.00	3,752,865.4931m	350,162.5112m	N51° 01' 59"E
40+600.00	3,752,940.0954m	350,228.4023m	N31° 52' 15"E
40+700.00	3,753,030.8793m	350,269.9716m	N22° 07' 37"E
40+800.00	3,753,123.5144m	350,307.6375m	N22° 07' 37"E
40+879.15	3,753,196.8352m	350,337.4501m	N22° 07' 37"E

Reference Only

CLIENT

PUNJAB MASSTRANSIT AUTHORITY

CONSULTANT

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.

HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	AS
SUBMITTED	AA
RECOMMENDED	
CHD./VER.	MZ
APPROVED	JF

PROJECT

FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE

SETTINGOUT DATA

DATE: APRIL, 2025

DRAWING No.: SA593/PMA/MGT/SOD-002

SCALE: N.T.S

REV.: 0

PUNJAB MASSTRANSIT AUTHORITY

FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE

(STATION 3D RENDERS & DRAWINGS)

Reference Only

NATIONAL ENGINEERING SERVICES
PAKISTAN (PVT) LTD.

HEAD OFFICE: NESPAK HOUSE, 1-C, BLOCK N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.



CLIENT :- PUNJAB MASSTRANSIT AUTHORITY	CONSULTANT :- NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	04				DRAWN	MENAHIL	PROJECT TITLE :- MURREE MONORAIL GLASS STATION	DRAWING TITLE :- 3D VIEW	ORIENTATION	SCALE NTS
		03				SUBMITTED					
		02				RECOMMENDED					
		01	--	----		CHD./VER.			DATE JULY 2025 / DWG. NO.		REV. 00
		REV.	DATE	DESCRIPTION	APPROVED	APPROVED					



For reference only

CLIENT :- PUNJAB MASSTRANSIT AUTHORITY	CONSULTANT :- NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	04				DRAWN	MENAHIL	PROJECT TITLE :- MURREE MONORAIL GLASS STATION	DRAWING TITLE :- 3D VIEW	ORIENTATION	SCALE NTS
		03				SUBMITTED					
		02				RECOMMENDED					
		01	--	-----		CHD./VER.			DATE JULY 2025 / DWG. NO.		REV. 00
		REV.	DATE	DESCRIPTION	APPROVED	APPROVED					



CLIENT :- PUNJAB MASSTRANSIT AUTHORITY	CONSULTANT :- NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	04				DRAWN	MENAHIL	PROJECT TITLE :- MURREE MONORAIL GLASS STATION	DRAWING TITLE :- 3D VIEW	ORIENTATION	SCALE NTS
		03				SUBMITTED					
		02				RECOMMENDED					
		01	--	-----		CHD./VER.			DATE JULY 2025 / DWG. NO.		REV. 00
		REV.	DATE	DESCRIPTION	APPROVED	APPROVED					



Reference Only

CLIENT :- PUNJAB MASSTRANSIT AUTHORITY	CONSULTANT :- NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	04				DRAWN	MENAHIL	PROJECT TITLE :- MURREE MONORAIL GLASS STATION	DRAWING TITLE :- 3D VIEW	ORIENTATION	SCALE NTS
		03				SUBMITTED					
		02				RECOMMENDED					
		01	--	-----		CHD./VER.			DATE JULY 2025 / DWG. NO.		REV. 00
		REV.	DATE	DESCRIPTION	APPROVED	APPROVED					



Reference

CLIENT :- PUNJAB MASSTRANSIT AUTHORITY	CONSULTANT :- NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	04			DRAWN: MENAHIL
		03			SUBMITTED:
		02			RECOMMENDED:
		01	--	-----	CHD./VER.:
		REV.	DATE	DESCRIPTION / APPROVED	APPROVED:

PROJECT TITLE :- MURREE MONORAIL GLASS STATION

DRAWING TITLE :- 3D VIEW

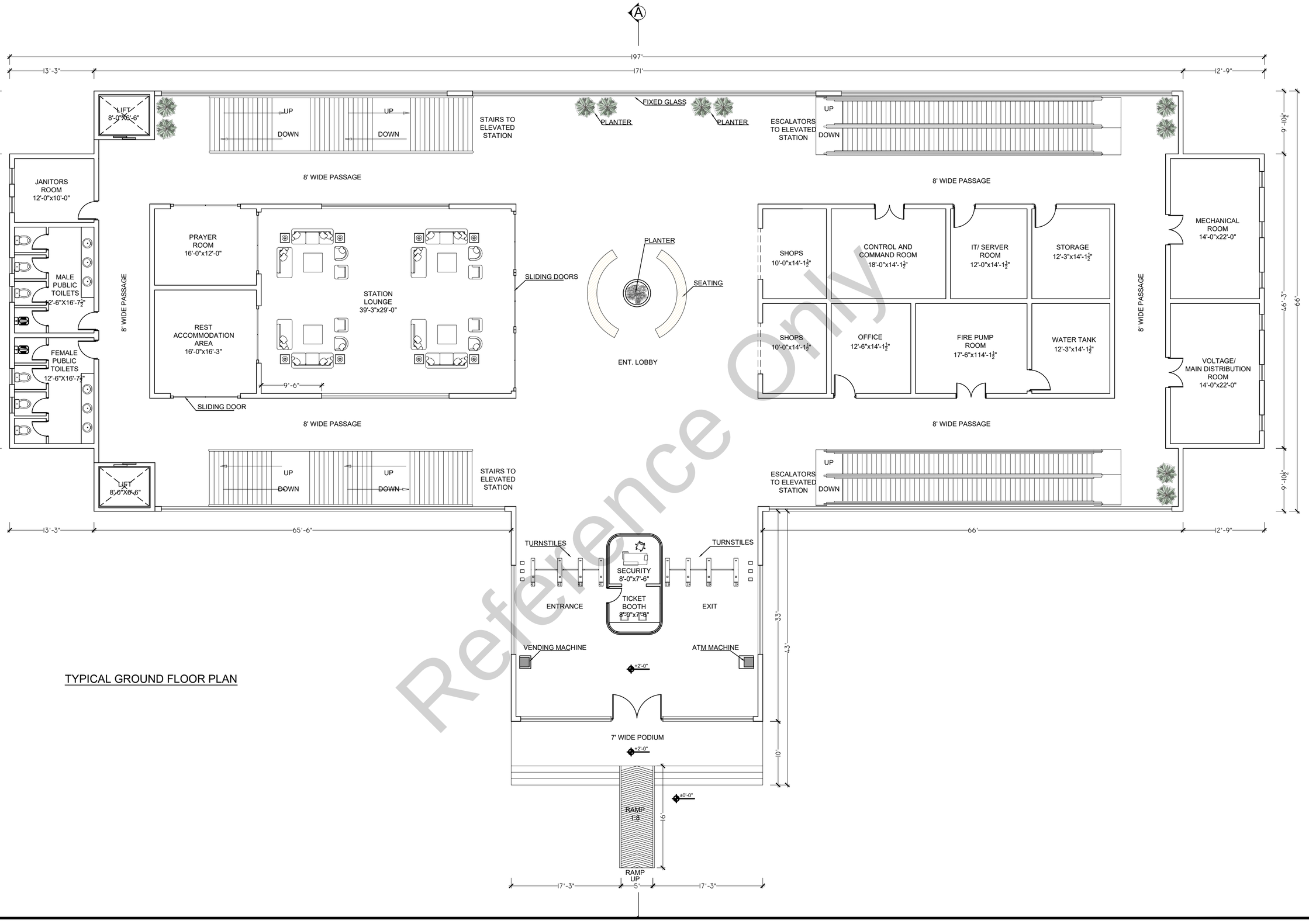
DATE: JULY 2025

DWG. NO.:

ORIENTATION:

SCALE: NTS

REV.: 00



TYPICAL GROUND FLOOR PLAN

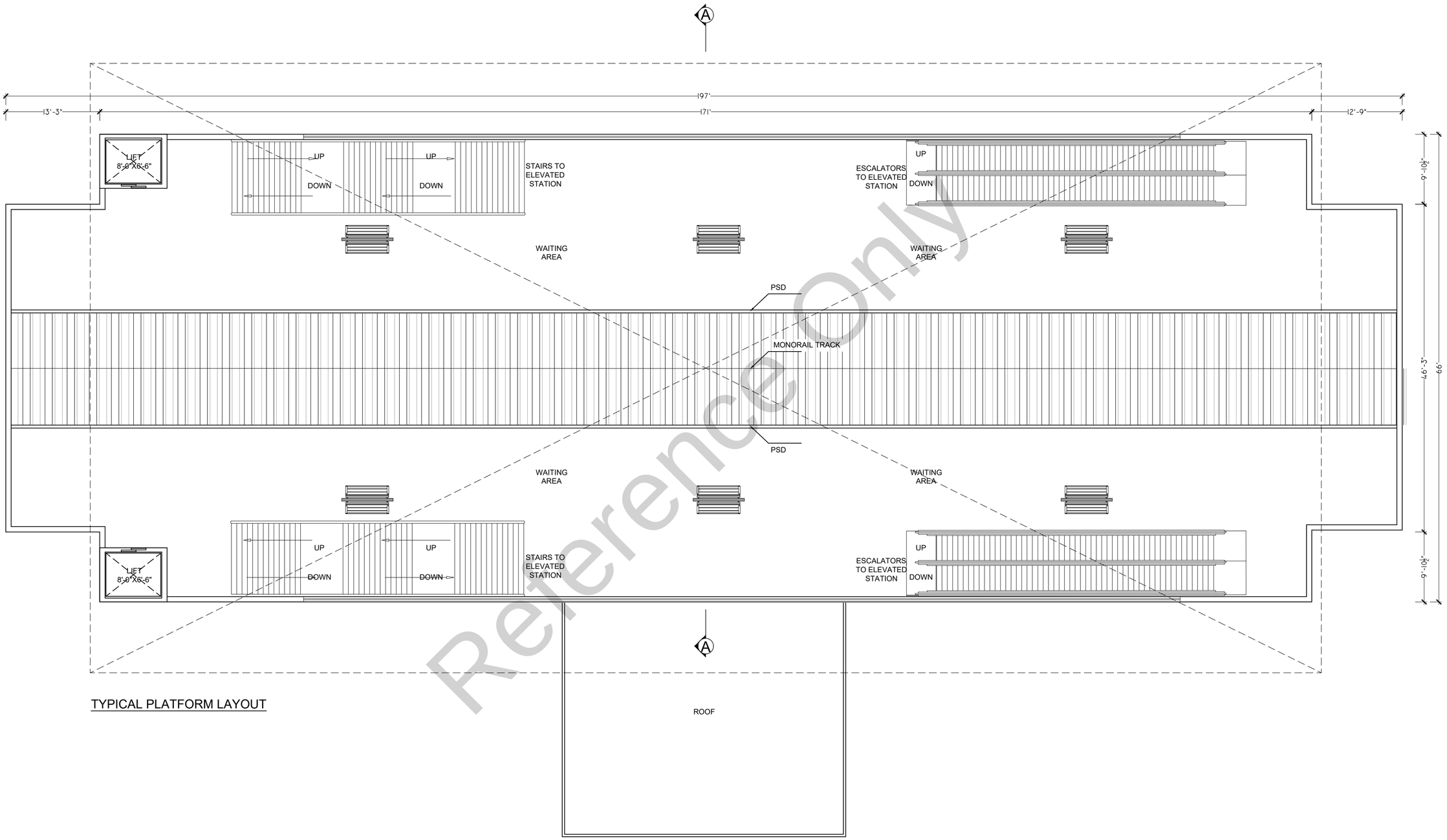
Reference Only

CLIENT :- PUNJAB MASSTRANSIT AUTHORITY	CONSULTANT :- NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	04			DRAWN: MENAHIL
		03			SUBMITTED:
		02			RECOMMENDED:
		01	--	-----	CHD./VER.:
		REV.	DATE	DESCRIPTION / APPROVED	APPROVED:

PROJECT TITLE :- MURREE MONORAIL GLASS STATION

DRAWING TITLE :- TYPICAL STATIONS GROUND FLOOR PLAN

DATE: JULY 2025 | DWG. NO.: A001 | ORIENTATION | SCALE: NTS | REV.: 00



TYPICAL PLATFORM LAYOUT

Reference Only

CLIENT :- PUNJAB MASSTRANSIT AUTHORITY	CONSULTANT :- NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	04			DRAWN: MENAHIL
		03			SUBMITTED:
		02			RECOMMENDED:
		01	--	-----	CHD./VER.:
		REV.	DATE	DESCRIPTION	APPROVED: APPROVED:

PROJECT TITLE :- MURREE MONORAIL GLASS STATION

DRAWING TITLE :- TYPICAL STATIONS FIRST FLOOR PLAN

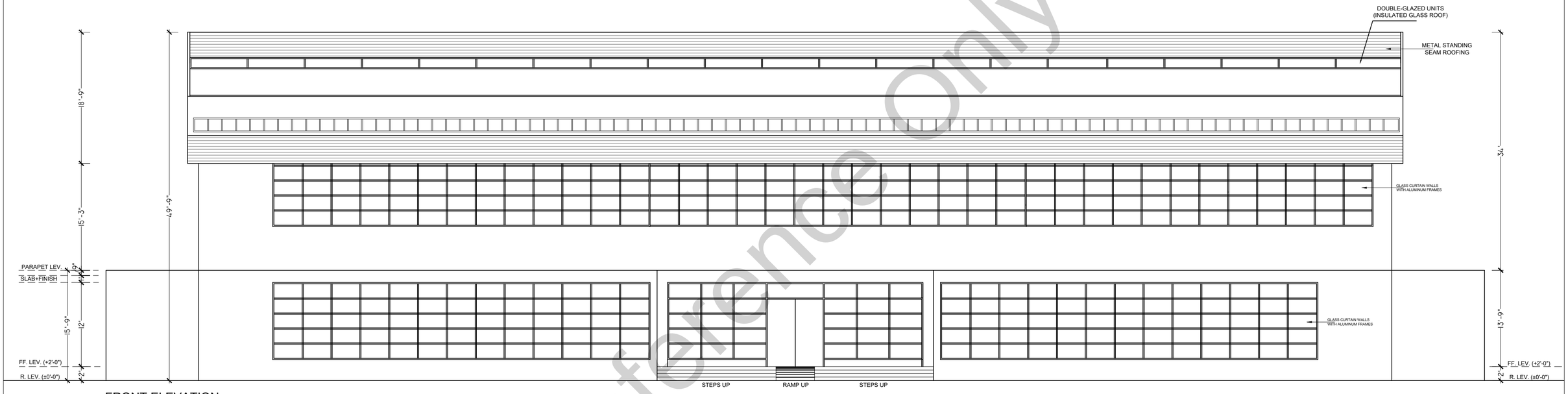
DATE: JULY 2025

DWG. NO.: A001

ORIENTATION

SCALE: NTS

REV.: 00



FRONT ELEVATION

Reference Only

CLIENT :- PUNJAB MASSTRANSIT AUTHORITY	CONSULTANT :- NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	04			DRAWN: MENAHIL
		03			SUBMITTED:
		02			RECOMMENDED:
		01	--	-----	CHD./VER.:
		REV.	DATE	DESCRIPTION / APPROVED	APPROVED:

PROJECT TITLE :- MURREE MONORAIL GLASS STATION

DRAWING TITLE :- TYPICAL STATIONS FRONT ELEVATION

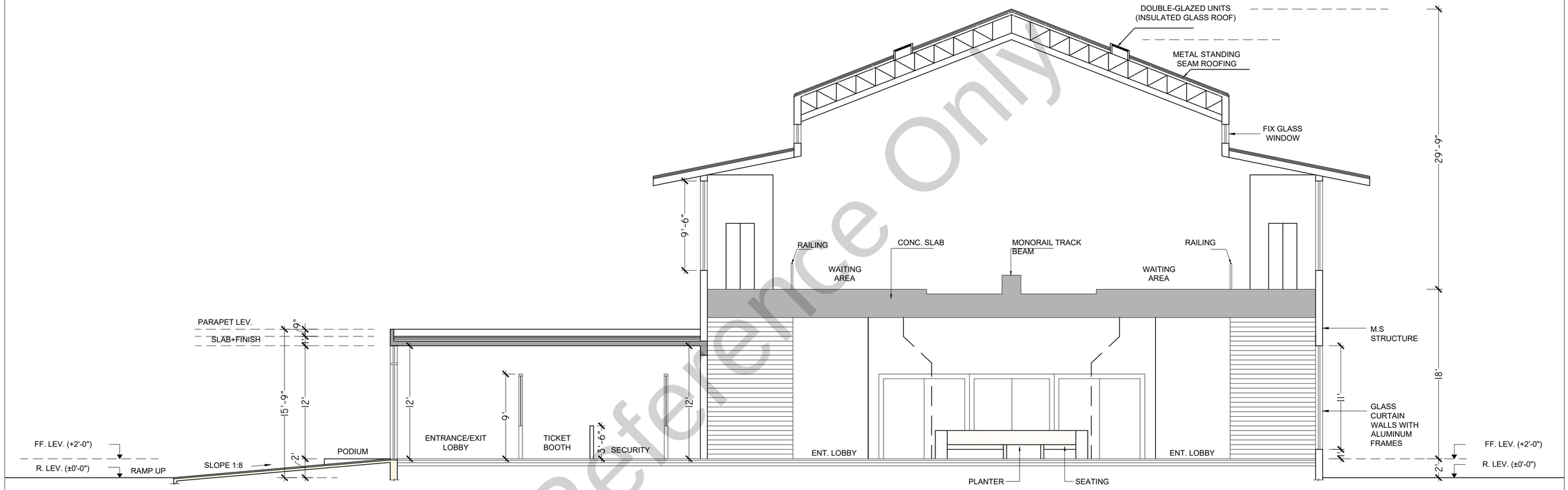
DATE: JULY 2025

DWG. NO.: A001

ORIENTATION

SCALE: NTS

REV.: 00



SECTION AA

Reference Only

CLIENT :- PUNJAB MASSTRANSIT AUTHORITY	CONSULTANT :- NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	PROJECT TITLE :- MURREE MONORAIL GLASS STATION	DRAWING TITLE :- TYPICAL STATIONS SECTION AA	ORIENTATION	SCALE NTS
			DATE JULY 2025		DWG. NO. A001
					REV. 00

REV.	DATE	DESCRIPTION	APPROVED		
04				DRAWN	MENAHIL
03				SUBMITTED	
02				RECOMMENDED	
01	--	-----		CHD./VER.	
				APPROVED	

PUNJAB MASSTRANSIT AUTHORITY

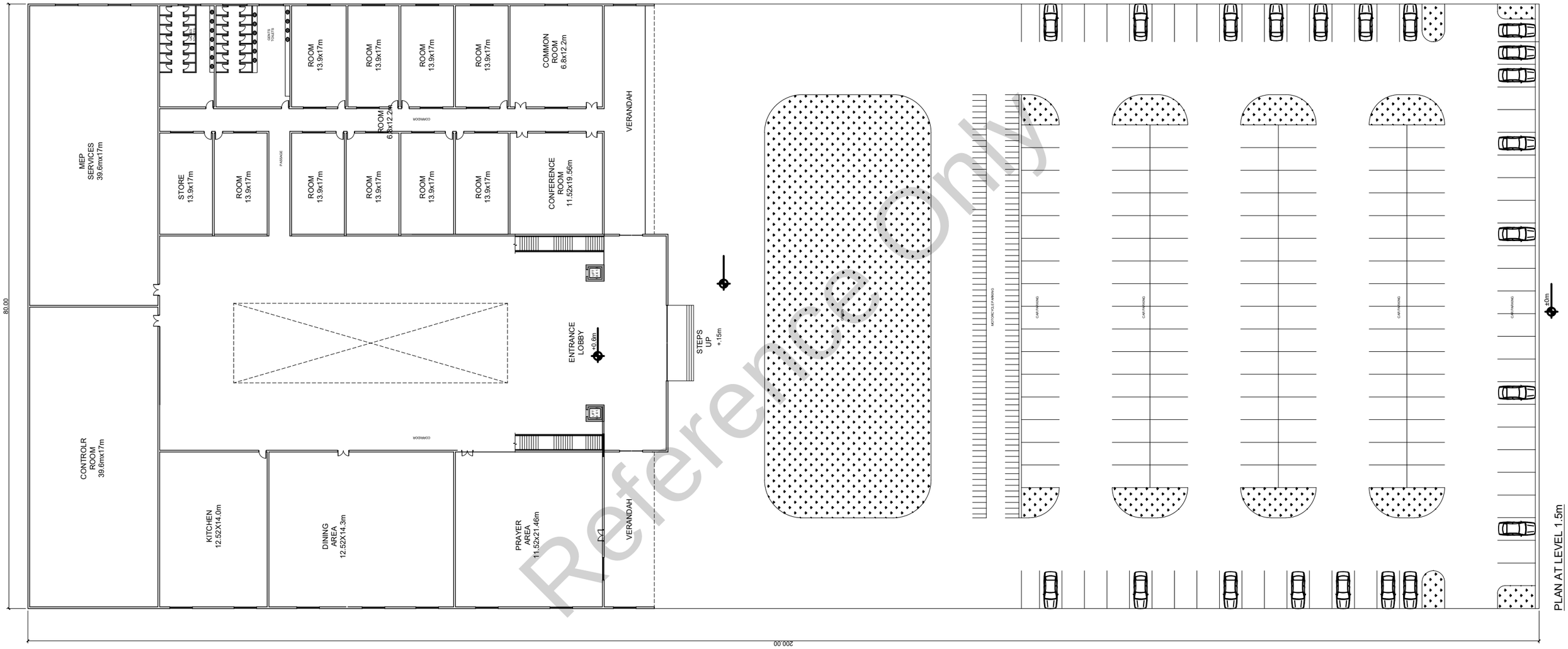
FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE

(DEPOT DRAWINGS)

Reference Only

NATIONAL ENGINEERING SERVICES
PAKISTAN (PVT) LTD.

HEAD OFFICE: NESPAK HOUSE, 1-C, BLOCK N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

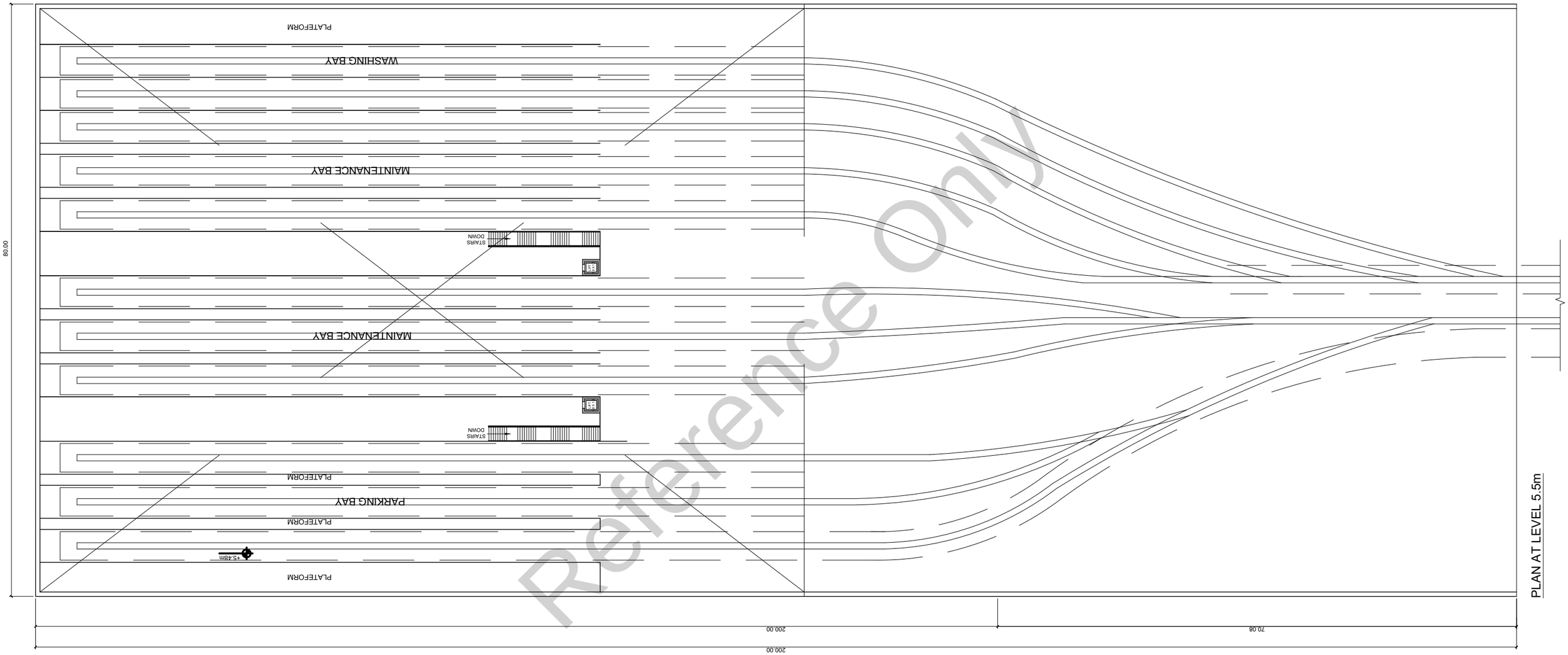


Reference Only

CLIENT :- PUNJAB MASSTRANSIT AUTHORITY	CONSULTANT :- NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	PROJECT TITLE :- MURREE MONORAIL GLASS STATION	DRAWING TITLE :- GLASS TRAIN DEPOT PLAN AT LEVEL 1.5 m	ORIENTATION	SCALE NTS

REV.	DATE	DESCRIPTION	APPROVED		
04				DRAWN	MENAHIL
03				SUBMITTED	
02				RECOMMENDED	
01	--	-----		CHD./VER.	
				APPROVED	

DATE: SEP 2025 | DWG. NO.: A001 | REV.: 00



Reference Only

CLIENT :- PUNJAB MASSTRANSIT AUTHORITY	CONSULTANT :- NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD. HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.	04			DRAWN: MENAHIL
		03			SUBMITTED:
		02			RECOMMENDED:
		01	--	-----	CHD./VER.:
		REV.	DATE	DESCRIPTION / APPROVED	APPROVED:

PROJECT TITLE :- MURREE MONORAIL GLASS STATION

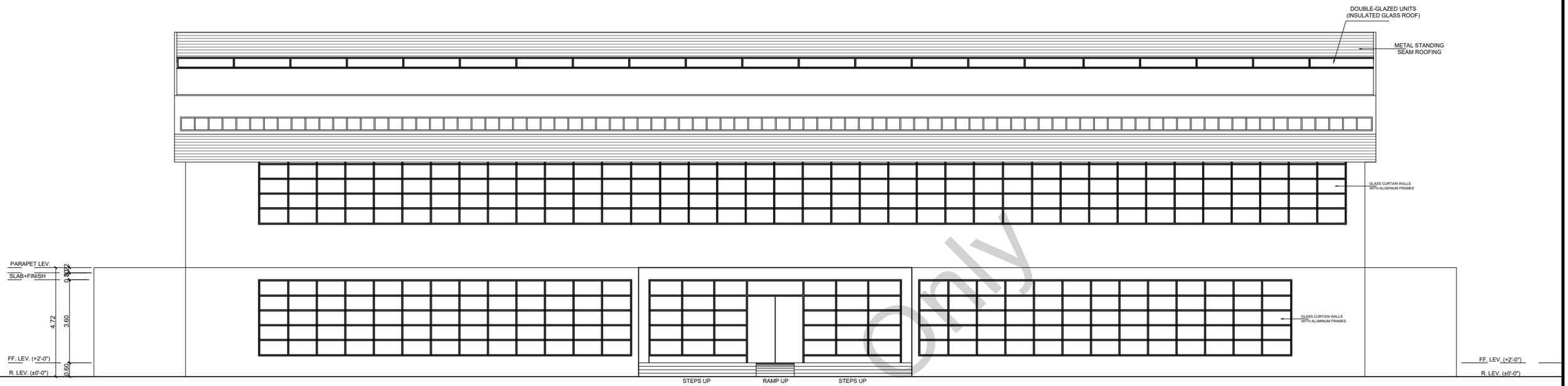
DRAWING TITLE :- GLASS TRAIN DEPOT PLAN AT LEVEL 5.5 m

DATE: SEP 2025 | DWG. NO.: A002

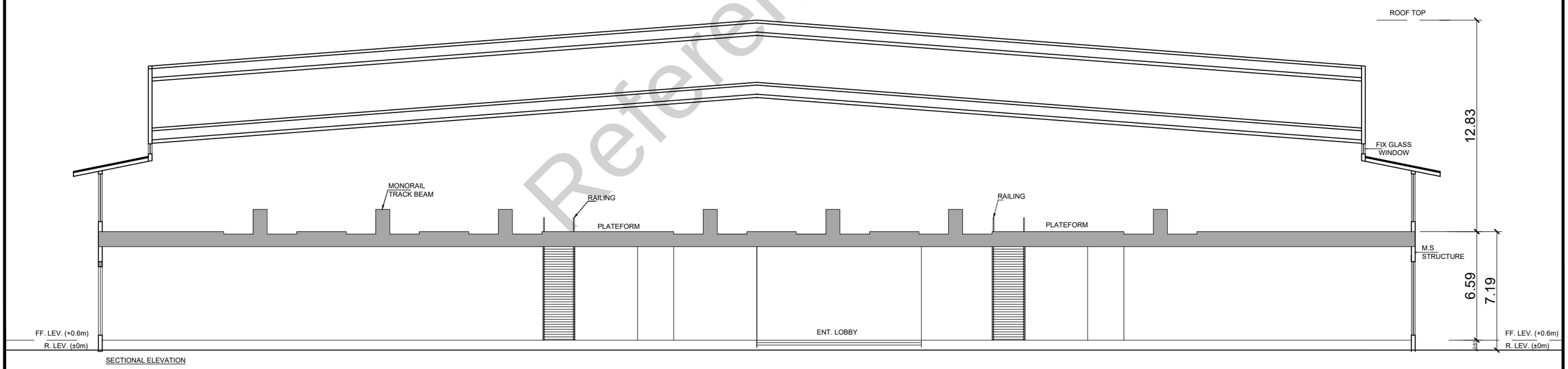
ORIENTATION

SCALE: NTS

REV.: 00



FRONT ELEVATION



SECTIONAL ELEVATION

Reference Only

CLIENT :-

PUNJAB MASSTRANSIT AUTHORITY

CONSULTANT :-

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.
HEAD OFFICE:- NESPAK HOUSE, I-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01	--	-----	

DRAWN	MENAHIL
SUBMITTED	
RECOMMENDED	
CHD./VER.	
APPROVED	

PROJECT TITLE :-

MURREE MONORAIL GLASS STATION

DRAWING TITLE :-

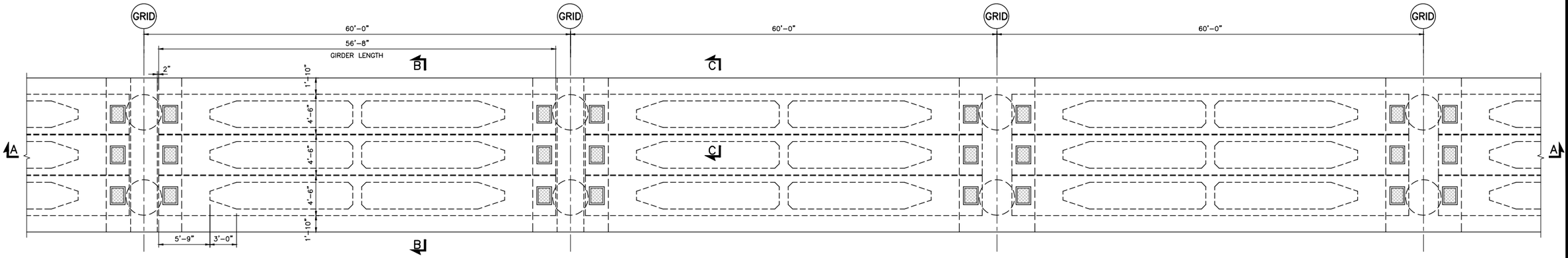
GLASS TRAIN DEPOT
ELEVATION & SECTION

DATE	DWG. NO.
SEP 2025	A003

ORIENTATION

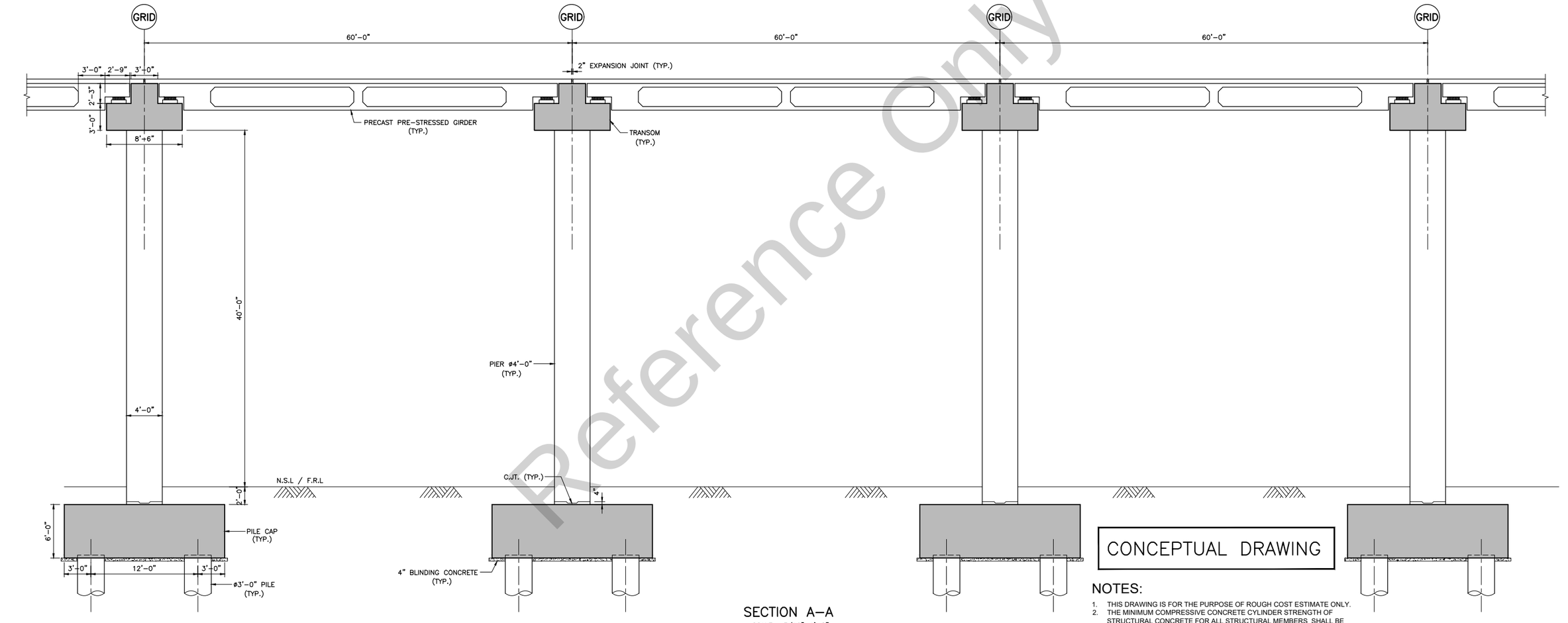
SCALE
NTS

REV.
00



LAYOUT PLAN

SCALE : 3/16"=1'-0"



SECTION A–A

SCALE : 3/16"=1'-0"

CONCEPTUAL DRAWING

NOTES:

1. THIS DRAWING IS FOR THE PURPOSE OF ROUGH COST ESTIMATE ONLY.
2. THE MINIMUM COMPRESSIVE CONCRETE CYLINDER STRENGTH OF STRUCTURAL CONCRETE FOR ALL STRUCTURAL MEMBERS SHALL BE 4000 psi AT 28 DAYS UNLESS OTHERWISE NOTED.
3. THE MINIMUM COMPRESSIVE CYLINDER STRENGTH OF LEAN/BLINDING CONCRETE SHALL BE 1500 PSI AT 28 DAYS.
4. ALL PRE-STRESSED CONCRETE SHALL HAVE A MINIMUM COMPRESSIVE CYLINDER STRENGTH OF 5000 PSI AT 28 DAYS.
5. REINFORCING STEEL SHALL BE GRADE 60 STEEL CONFORMING TO AASHTO M-31 (ASTM A-615) WITH MINIMUM YIELD STRENGTH OF 414 N/mm² (60,000 psi).
6. PRESTRESSING STEEL SHALL BE LOW RELAXATION STRAND CONFORMING TO AASHTO M203 (ASTM A-416), GRADE 270 HAVING MINIMUM ULTIMATE TENSILE STRENGTH OF 1862 N/mm² (270 ksi).

Reference Only

PUNJAB MASSTRANSIT AUTHORITY

GOVT. OF THE PUNJAB

CONSULTANT

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.

HEAD OFFICE:– NESPAK HOUSE, I–C, BLOCK–N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

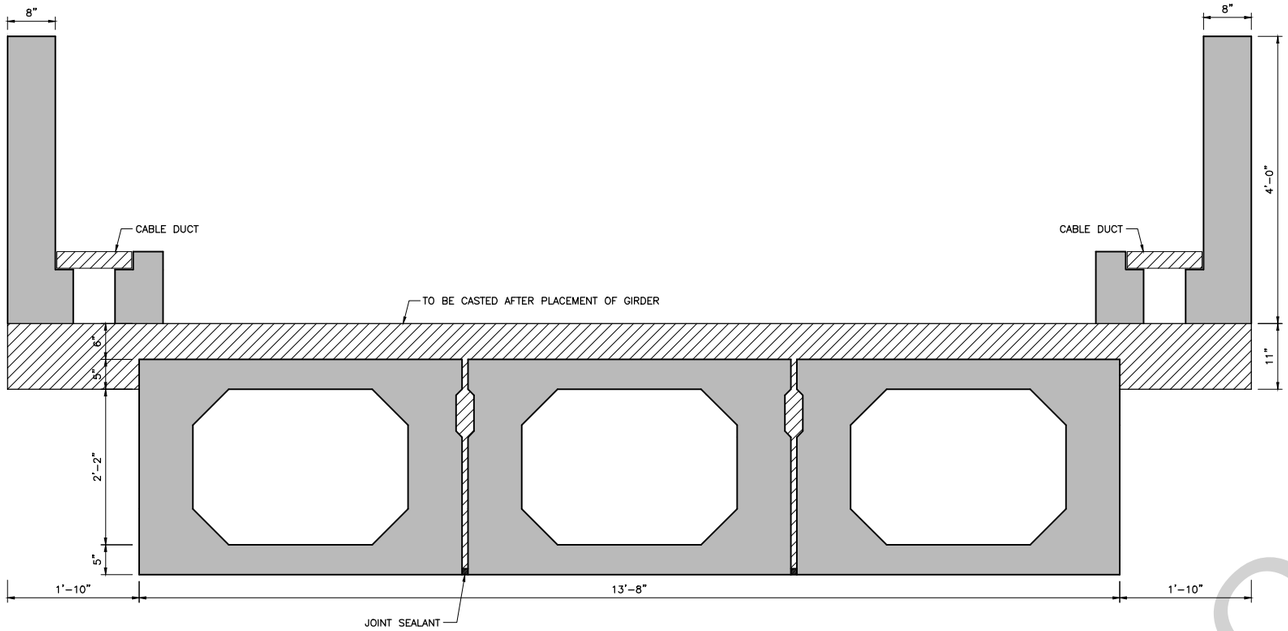
REV.	DATE	DESCRIPTION	APPROVED	APPROVED	
04				DRAWN	M.ASIM
03				SUBMITTED	
02				RECOMMENDED	
01				CHD./VER.	

PROJECT

FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE.

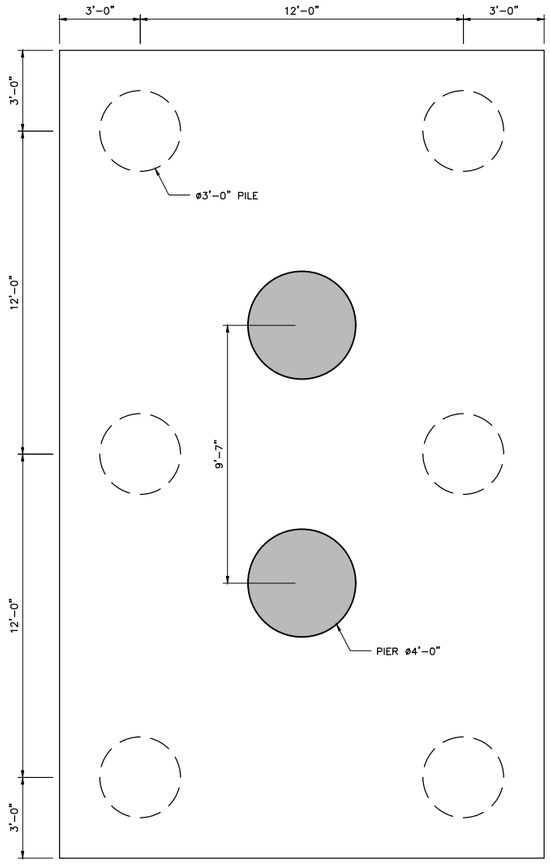
STRUCTURAL ARRANGEMENT
GLASS TRAIN BRIDGE

DATE	DRAWING No.	SCALE	REV.
MAY, 2025	DRAWING NO. 01	1/8"=1'-0"	0



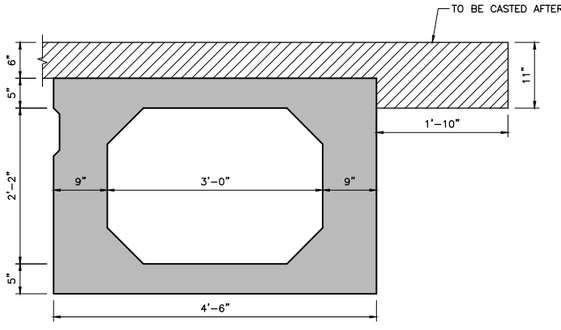
SECTION B–B

SCALE : 1"=1'-0"



PILE CAP PLAN

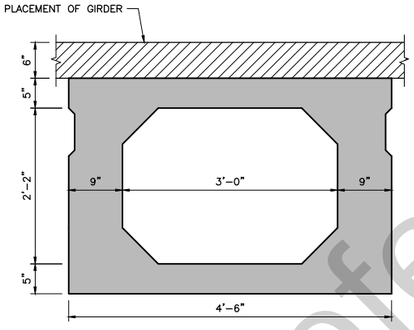
SCALE : 3/8"=1'-0"



EDGE GIRDER

(CONCRETE OUTLINE)

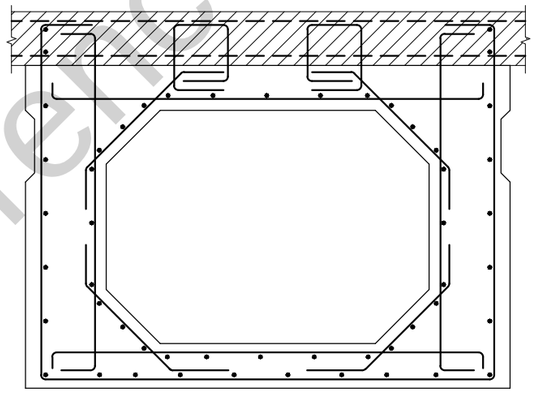
SCALE : 1"=1'-0"



CENTER GIRDER

(CONCRETE OUTLINE)

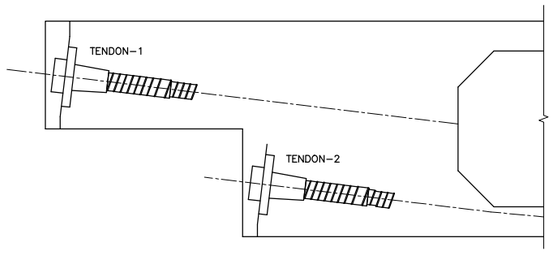
SCALE : 1"=1'-0"



CENTER GIRDER

(REINFORCEMENT)

SCALE : 1"=1'-0"



TENDON PROFILE DETAIL

SCALE : 1"=1'-0"

CONCEPTUAL DRAWING

NOTES:

1. THIS DRAWING IS FOR THE PURPOSE OF ROUGH COST ESTIMATE ONLY.
2. THE MINIMUM COMPRESSIVE CONCRETE CYLINDER STRENGTH OF STRUCTURAL CONCRETE FOR ALL STRUCTURAL MEMBERS SHALL BE 4000 psi AT 28 DAYS UNLESS OTHERWISE NOTED.
3. THE MINIMUM COMPRESSIVE CYLINDER STRENGTH OF LEAN/BLINDING CONCRETE SHALL BE 1500 PSI AT 28 DAYS.
4. ALL PRE-STRESSED CONCRETE SHALL HAVE A MINIMUM COMPRESSIVE CYLINDER STRENGTH OF 5000 PSI AT 28 DAYS.
5. REINFORCING STEEL SHALL BE GRADE 60 STEEL CONFORMING TO AASHTO M-31 (ASTM A-615) WITH MINIMUM YIELD STRENGTH OF 414 N/mm² (60,000 psi).
6. PRESTRESSING STEEL SHALL BE LOW RELAXATION STRAND CONFORMING TO AASHTO M203 (ASTM A-416), GRADE 270 HAVING MINIMUM ULTIMATE TENSILE STRENGTH OF 1862 N/mm² (270 ksi).

Reference Only

PUNJAB MASSTRANSIT AUTHORITY

GOVT. OF THE PUNJAB

CONSULTANT

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.

HEAD OFFICE:– NESPAK HOUSE, I–C, BLOCK–N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	M.ASIM
SUBMITTED	
RECOMMENDED	
CHD./VER.	
APPROVED	

PROJECT

FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE.

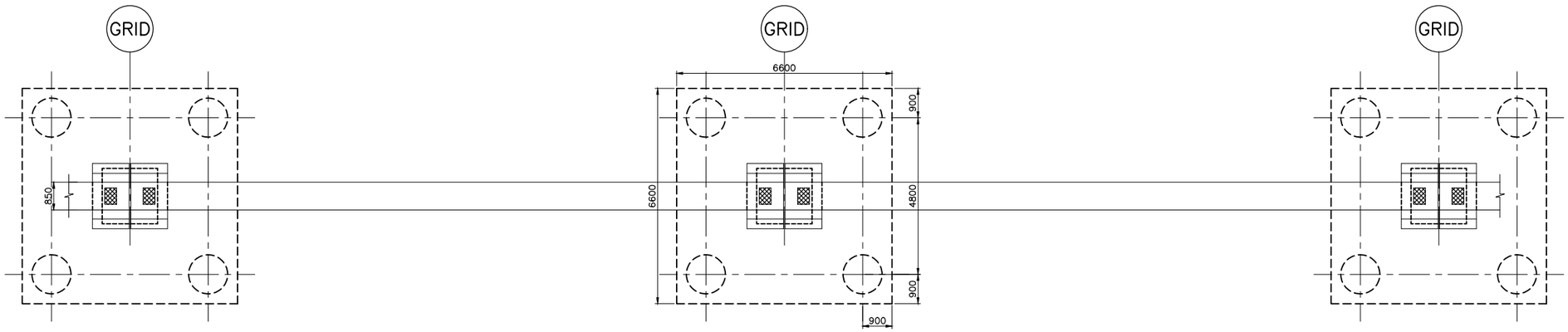
STRUCTURAL ARRANGEMENT
GLASS TRAIN BRIDGE

DATE: MAY, 2025

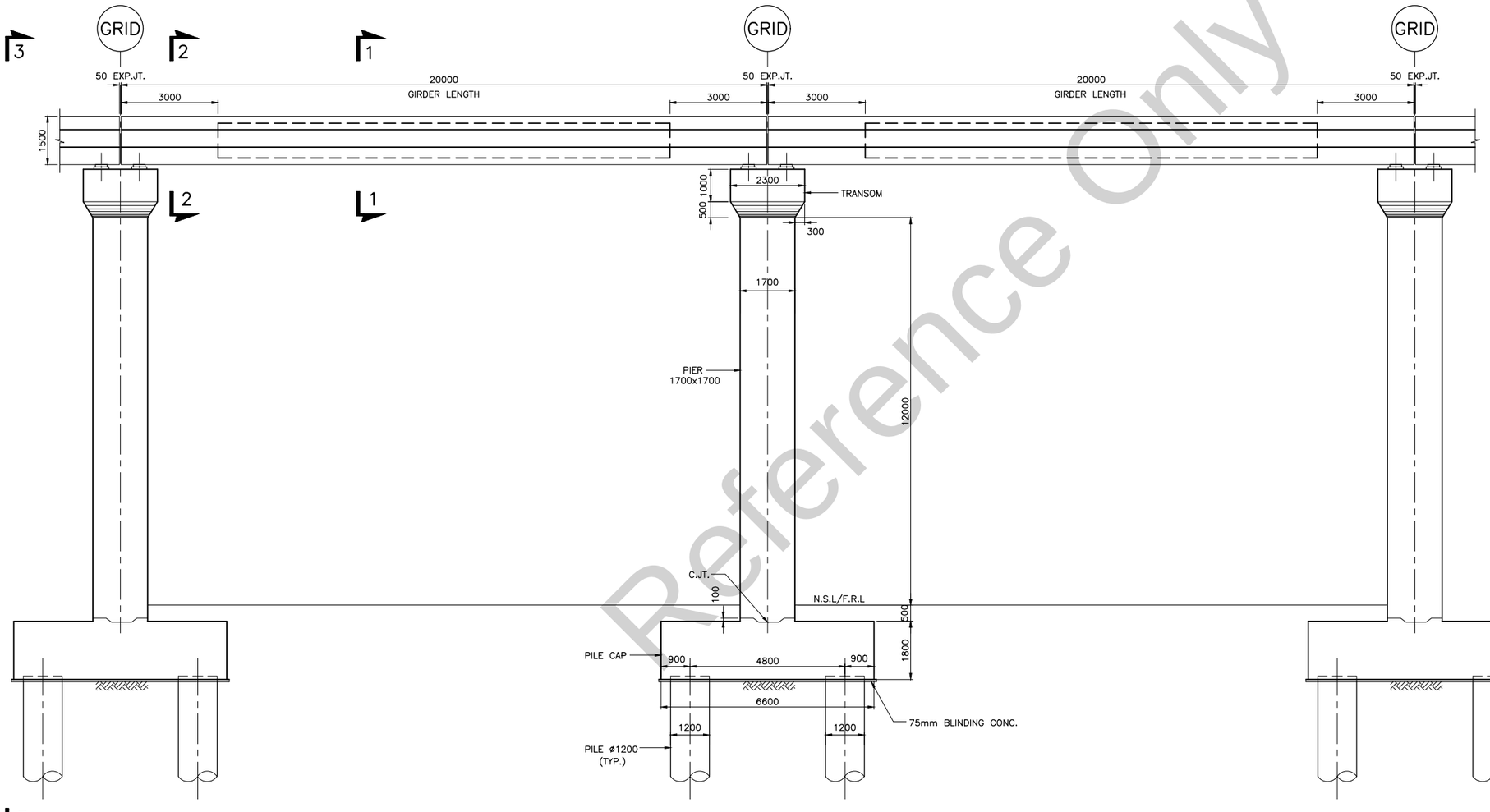
DRAWING No.: DRAWING NO. 02

SCALE: 1/8"=1'-0"

REV.: 0



PLAN



ELEVATION

Reference Only

CONCEPTUAL DRAWING

NOTES:

1. THIS DRAWING IS FOR THE PURPOSE OF ROUGH COST ESTIMATE ONLY.
2. THE MINIMUM COMPRESSIVE CONCRETE CYLINDER STRENGTH OF STRUCTURAL CONCRETE FOR ALL STRUCTURAL MEMBERS SHALL BE 4000 psi AT 28 DAYS UNLESS OTHERWISE NOTED.
3. THE MINIMUM COMPRESSIVE CYLINDER STRENGTH OF LEAN/BLINDING CONCRETE SHALL BE 1500 PSI AT 28 DAYS.
4. ALL PRE-STRESSED CONCRETE SHALL HAVE A MINIMUM COMPRESSIVE CYLINDER STRENGTH OF 5000 PSI AT 28 DAYS.
5. REINFORCING STEEL SHALL BE GRADE 60 STEEL CONFORMING TO AASHTO M-31 (ASTM A-615) WITH MINIMUM YIELD STRENGTH OF 414 N/mm² (60,000 psi).
6. PRESTRESSING STEEL SHALL BE LOW RELAXATION STRAND CONFORMING TO AASHTO M203 (ASTM A-416), GRADE 270 HAVING MINIMUM ULTIMATE TENSILE STRENGTH OF 1862 N/mm² (270 ksi).

PUNJAB MASSTRANSIT AUTHORITY

GOVT. OF THE PUNJAB

CONSULTANT

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.

HEAD OFFICE:– NESPAK HOUSE, I–C, BLOCK–N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	AHMAD RAZA
SUBMITTED	
RECOMMENDED	
CHD./VER.	
APPROVED	

PROJECT

FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE.

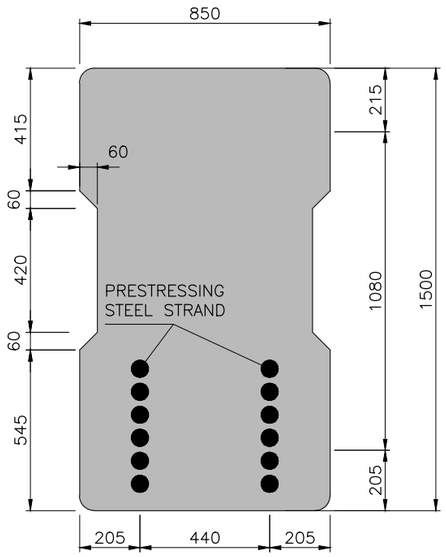
STRUCTURAL ARRANGEMENT
STRADDLE TYPE MONORAIL

SCALE 1/8"=1'–0"

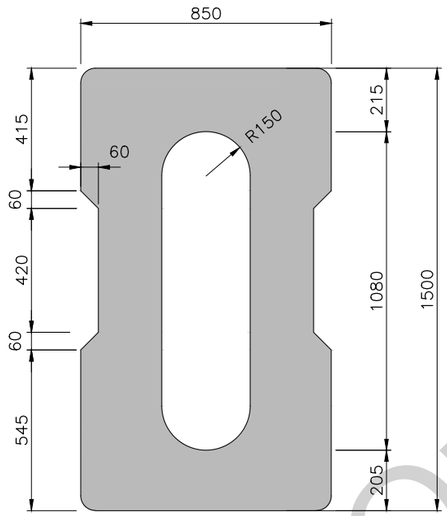
DATE MAY, 2025

DRAWING No. DRAWING NO. 01

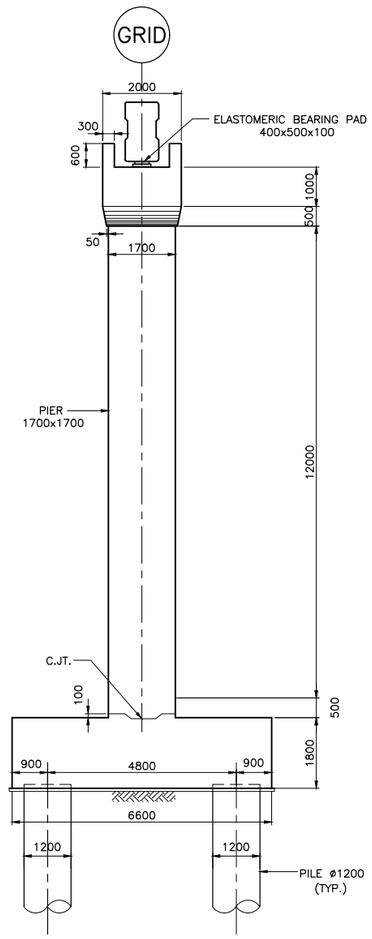
REV. 0



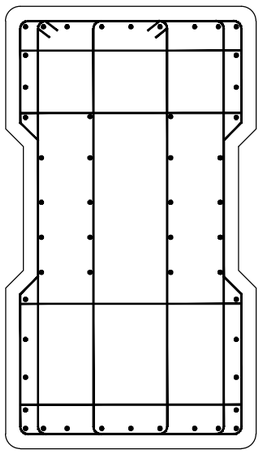
SECTION 2–2
(CONCRETE OUTLINE)



SECTION 1–1
(CONCRETE OUTLINE)



SECTIONAL ELEVATION 3–3



SECTION 2–2
(REINFORCEMENT)

Reference Only

CONCEPTUAL DRAWING

NOTES:

1. THIS DRAWING IS FOR THE PURPOSE OF ROUGH COST ESTIMATE ONLY.
2. THE MINIMUM COMPRESSIVE CONCRETE CYLINDER STRENGTH OF STRUCTURAL CONCRETE FOR ALL STRUCTURAL MEMBERS SHALL BE 4000 psi AT 28 DAYS UNLESS OTHERWISE NOTED.
3. THE MINIMUM COMPRESSIVE CYLINDER STRENGTH OF LEAN/BLINDING CONCRETE SHALL BE 1500 PSI AT 28 DAYS.
4. ALL PRE-STRESSED CONCRETE SHALL HAVE A MINIMUM COMPRESSIVE CYLINDER STRENGTH OF 5000 PSI AT 28 DAYS.
5. REINFORCING STEEL SHALL BE GRADE 60 STEEL CONFORMING TO AASHTO M-31 (ASTM A-615) WITH MINIMUM YIELD STRENGTH OF 414 N/mm² (60,000 psi).
6. PRESTRESSING STEEL SHALL BE LOW RELAXATION STRAND CONFORMING TO AASHTO M203 (ASTM A-416), GRADE 270 HAVING MINIMUM ULTIMATE TENSILE STRENGTH OF 1862 N/mm² (270 ksi).

PUNJAB MASSTRANSIT AUTHORITY
GOVT. OF THE PUNJAB

CONSULTANT
NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LTD.
HEAD OFFICE:– NESPAK HOUSE, I–C, BLOCK–N, MODEL TOWN EXTENSION, LAHORE, PAKISTAN.

REV.	DATE	DESCRIPTION	APPROVED
04			
03			
02			
01			

DRAWN	AHMAD RAZA
SUBMITTED	
RECOMMENDED	
CHD./VER.	
APPROVED	

PROJECT
FEASIBILITY STUDY FOR TOURIST GLASS TRAIN FROM RAWALPINDI TO MURREE.

STRUCTURAL ARRANGEMENT
STRADDLE TYPE MONORAIL

SCALE: 1/8"=1'–0"
DATE: MAY, 2025
DRAWING No.: DRAWING NO. 02
REV.: 0