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Risk Assessment Report

Orange Line Metro Train Project, Lahore [E&M works]

Location	Dera Gujran, Herbanspura to Ali Town, Thokar Niaz Bag, Lahore, Pakistan
Requested by	**National Insurance Co Ltd**
Report ref	851_01189937A_18130502
Dated	14 June 2021
Prepared by	**Joseph Lobo (Pvt) Ltd, Pakistan**

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Survey Report - Risk

[Issued Without Prejudice - for the internal use of the Underwriters concerned]

Target Risk	Orange Line Metro Train Project, Lahore [E&M works] [OMT].
Insured	Punjab Mass Transit Authority 346-B, 5th-Floor, Arfa Software Technology Park, Ferozepur Road, Lahore.
Location/ alignment	From Dera Gujran, Herbanspura, Lahore to Ali Town, Thokar Niaz Baig, Lahore.
On instructions from	National Insurance Co Ltd [NIC].
Date of Survey	19-, 20-May-2021, followed by several meetings, data collection & review | 10-Jun-2021.

0100 Executive Summary | Preamble

0101 The Punjab Mass Transit Authority [PMA] is a public transportation authority of the Punjab province. PMA operates in the province's urban centers namely Lahore, Multan & the twin cities of Islamabad & Rawalpindi.

0102 PMA is a statutory body established by the Government of the Punjab which plans, constructs, maintains & operates the mass transit systems in the major cities of the Punjab. Set up in 2012, the authority is tasked with providing safe, efficient & comfortable urban transportation systems in the province. It is headquartered from the 5th floor of the Arfa Software Technology Park on Ferozepur Road, Lahore.

0103 The PMA operates the following systems:

- Orange Line Metro Train System Lahore
- Lahore Metrobus System
- Lahore Feeder Routes
- Multan Metrobus
- Multan Feeder Routes
- Pakistan Metrobus System [Rawalpindi-Islamabad]

0104 The Orange Line Metro Train System is an automated rapid transit line in Lahore, Punjab, Pakistan & the first driverless metro in Pakistan. It is operated by the Punjab Mass Transit Authority & forms part of the Lahore Metro system. The line is Pakistan's first metro train. The line spans 27.1 km [16.8 mi] with 25.4 km [15.8 mi] elevated & 1.72 km [1.1 mi] underground. The line is served by 26 stations & is expected to handle 250,000 passengers daily. It is a part of the wider CPEC China Pakistan Economic Corridor, the Orange line is being financed by both the Government of Pakistan, & Government of China.

0105 The project was initiated with a signed memorandum of understanding between the governments of Pakistan & China in May 2014. Financing for the project was secured in December 2015 when China's Exim Bank agreed to provide a soft loan of $1.55 billion for the project. Construction works on the project began in October 2015. Habib Construction Services was awarded the first phase in October 2015 for Rs21.49 billion [US$130 million]. In October 2016, Phase 2 of the project was awarded to ZKB Engineers & Constructors for civil works between Chauburji & Ali Town at a cost of 11.39 billion rupees. CRRC Zhuzhou Locomotive rolled out the first of 27 trains for the metro on 16 May 2017.

0106 Testing & trial runs began in March 2018. The first test-run of OMT took place on 25-Oct-2020 & the operations were formally inaugurated on 25-Oct-2020.

0107 Contractors: PMA handed over the complete project to four companies to maintain & operate the orange line trains system. PMA assigned the contracts with these companies & categorized them in four as follows;

0107.1 **L2SP1** [Line to service provider 1]
0107.2 Norinco International Cooperation Ltd JV
0107.3 GMG [Guangzhou Metro Group Co. Ltd

0107.4 Daewoo Pakistan Express Bus Service Ltd
0107.5 **L2SP2** Infotech [Pvt] Ltd
0107.6 **L2SP3** Security 2000 [Pvt] Ltd
0107.7 **L2SP4** Lahore waste management Co.
0107.8 **L2SP1** [Norinco International Cooperation Ltd J.V]

0108 On February 25th, 2020, the contract for operation & maintenance of Lahore Metro Orange Line was signed between the PMA & a set of firms including Guangzhou Metro, NORINCO International & Daewoo Express to operate & maintenance of trains including depot, stabling yard & both substations for eight years. Detail of staff given as follows;

0200 Scope of Survey

0201 The subject survey was carried out with the consent & cooperation of OMT & NIK / NIL.

0202 Principal persons liaised with were: [a] Mr Uzair Ahmad [UA]: General Manger Operations, OMT; [b] Mr Tan Zidong [TZ]: General Manger Coordination, Noringo; [c] Mr Rizwan Aziz [RA]: Manager Operation Technical, OMT; [d] Mr Muhammad Asad [MA]: Head E&M, Noringo; [e] Mr Mohaimin Danish [MD]: Manger Coordination, Noringo; besides several other engineers, technicians & support staff.

0203 The scope of the assignment includes assessment for the level of exposure of the OMT plant to perils relating to:

- 0203.1 Standard insurance policy named perils: Fire, Lightning, Explosion, Earthquake-Fire-Shock, Atmospheric Disturbance [AD] / Flood, Aircraft & Falling-Aerial-Objects, Impact Damage, Malicious-Damage, Riot-Strike-Damage, Burglary-Theft- Armed-Holdup & Third-Party-Liability.
- 0203.2 Terrorism.
- 0203.3 Plant-Machinery including:
  - 0203.3.1 Equipment / Machinery Breakdown.
  - 0203.3.2 Electrical Electronic Equipment.
- 0203.4 Business Interruption & Loss of Profits.
- 0203.5 Cash-in-Safe & Cash-in-Transit.

0204 With respect to OMT, we examined the:

- 0204.1 Operations layout of the civil structures & plant / machinery components.
- 0204.2 Current & projected long-term integrity of these said components.

0205 General Industrial / Infrastructure / Commercial Operational Hazards, including procedural protocols in place for:

- 0205.1 General industrial practices.
- 0205.2 Material & equipment storage / transport / handling.

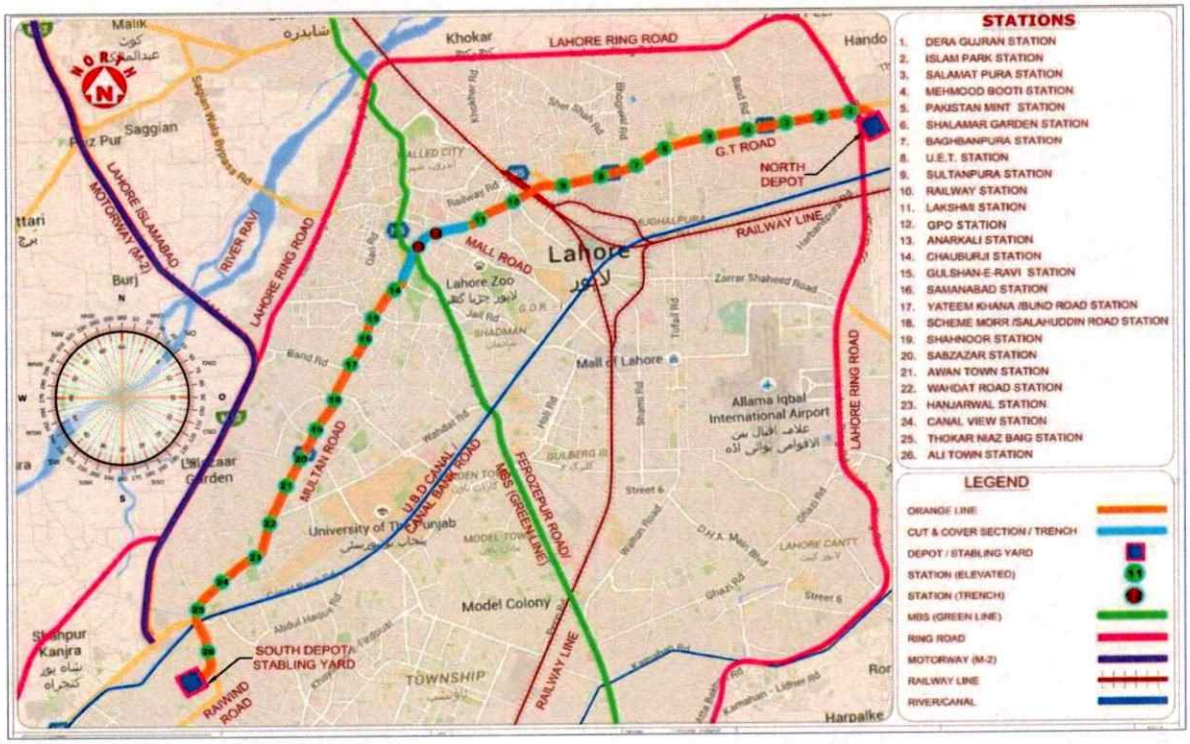
0206 Potential loss scenarios that could occur at the subject location[s] due to failures &/or losses sustained with respect to non-compliance &/or failures involving the above protocols.

0207 We also studied the general level of housekeeping, the cleaning & waste removal protocols in place, the emissions issues, training & awareness especially with respect to hazard & disaster management in the face of contingencies.

0208 A preliminary assessment & estimation for the total sum-insured [SI], Probable Maximum Loss [PML] & Maximum Foreseeable Loss [MFL] was also made.

0300 Site Location

0301 Route: The OMT route begins at the northeastern terminus at Dera Gujran, the track is elevated & runs in the median of the GT Road until Shalimar Station. From Dera Gujran Station in northeast Lahore, the route travels 5.5 kilometers westward with stations at Islam Park, Salamatpura, Mahmood Booti, Pakistan Mint, & Shalimar Gardens. The track does not run in the GT Road's median near Shalimar Station - it instead turns & travels along the southern edge of the GT Road in order to bypass the garden in order to prevent damage to mature trees there. Traveling west from Shalimar Station, the track returns to the median of GT Road, with stops at Baghbanpura, University of Engineering & Technology, & Sultanpura. From Sultanpura, the line then travels towards Lahore's central Junction Railway Station. From there, it travels southwest along McLeod road towards Lakshmi Chowk Station. The total distance from Sultanpura to Lakshmi Chowk is 2.5 km.



▲ OMT route

0302 Leaving Lakshmi Chowk, the line travels southwest along McLeod Road, & descends into the 1.15 km underground portion that leads to the first underground station in the system, the Central Station. Central Station is located at the intersection of The Mall & McLeod Road, in front of Lahore's General Post Office [GPO] & the Lahore High Court. From Central Station, the line continues from McLeod Road & travels under Allah Baksh Road before turning south where the second underground station, Anarkali, is located. Connections from the OMT to the Lahore Metrobus will be available via an underground walkway. From Anarkali Station, the route continues under Jain Mandir & Lytton Road. It then emerges along Lake Road & again travels above ground towards Chauburji Station.

0303 From Chauburji the line continues 4.5 km towards the southwest, along the median of Multan Road. Elevated stations are located at Gulshan-e-Ravi, Samanabad, Bund Road, Salahuddin Road, & Shahnoor. From Shahnoor, the line shifts from Multan Road's median & travels along the road's southern/eastern side with a stop at Sabzazar Station. The line continues along Multan Road's edge until Awan Road Station, after which it reverts to Multan Road's median. Leaving Awan Road Station, the line continues to travel southwest along Multan Road until it reaches Vahdat Station, which lies 2.85 km to the southwest of Sabzazar Station. The line 5.2 kilometers along Multan & Raiwind Roads, with stops at Hanjarwal Station, Canal View, Thokar Niaz Baig, before terminating at Ali Town.

0304 The OMT connects to the Lahore Metrobus via an underground walkway from the Anarkali Station of the OMT, to MAO College Station of the Metrobus. The line connects to the Lahore Railway Station via a moving walkway to the OMT's Bohrwala Chowk Station.

0305 Coordinates for the exact locations of each site are listed as under:

Sr	Station	Geo-Coordinates
01	Main Depot	31°35'01.7"N 74°26'26.3"E
02	Station 1 Dera Gujran	31°35'23.2"N 74°25'51.9"E
03	Station 2 Islam Pura	31°35'20.6"N 74°25'22.0"E
04	Station 3 Salamatpura	31°35'18.0"N 74°24'50.1"E
05	Station 4 Mehmood Booti	31°35'12.6"N 74°24'08.9"E
06	Station 5 Pakistan Mint	31°35'07.7"N 74°23'20.5"E
07	Station 6 Shalimar Garden	31°35'01.4"N 74°22'48.2"E

08	Station 7 Baghbanpura	31°34'45.9"N 74°22'14.1"E
09	Station 8 UET station	31°34'38.5"N 74°21'38.1"E
10	Station 9 Sultanpura	31°34'35.7"N 74°21'21.1"E
11	Station 10 Railway station	31°34'20.4"N 74°20'10.0"E
12	Station 11 Lakshmi chowk	31°34'07.3"N 74°19'38.2"E
13	Station 12 GPO	31°33'56.1"N 74°18'51.2"E
14	Station 13 Anarkali	31°33'44.3"N 74°18'35.7"E
15	Station 14 Chauburji	31°33'08.4"N 74°18'11.3"E
16	Station 15 Gulshan-e-Ravi	31°32'36.4"N 74°17'38.7"E
17	Station 16 Samanabad	31°32'24.0"N 74°17'34.8"E
18	Station 17 Bund Road	31°31'55.7"N 74°17'15.4"E
19	Station 18 Salahudin	31°31'15.3"N 74°16'12.4"E
20	Station 19 Sabzazar	31°31'03.8"N 74°16'39.8"E
21	Station 20 Shahnoor	31°31'02.9"N 74°16'39.6"E
22	Station 21 Awan Town	31°30'12.1"N 74°16'06.0"E
23	Station 22 Vahdat Road	31°29'41.0"N 74°15'48.3"E
24	Station 23 Hanjarwal	31°29'10.9"N 74°15'30.9"E
25	Station 24 Canal view	31°28'50.4"N 74°14'56.7"E
26	Station 25 Thokar Niaz	31°28'23.5"N 74°14'29.9"E
27	Station 26 Ali Town	31°27'51.5"N 74°14'37.8"E
28	Sub-station UET	Unconfirmed
29	Sub-station Shahnoor	Unconfirmed
30	Stabling yard Ali Town	31°27'28.7"N 74°14'28.6"E

0400 ***Configuration, Main Components***

0401 The main project components & modules which are configured as under:

0402 Track: The Orange Line's 27.10km long track meets China's national standards, & employing jointless track circuits. Mainline track is capable of supporting 60 kg/m, while track in the depot & storage yards is capable of supporting 50 kg/m. The track was laid upon a monolithic concrete track bed, with crossovers located between every 2 to 3 stations. Double turnover tracks are used at each terminus for turnaround. Track is standard gauge at 1435mm. Fasteners between tracks are elastic.

0403 Rolling stock / locomotives: Orange Line trains are each composed of five wagons manufactured by China's CRRC Zhuzhou Locomotive, & automated & driverless. A standard Chinese "Type B" train-set consisting of 5 cars with 4 doors each used, that has a stainless-steel body & illuminated by LED lighting. Each car has a nominal capacity of 200 seated & standing passengers at an average density of 5 persons per square meter with 20% of passengers seated & 80% standing. A total of 27 trains with 135 cars have been procured. A total of 54 trains are expected to be in service by 2025. The trains powered by a 750-volt 3rd-rail.

0404 Operation Control Center: Control of operations is carried out from Depot to supervise all operational activities, movement of trains throughout the stations, depot, stabling yard & substations via CCTV cameras & SCADA system. Any fire detection & electrical/ mechanical breakdown at any position OCC monitor them & accordingly pass on the instructions to relevant department. OCC supervised subsystems of electro-mechanical equipment & the Comprehensive Maintenance Centers. 36x personnel operate the said system in 3x shifts.

0405 Spare Parts: Spares related to rolling stock & operations tools stored under the industrial shed at depot. No other location set for spare parts other than depot. Spares are packed in cartons. An SAP-based electronic system is installed to source the required spare parts from the warehouse.

0406 Sub Stations: 2x high-voltage electrical substations built for the line - one near UET Station, & the other at Shahnoor Station. The project also included 16x traction substations.

0407 The construction of the UET station building is of IAP-Class-1 category. Boundary wall of the station is of RCC slab say 6ft high topped by reservoir wire of 3ft height over it. 02x security guards remain on duty round the clock. Smoke detectors & 04x CO2 cylinders are present inside the rooms while hydrant points are available in galleries/ pathways. Fire Suppression [CO2] system also available where equipment are installed. ACS for opening the doors of the rooms are also available. Linear Heat detection [LHD] cables for power are installed there. 2x WAPDA lines are operational which come from Fateh Gar Grid stations & PWR grid stations. 2x additional lines, from the Shalimar Grid, are under construction. The UET substation provides electricity to Depot, & 13x orange lines stations from Dera Gujran Station to Anarkali station.

0408 The construction of the Shahnoor building is also of IAP-Class-1 category & basically along identical lines to that of the UET substation. Same type of equipment is installed except for the additional GIS system there. Reportedly 3x security guards remain on duty. A total of 4x power lines are operational [2x lines from Saidpur grid station & 2x from Bund Road]. Shahnoor substation provides electricity to stabling yard, & 13x numbers upward orange lines stations from Anarkali station to Ali Town station.

0409 Stabling yard: The yard is constructed at the line's southern terminus at Ali Town. Similar type of construction of the buildings is built as of depot. Stabling yard respectively required 0.49 kilometers of track

0410 Alignment: The line spans 27.1 km [16.8 mi]. 1.72 km [1.1 mi] of the line is underground, while transition zones between underground & elevated portions covers 0.7 km [0.4 mi]. The remaining track is elevated. The maximum gradient for the track's main-line is 30%, while the minimum turning radius on the mainline is 250 meters. The alignment roughly parallels several of Lahore's major thoroughfares, including the Grand Trunk Road, McLeod Road, Lake Road, Multan Road & Raiwind Road. The Orange Line connects several important nodes in Lahore, including the Shalimar Gardens, University of Engineering & Technology, Lahore's main train station, Chauburji Square, & Ali Town.

0411 Speed: The maximum speed of the trains is 80 km/h [50 mph]. Riders will be served by 26 stations, two of which will be underground stations. The total ride time from one end of the system to the other is estimated to be 45min, compared to the current average commuting time of 60-90min [even up to 120min during peak traffic].

0412 Timings: The Orange Line operates for 16h/d, between 0615h & 2200h. Thereafter, maintenance work starts to lines as well trains till 0615h. Security Staff of Security 2000 works in three shifts at stations for 8 hours each while the staff of Superior security Co. works in two shifts on Depot, Both substations & stabling yard for 12 hours each

0413 Elevators / Escalators: Two elevators & two escalators installed on each station for passenger's movement on entrance & exit beside stairs. [Details are attached]

0414 Stations [Underground]: Anarkali & GPO Stations were initially planned to have two underground levels, Anarkali Station now both feature a ground-level concourse with 1x underground level, effectively reducing the maximum gradient for trains from 35% to 30%. Rail tracks are 9.7m below street level at GPO Station, & 8.7m below street level at Anarkali Station. Underground stations feature automated doors between platforms & trains. Public areas of the station are air conditioned during the summer. Underground track including both stations is 1.7km distance.

0500 Building & Structures

0501 All the main plant components, are housed in dedicated, fully enclosed buildings, with RCC-frame columns & beams, mixed non-load-bearing block-masonry [with some steel sandwich-panel walls & partitions], vaulted steel-truss supported, largely symmetric-pitch roofing.

0502 Operation Control Center: Control of operations is carried out from Depot to supervise all operational activities, movement of trains throughout the stations.

0503 Sub Stations: 2x high-voltage electrical substations built for the line - one near UET Station, & the other at Shahnoor Station. The project also included 16x traction substations. The construction of the UET station building is of IAP-Class-1 category. Boundary wall of the station is of RCC slab say 6ft high topped by reservoir wire of 3ft height over it. 02x security guards remain on duty round the clock. Smoke detectors & 04x CO2 cylinders are present inside the rooms while hydrant points are available in galleries/ pathways. Fire Suppression [CO2] system also available where equipment are installed. ACS for opening the doors of the rooms are also available. Linear Heat detection [LHD] cables for power are installed there. 2x WAPDA lines are operational which come from Fateh Gar Grid stations & PWR grid stations. 2x additional lines, from the Shalimar Grid, are under construction. The UET substation provides electricity to Depot, & 13x orange lines stations from Dera Gujran Station to Anarkali station. The construction of the Shahnoor building is also of IAP-Class-1 category & basically along identical lines to that of the UET substation. Same type of equipment is installed except for the additional GIS system there. Reportedly 3x security guards remain on duty. A total of 4x power lines are operational [2x lines from Saidpur grid station & 2x from Bund Road]. Shahnoor substation provides electricity to stabling yard, & 13x numbers upward orange lines stations from Anarkali station to Ali Town station

0504 Stations [Elevated]: The line has 26 stations. Anarkali station # 12 & Central [GPO] stations #13 are underground, while the remaining 24 are elevated with same pattern. The rail line runs through the center of each station, with platforms flanking the track. Elevated stations have a width of 22.5 meters, while Anarkali Station is 16 meters wide, & GPO Station 49.5 meters wide. Elevated stations are all 102 meters long, while Anarkali & GPOI Stations are 121.5 & 161.6 meters long, respectively. Elevated stations feature natural ventilation throughout the platforms, with localized air conditioning in public areas of the ticket-hall level, & pillar-less single-span convex cantilevered roofing. Detail of entrance wise station is as follows:

1- Elevated Station with 2 Entrances [Total Station = 21]
2- Elevated Station with 4 Entrances [Total Stations = 3]
3- Anarkali Station [Underground]
4- GPO Station [Underground]

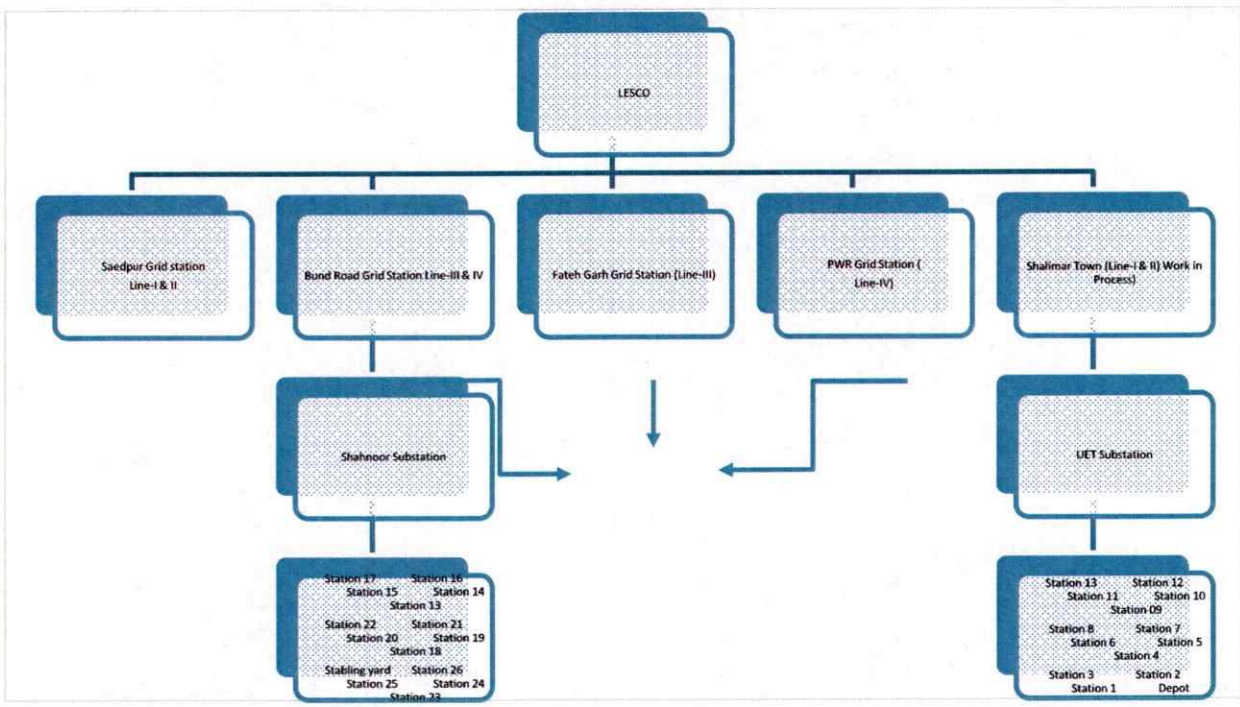
0506 Electrical Substations: 2x high-voltage electrical substations built for the line - one near UET Station, & the other at Shahnoor Station.

0600 Electrical Installations | General Cabling / Electrical Hardware Integrity

0601 The electrical profile & design loads for various components of OMT are as listed below:

0601.1 The system requires 20 + MW of electricity to power the trains & stations. 80 MWs of electricity have been secured for the project's operations from the Lahore Electric Supply Company. The system has 2x levels of back-up unit in the event of power failure, while a 3rd emergency system is also available if both power sources fail.

0601.2 Electrical Substations: 2x WAPDA lines are operational which come from Fateh Gar Grid stations & PWR grid stations. Two lines are in working process & will come from Shalimar Grid stations. UET substation provides electricity to Depot, & 13x numbers orange lines stations from Dera Gujran Station to Anarkali station.



Electrical load profile of Depot, Stabling yard & substations & each station

Sr.	*Station Name [Type]*	*Electrical Load [kW]*	*Transformer Capacity [kVA]*	*Transformer Quantity*	*Location*
01	Working 1 / Gujran, 26-Ali Town	821.4	2x500	4	01-Gujran, 26-Ali Town
02	Working 2 / 03-Salamat Pura, 05-Pakistan Mint, 07-Baghbanpura, 09-Sultanpura, 15-Gulshan-e-Ravi, 17-Bund Road, 19-Shahnoor, 21-Awan Town, 23-Hanjarwal	781.56	2x500	18	03-Salamat Pura, 05-Pakistan Mint, 07-Baghbanpura, 09-Sultanpura, 15-Gulshan-e-Ravi, 17-Bund Road, 19-Shahnoor, 21-Awan Town, 23-Hanjarwal

03	Working 3 / 08-UET, 18-Salahudin Road, 22-Wahdat Road	731.56	2x500	6	08-UET, 18-Salahudin Road, 22-Wahdat Road
04	Working 4 / 02-Islam Park, 04-Mahmood Booti, 06-Shalimar Garden, 14-Chuburji, 16-Samnabad, 20-Sabzazar, 24-Canal View	696.56	2x500	14	02-Islam Park, 04-Mahmood Booti, 06-Shalimar Garden, 14-Chuburji, 16-Samnabad, 20-Sabzazar, 24-Canal View
05	Railway	787.08	2x500	2	
06	Lakshmi Chowk	857.08	2x500	2	
07	Thokar Niaz Baig	857.08	2x500	2	
08	G.P.O	1668.84	2x1000	2	
09	Anarkali	1242.94	2x1000	2	
10	Depot Base-combined Substation	5894	2x2000	2	
11	Depot Comprehensive Maintenance Center Following Substation	789.7	2x630	2	
12	Depot Control Center Following Substation	1985.67	2x1250	2	
13	Depot Siding & Maintenance Workshop Following Substation	1295.14	2x1250	2	
14	Stabling Yard Base-combined Substation	2091.51	2x1250	2	

Detail of genset installed on each station, depot, stabling yard etc

Sr	Station Name [Type]	Gen-set Capacity [kW]	Gen-set Quantity	Location	Operating System of Gen-set
01	Working 1	1x400	2	01-Dera Gujran, 26-Ali Town	Auto
02	Working 2	1x400	9	03-Salamat Pura, 05 Pakistan Mint, 07-Baghbanpura, 09-Sultanpura, 15-Gulshan-e-Ravi, 17-Bund Road, 19-Shahnoor, 21-Awan Town, 23-Hanjarwal	Auto
03	Working 3	1x4000	3	08-UET, 18-Salahudin Road, 22-Wahdat Road	Auto
04	Working 4	1x400	7	02-Islam Park, 04-Mahmood Booti, 06-Shalimar Garden, 14-Chuburji, 16-Samnabad, 20-Sabzazar, 24-Canal View	Auto
05	Railway	1x400	1		Auto
06	Lakshami Chowk	1x400	1		Auto
07	Thokar Niaz Baig	1x400	1		Auto
08	G.P.O	1x1000	1		Auto
09	Anarkali	1x1000	1		Auto
10	Depot Base-combined Substation	1x400	1	Moveable Generator	Manual
11	Depot Control Center Following Substation	1x400	1		Auto
12	Depot Siding & Maintenance Workshop Following Substation	1x400	1	Moveable Generator	Manual
13	Stabling Yard Base-combined Substation	1x400	1	Moveable Generator	Manual

0602 Operating voltage level of OLMT:750V[DC] for the train, 380V for the Station electrical equipment.

0603 Power consumption of the train [complete detail DC/AC, inductive/resistive load etc.]:

0603.1 One train from Dera Gujran to Ali Town: 663kWh

0603.2 One train from Ali Town to Dera Gujran: 685kWh

0604 Wiring, in conduits, trenched & in cable trays at all locations appeared to be brand new, well-conceived & laid out, & except for 1x area, in satisfactory condition.

0605 Several significantly large apertures were observed in cable-to-trench / wall junctions at the main depot where rain water ingress, rodent- & bio-infestation would be an issue.

0606 Possibly due to the above, the basement & sub-grade trenches in the main depot substation cable-room were observed to be filled with water, submerging the cables within. While the cable insulation is water resistant, this is a potential short- & long-term flashover / short-circuit hazard if there is the slightest damage or error during installation, or quality-control issue or other agencies causing incremental damage over time. There is apparently no initiative yet to dewater the trench & no SOP to prevent it from reoccurring. The imminent monsoon will cause even more flooding issues.

0607 We recommend immediate dewatering & hot-air blow / IR-drying of the affected basements & trenches immediately.

0608 The risk of electrical equipment failure, flashover / short-circuit, over-heating & arcing at faulty electrical junctions, etc, is expected to be lower for the initial few years for this project. The level of failure hazards will however, increase with time as the equipment, cabling insulation & connectors age & degrade.

0609 The overall risk of Electrical & Electronic Equipment generic failure for the installed plant, machinery & equipment is considered to be *Moderate*.

0700 Plant: Preventive Maintenance & Condition Monitoring

0701 Details with respect to preventive maintenance & condition monitoring programs in place for mechanical systems are awaited. The overall condition however, was better than expected for a plant of this age, & indicates that preventive maintenance & condition monitoring programs, while not recorded in a fully organized manner, are in place & indeed conducted, follow-up enforced, budgetary constraints notwithstanding.

0702 OMT apparently have several preventive maintenance programs in place to keep the installed machinery & equipment in optimum condition. While, these include Dissolved Gases Analysis, basic vibration, temperature & pressure monitoring, etc, other, more involved chemical & lube-oil particulate tests, record-keeping & vibration analysis lags, without the all-too-critical follow-up. Approaches are still more reactive than proactive, & unplanned, preventable failures are inevitable.

0703 The nature of the subject machinery & processes makes wear-&-tear failures unavoidable. The conglomeration of equipment of widely differing categories, durability & operational life, with their component electronics, sensors, motors & materials, are potentially a constant area of attrition & breakdowns during the course of operation. The breakdowns & Mean-Time-Between-Failures [MTBF] tend to increase exponentially as the plant ages.

0704 Breakdowns & malfunctions are inevitable & can only be minimized, mitigated, predicted & proactively planned for within given budgetary constraints.

0705 The equipment for this industry are typically robust & designed to withstand an aggressive work environment, with higher-than-normal power supply aberrations. Many factors affect a property's useful life including the frequency of use, subjected mechanical & electrical loads, corrosivity of process line chemicals & products, the age or running hours already incurred at the time of acquisition as well as the repair programs & policies as well as the ambient environmental & climatic conditions [atmospheric corrosivity index, temp, humidity, suspended particulates] during operation or storage of the asset. Useful life of identical type of assets will differ from user to user depending on the above factors as well as additional factors as foreseeable technological improvements, changes in macro cost-driven directives affecting maintenance program standards, benchmarks & component repair-replacement policies.

0706 Details for the preventive maintenance & condition monitoring regimens / plans for the plant component machinery, equipment & ancillaries along with the Mean-Time-Between-Failures [MTBF] schedules being followed are awaited.

0707 Possible, foreseeable, probable &/or potential failures with respect to main equipment & machinery installed & in use at the OMT are as below:

Note: The list below has been compiled as hypothetical 'worst-case scenarios'. The list does not in any way, or at any instance, assume / presume that any incidents or errors occurred, or may occur in the future, or that adverse pre-existing problems / conditions / issues, if any, were known / discovered & subsequently allowed to propagate unresolved.

	Component	Possible Failures
0707.1	Piping | lubricants / steam / compressed air / water / fluidized solids	▪ Corrosion failure ▪ Bio-fouling ▪ Cavitation ▪ Water-hammer ▪ Vibration induced failure ▪ Mechanical impact damage ▪ Fastener failure ▪ Joint/union seal failure ▪ Deformation & buckling
0707.2	Valves	▪ Seal / gasket failure ▪ Corrosion induced failure ▪ Electrical component failure [solenoids, etc] ▪ Pneumatic component failure [cylinders, pistons, etc] ▪ Hydraulic component failure [cylinders, pistons, etc] ▪ Diaphragm failure
0707.3	Pumps	▪ Seal / gasket failure ▪ Overheating ▪ Bearing failure ▪ Mounting failure ▪ Shaft alignment, end-float, eccentricity &/or other deformation problems ▪ Vibration induced failures &/or malfunctions ▪ Electrical component failure [solenoids, etc] ▪ Pneumatic component failure [cylinders, pistons, etc] ▪ Hydraulic component failure [cylinders, pistons, etc] ▪ Diaphragm failure ▪ Casing damage ▪ Impact damage ▪ Drive issues [motors]
0707.4	Motors	▪ Bearing failure ▪ Seal / gasket failure ▪ Vibration induced failure &/or malfunction ▪ Shaft alignment, end-float, eccentricity &/or other deformation problems ▪ Overheating induced failure ▪ Mounting failure ▪ Cabling / switch / connector &/or electrical component failures
0707.5	Electrical cabling, wires | cable-trays / trenches | power utility plugs & sockets	▪ Corrosion failures ▪ Vibration induced failures ▪ Mechanical impact damage ▪ Joint / termination failure ▪ Water, steam or dust ingress

0707.6	Detectors | smoke, temperature, gas & proximity sensors	▪ Cabling / switch/ connector failure &/or faults ▪ Absence of alternate backup wiring installation ▪ Absence of alternate wiring UPS source ▪ Power supply/battery failure ▪ Dust contamination / corrosion / clogging [especially ionization types] ▪ Vibration induced failure ▪ Bio-infestation
0707.7	Transformers	▪ Oil contamination ▪ Casing corrosion | Contamination ▪ Connector hotspots | Arc damage ▪ Impact damage | Roof spall debris, etc ▪ Excess humidity ▪ High ambient temperature ▪ Insulator damage | Thermal &/or mechanical induced stress ▪ Dust contamination flashover ▪ Vibration induced failures &/or malfunctions
0707.8	Hydraulic rams	▪ Seal / gasket failure ▪ Mounting failure ▪ Shaft alignment, end-float, eccentricity &/or other deformation problems ▪ Vibration induced failures &/or malfunctions ▪ Casing damage ▪ Impact damage ▪ Corrosion failure
0707.9	Heat-exchangers [incl HVAC]	▪ Thermal fatigue | super-heater tube condensation residue tube-end cracks ▪ Corrosion induced tube failures | oxygen pitting | caustic ash | stress corrosion [especially with stainless steel super-heaters] | furnace-tube to tube-sheet & tube to shell fillet welds | burner fuel sulfur content corrosion ▪ Feed water quality problems | scaling | sensor fouling [scale & bio-debris] | RO plant problems ▪ Main burner & pilot flame adjustment induced problems ▪ Fuel supply metering failure | feed check valve malfunction ▪ Water quality problems ▪ Instrumentation failures ▪ PLC signal harmonic disturbances due to UPS circuit-related interference & shielding issues ▪ Load-swing overheating
0707.10	Overhead travelling cranes, hoists & slings	▪ Control cable damage ▪ Wire rope failure | mechanical impact &/or corrosion induced damage ▪ Hydraulic system failure | valve-body | seals | diaphragm

		▪ Thimble, shackle, hard-eye, cuff failures | mechanical impact &/or corrosion induced damage ▪ Hi-torque motor failure ▪ Magnetic starter/contactor failure ▪ Control key-pad button/switch malfunction
0707.11	Fire alarm systems | audible & visual	▪ Cabling / switch / connector failure &/or faults ▪ Power supply/battery failure ▪ Dust contamination / corrosion / clogging ▪ Vibration induced malfunctions
0707.12	Firefighting | deluge / hydrant actuation systems	▪ Cabling / switch/ connector failure &/or faults ▪ Absence of alternate back-up wiring installation ▪ Absence of alternate wiring UPS source ▪ Power supply/battery failure ▪ Dust contamination / corrosion / clogging [especially ionization types] ▪ Vibration induced failure ▪ Bio-infestation
0707.13	PLCs, computers &/or other micro-processor-based hardware	▪ Temperature fluctuations ▪ Power supply quality issue &/or failure ▪ EM harmonic disturbance malfunction ▪ Dust contamination ▪ Humidity ▪ Corrosion ▪ Cabinet cooling fan failure ▪ Cabling / connector failure
0707.14	Instrumentation & gauges	▪ Vibration induced failures &/or malfunction ▪ EM harmonic disturbance malfunction ▪ Power supply quality issues ▪ Cabling / switch / connector failure ▪ Recalibration issues
0707.15	CO2 / pressurized foam firefighting systems	▪ Absence of alternate back-up wiring installation ▪ Absence of alternate wiring UPS source ▪ Power supply/battery failure ▪ Dust contamination & clogging [especially ionization types] ▪ Cabling failure ▪ Vibration induced failure ▪ Cover interlock switch problem ▪ Bio-infestation
0707.16	Air-handling units	▪ Main plenum chamber &/or secondary leakages ▪ Corrosion | casings | fans | shafts | fasteners | coils ▪ Drive motor failure ▪ Bearing failure ▪ Shaft, pulley, V-belt alignment problems ▪ Cooling/heating coil failure ▪ Plate-heater exchanger problems ▪ Pump failure

		▪ Fan shroud problems ▪ Cabling / switch / connector failure
0707.17	Air / Gas Compressors	▪ Cabling / switch / connector failures ▪ Solenoid &/or control valve problems ▪ Oil filter &/or separator problems ▪ Inlet / exhaust bearing damage ▪ Bearing failure ▪ Seal failure ▪ Vibration induced failure &/or malfunction ▪ Shaft / pulley alignment, end-float, eccentricity &/or other deformation problems ▪ Overheating induced failure ▪ Mounting failure ▪ Electrical component failure
0707.18	Packaged-type air-conditioning units	▪ Cabling / switch / connector failures ▪ Compressor failure ▪ Refrigerant gas leakage ▪ Corrosion: casings | fans | shafts | fasteners | coils | cooling fins ▪ Drive motor failure ▪ Bearing failure ▪ Shaft, pulley, V-belt alignment problems ▪ Cooling/heating coil failure ▪ Fan shroud problems
0707.19	LT & HT panels	▪ Connector hotspots | Arc damage ▪ Excess humidity ▪ High ambient temperatures ▪ Ventilation fan failure ▪ Dust contamination flashover

0708 For sensitive & critical equipment, we recommend regularly scheduled monitoring using IR thermography, Acoustic Emissions & vibration analysis of the installed accelerometer / vibration sensors, for in-depth & pro-active detection of potential failure with respect to high-speed rollers, bearings, pumps, other rotary equipment, mechanical & electrical hot-spots, arc-sites at connectors & in circuitry, nodes & cabling.

0709 The main server & control rooms appear to have unacceptable levels of dust contamination for such critical areas. The probability of unexpected & premature electronic component failures is increased dramatically due to the dust pollution issue.

0710 We recommend that a simple, filtered-air, positive pressure-differential, be maintained for the said control rooms, with installation of air-locks at the entrance / exit points, air-purifier / de-duster & dehumidifier units, to minimize the dust pollution issues & partially mitigate & minimize related failures.

0711 Power supply aberrations including waveform distortions, spikes, flicker, under & over-voltage, frequency & voltage fluctuations, RF / EM interferences are the most underestimated cause of instrumentation failures.

0712 We recommend incorporation of high-quality surge-protection & line-conditioners in the power supply for the more sensitive & critical instrumentation modules & control panels.

0713 Corrosivity index for the site is assessed to be in the region of C4. All unprotected surfaces, or where protection has been removed by impact / abrasion etc, &/or exposed unprotected sections of cabling, piping, steel components, etc, will degrade fairly rapidly & lead to premature failure.

0714 The risk of mechanical equipment failure is expected to be lower for the initial few years for this project. The level of failure hazards will however, increase with time as the equipment ages & degrades.

0715 The risk of Machinery Breakdown & generic failure for the installed plant, machinery & equipment of YoM 2014-2019 is considered to be Moderate.

0800 Risk Zoning & Critical Hazard Areas

0801 The hazard ratings have been quantified on the basis of computing the 3-axis occurrence-probability, exposure-frequency & consequence-severity values for up to 60x plant asset operational, personnel operational & stock storage parameters, including available installed protection systems, projected extent of physical damage to assets, probable degree of collateral impact to adjacent assets, prospective duration of plant downtime caused, etc, for each of the identified & demarcated hazard zones derived above.

0802 to 10,000. These ratings are classified in 6x categories: [a] Up to 88.45 - Negligible; [b] Up to 306.95 - Low; [c] Up to 2,062.30 - Moderate; [d] Up to 4,371.35 - Substantial; [e] Up to 7,610.44 - High; [f] Up to 10,000.00 - Very high / critical.

0803 Monitoring & control hardware / software: The main simultaneous control of all the trains is conducted via the Computer Based Interlocking [CBI] system. Failures leading to loss of control & timing for starts, stops, slow-downs, speed-ups, jog, etc, leading to collisions, positioning problems with 2x or more trains arriving, or departing too close to each other.

0804 Traveling & Ticketing Protocols: The procedure of entrance/ traveling of passenger at each station is as below:

- 0804.1 The guard standing at the main entrance gate scans the body of passenger by using hand held metal detector.
- 0804.2 Que management in front of baggage machine / walkthrough gate in order to maintain discipline. The passenger gets himself scanned along with his luggage via walkthrough gate and baggage machine installed at concourse area.
- 0804.3 Que management in front of ticket office. The passenger purchases his ticket from ticket office.
- 0804.4 The passenger gets passed through AGM installed next to ticket office by scanning his token on AGM.
- 0804.5 Que management at platform in order to maintain discipline and to ensure safety of passengers.
- 0804.6 The passenger embarks onto the train.
- 0804.7 The passenger disembarks at his destination at platform.
- 0804.8 The passenger inserts his token inside the AGM and exits the destination station.

0805 Several protocols are still unconfirmed:

- 0805.1 Technical failure / breakdown of the CBI system & its backups.
- 0805.2 Technical failure / breakdown [or power outage] between stations.
- 0805.3 Presence of, authority given & capabilities of staff on board each train requires further clarification.
- 0805.4 Emergency disembarkation between stations.
- 0805.5 Experience levels & training for OMTs CBI operators, Train Dispatchers & their performance overall, as well as in simulated emergencies in Pakistan & China.

0806 Derailment: A derailment of a train can be caused by a collision with another object, an operational error, the mechanical failure of tracks, such as broken rails, or the mechanical failure of the wheels. In emergency situations, deliberate derailment with derails or catch points is sometimes used to prevent a more serious accident. These protocols have yet to be clarified.

0807 Derailments result from one or more of a number of distinct causes; these may be classified as:

0808 Dynamic effect of the track-vehicle interaction (for example extreme hunting, excessive speed)

0809 the primary mechanical failure of a track component (for example broken rails, gauge spread due to sleeper (tie) failure)

0810 Improper operation of points, or observance of signals protecting them [signal errors]. The Chain-of-Command & responsibilities still awaits clarification.

0811 Collision of trains: There are very rare chances of collision of trains as 100-meter distance between two trains automatically maintained through Computer based interlocking (CBI) programming.

0812 However, any fault occurs in CBI programing, the train dispatcher shall follow the process of "judgment - train control - searching of train. Train dispatcher refer to the position of the remaining trains on the MMI, and checks the train position in the fault area in a clockwise sequence in the exit direction and " Full roll call one by one after interval. the number of on-line trains will be checked to be consistent with the timetable. The Train Dispatcher will check whether the number of trains on line is correct with the signal building of the train factory.

The principle of "check one, place one, and write one on the schematic diagram" will be followed when placing the board on the busy board. The train dispatcher is responsible for using the full call channel, referring to the residual train number position on MMI, and pressing "station by station and section by section" with the drivers in the fault area in clockwise order; meanwhile, the chief dispatcher shall assign the equipment dispatcher on duty to list on the busy board according to the principle of "checking one, placing one", and making records on the printed circuit diagram.

0813 The train is tightly controlled in the platform area, and the train dispatcher confirms with the station that the station platform is free through CCTV, and priority is given to organize the driver RM mode speed limit 10km / h EMU benchmarking. When other trains stop in the section, after the train finding link is completed, check the correct position and quantity of all trains in the degraded area, and then organize the section trains with idle platform and no turnout to enter the station at the speed limit of 10km / h in RM mode. For the train with turnout on the route or occupied by the train in front of the platform, after the train finding link is completed and the position and quantity of all trains in the degraded area are correct, the train dispatcher shall organize the station personnel to get off the line to lock the switch, and after the switch hook is locked, the train in the section shall be organized to enter the station at a speed limit of 10km / h, so as to ensure that all trains in the fault area stop at the platform. In the process of verification, it is required that the monitoring and train dispatcher is responsible for monitoring

0900 Standard Policy Risks | Fire & Allied Perils

0901 Fire, Lightning, Explosion, Earthquake-Fire-Shock, AD-flood, Aircraft & Falling-Aerial-Objects, Impact-Damage, Malicious-Damage, Riot-Strike-Damage & Burglary [incl Theft, Armed Holdup].

0902 Other related perils considered are Third Party Liability & Terrorism.

0903 The risk levels for the following perils [item heads 1000 to 2300 listed below] are graded as: Very High / Critical [highest risk: rated 6], High [risk rating 5], Substantial [risk rating 4], Moderate [risk rating 3], Low [risk rating 2] & Negligible [least risk: rated 1].

1000 Fire

1001 The hydrant systems installed at the OMT sites are listed as under:

Sr	Flow rate	Head	Power	Quantity	Type
Elevated Station					
01	120m3/h	70m	45KW	48	Fire pump
02	5m3/h	77m	2.2KW	48	[Pressure stabilizing pump
Anarkali Station					
03	120m3/h	77m	45KW	2	Fire pump
04	5m3/h	84m	4KW	2	[Pressure stabilizing pump
GPO Station					
05	120m3/h	84m	55KW	2	Fire pump
06	5m3/h	92m	4KW	2	[Pressure stabilizing pump
Main Substation					
07	140m3/h	82m	55KW	4	Fire pump
08	5m3/h	90m	4KW	4	[Pressure stabilizing pump
Depot					
9	40L/s	100m	55KW	2	fire pump
10	45L/s	52m	37KW	3	sprinkling pump
11	24m3/h	50m	5.5KW	2	[pressure stabilizing pump of fire hydrant system
12	8m3/h	40m	2.2KW	2	[pressure stabilizing pump of atuo sprinkling system
Stabling yard					
13	40L/s	90m	55KW	2	fire pump
14	21L/s	50m	30KW	2	sprinkling pump
15	24m3/h	50m	5.5KW	2	[pressure stabilizing pump of fire hydrant system
16	8m3/h	40m	2.2KW	2	[pressure stabilizing pump of atuo sprinkling system

1002 Fire extinguishers are installed as under:

Sr	Location	Cylinders CO2/ kg	Qty	Fire trolley	Qty
01	Station 1	5	88	20	2
02	Station 2	5	69	20	2
03	Station 3	5	80	20	2
04	Station 4	5	69	20	2
05	Station 5	5	80	20	2
06	Station 6	5	69	20	2
07	Station 7	5	80	20	2
08	Station 8	5	69	20	2
09	Station 9	5	80	20	2
10	Station 10	5	75	20	2
11	Station 11	5	96	20	2
12	Station 12	5	99	20	2
13	Station 13	5	126	20	2
14	Station 14	5	69	20	2
15	Station 15	5	80	20	2
16	Station 16	5	69	20	2
17	Station 17	5	80	20	2
18	Station 18	5	69	20	2
19	Station 19	5	80	20	2
20	Station 20	5	69	20	2
21	Station 21	5	80	20	2
22	Station 22	5	69	20	2
23	Station 23	5	80	20	2
24	Station 24	5	69	20	2
25	Station 25	5	86	20	2
26	Station 26	5	88	20	2
27	Shanoor Sub-Station	5	64	0	0
28	UET sub-Station	5	64	0	0
29	Depot	5	449	0	2
30	Stabling yard	5	149	0	0

1003 The total quantities of PFEs appear to be adequate for the covered areas at the sites. Their distribution throughout the sites is also assessed to be satisfactory.

1004 Water tanks: Fire tank with their capacity installed on each station as given below

Sr	Location	Installed at	Volume/ m^3	Gallons	material/ Made of
01	Depot	Fire pump room	926	244,623	Concrete
02	stabling yard	Fire pump room	215	56,797	Concrete
03	Station # 1 to Station # 11 each	Fire pump room	60	15,850	Stainless steel
04	G.P.O Station 12 [Underground]	Fire pump room	360	95,102	Concrete
05	Anarkali Station 13 [Underground]	Fire pump room	120	31,701	Stainless steel
06	Station # 14 to Station# 26 each	Fire pump room	60	15,850	Stainless steel
07	UET Substation	Fire pump room	160	42,268	Concrete
08	Shanoor Substation	Fire pump room	160	42,268	Concrete

1005 Smoke detectors are installed. Full details are awaited.

1006 Fire Protocols: Procedures in place for execution in the event of fire onboard the train, the train driver is required to drive the train to the front station as much as possible. When evacuating passengers, in principle, the staff will not organize passengers to escape from the fire.

1007 When the train is forced to stop in the section & unable to move, the Train driver shall try his best to understand the location of the fire & report the Train Dispatcher.

1008 If the Train driver confirms the fire in the carriage & the Train Dispatcher cannot contact the Train driver 5 minutes later, the equipment dispatcher & Train Dispatcher must handle it as "the situation is unknown".

1009 When a fire occurs in the train Compartment, if it is confirmed that the fire or the scene is out of control or seriously endangering the personal safety of passengers, the train should be stopped immediately to evacuate the passengers. Evacuate passengers on foot & organize passengers to evacuate to the nearest station.

1010 The existing SOPs do not appear to give adequate consideration to the guidance & orderly evacuation of passengers - there are too may gaps & not enough coverage for individual scenarios.
1011 We recommend that the inadequate SOPs for orderly evacuation of passengers onboard the train & at the waiting areas be reorganized & streamlined at the earliest.
1012 There are no large cutting tools [shears, crowbars, hydraulic jacks, etc] onboard the trains for assisting trapped passengers in forcing their way out in the event of a collision, with the train upside down or lying on its side, where exit doors are jammed, etc.
1013 We recommend installation of at least 2x sets of cutting tools [shears, crowbars, hydraulic jacks, etc], 1x set at each end, onboard every train for meeting all exigencies regarding trapped passengers.
1014 While access was not possible for photographic record due to the energized state of the track during our physical surveys, & the relevant P&ID plans are still awaited, it is reported that heat & smoke detectors are installed in all basements & sub-grade trenches. Linear Heat detection [LHD] cables for power are installed there.
1015 The overall arrangement & capacity of the fire-water storage, pump specifications, hydrant points & procedures appear to be adequate for all the OMT locations. The flow at one hydrant on the depot / Central Control Complex roof however, was completely deficient & was visibly unable to produce the required pressure.
1016 We recommend immediate rectification of this particular pressure / flow issue & a comprehensive physical audit with pitot-tube & pressure gauge equipment for static & dynamic pressures & flow-rates at all the hydrant points throughout the project areas.
1017 Wet fire drills are reportedly conducted every 3x months with the events & results fully documented. Copies of the records are awaited.
1018 The cctv coverage throughout the OMT stations, substations, depot areas, etc, appeared to be adequate. The depot alone is covered at 83x points. This appears to be adequate for the operational activities & security supervision of the subject operation.
1019 The overall risk due to fire is considered to be *Moderate*.

1100 Burglary, Theft, Armed Holdup & Pilferage

1101 Full details are awaited. Security appears to be satisfactory.
1102 There appears relatively less risk to specific spares due to the unique nature of the project which has no similar operational parallels.
1103 The category of consumables including lubricants, small standard sized bearings, seals, other similar spares & hand-tools present a higher hazard level with respect to pilferage.
1104 The issues with respect to hazards regarding the cash handling & movements from non-smartcard ticket transactions is discussed under section-2000 Cash-in-Safe / Cash-in-Transit.
1105 The overall risk of burglary, theft & pilferage is considered to be *Low-to-Moderate*.

1200 Atmospheric Disturbance | Flood / Rain, Wind-storm

Flood/Rain

1201 The water run-off gradient for the depot site is: [a] 0.029536 or ~1/33 [-7.00m @ NW face & lower corner [31.585447 / 74.437474] / 237m @ mid-site].
1202 This will lead to rain water pooling at the NW end of the depot. The area within a 120m radius of this low point has an even steeper gradient for water ingress & pooling.
1203 The water ingress issues at the basement & sub-grade trenches in the main depot substation cable-room were observed to be filled with water, submerging the cables within. While the insulation is water resistant, this is a potential short- & long-term flashover / short-circuit hazard if there is the slightest damage or error during installation, or quality-control issue. There is apparently no initiative yet to dewater the trench & no SOP to prevent it from reoccurring. The imminent monsoon will cause even more flooding issues.
1204 We recommend immediate dewatering & hot-air blow / IR-drying of the affected basements & trenches immediately.
1205 The overall risk due to AD / Flood is considered to be *Moderate*.

Wind-storm

1206 While wind-storms are regularly reported, damage from them are generally confined to poorly secured roofing, bill-boards & cell-phone towers, etc. The subject site has none of these issues.

1207 All the OMT power supplies are at ground-level, or below-grade. Except for the main pylons to the depot, the number of components [& their criticality] that could be affected by Wind-Storm are minimal.

1208 The overall risk due to wind-storms is considered to be *Low*.

1300 Earthquake-Fire-Shock

1301 The seismic classification for the site is categorized as Very Low, Zone-A, [≤ 3.4 Richter scale; ≤ IV on the Modified Mercalli scale]. The relevant map is attached as Annexure-08.

1302 There has never been any reported loss or damage from seismic tremors for this area.

1303 The data for design parameters with respect to [wrt] structures at the OMT sites & seismic PGA [Peak Ground Acceleration] are awaited.

1304 The overall hazard to the subject site due to seismic activity is considered to be *Low*.

1400 Lightning

1401 Lightning conductors are planned to be installed on the tops of the OMT buildings & structures.

1402 The risk to the site due to lightning is considered to be *Low-to-Moderate*.

1500 Aircraft, falling aerial objects

1501 The nearest relevant hubs for air activity are:

	Air Activity	*Distance from OMT Depot km*	*Bearing*
1501.1	Allama Iqbal Int Airport	5.8	212
1501.2	Walton Airport	13.2	219

1502 The overall risk to the subject site due to aircraft &/or falling aerial objects is considered to be *Low*.

1600 Malicious-Damage | Riot-Strike-Damage

1601 The site is well guarded but being a public service project, regardless of heavy security, the stations especially with be particularly susceptible to Malicious Damage as well as Riot-Strike-Damage.

1602 30-40% of the track passes within 15-20m of crowded urban residential areas.

1603 Events of 18-Apr-2021, resulted in riots where there was damage to glazing, facade & equipment at 2x stations. Full details & the extent of loss is still awaited.

1604 The risk from malicious- & riot-strike-damage is considered to be *Substantial-to-High*.

1700 Explosion

1701 We recommend that all the gas supply line headers, along with their distribution to the tuber / bottomer lines be inspected on a regular basis to eliminate the possibility of corrosion induced or seal /joint failures causing leaks that could lead to ignition & explosion.

1702 Till the gas supply line audit is completed & subsequently organized to be conducted regularly on an continuous basis, with a full complement of detectors installed, the explosion hazard is considered to be *Moderate*.

1800 Impact Damage

1801 Impact damages manifest themselves to a higher degree wherever there is high volume of vehicular traffic, internal movements of heavy construction equipment & building materials as is the case at the subject premises.

1802 There is no apparent congestion for maneuvering load-carrying trucks, tankers or other heavy commercial vehicles, etc.

1803 There are no extra heavy lifting procedures in the normal course of the current production process.

1804 Heavy vehicular traffic, trucks, trailers, fork lifters & use of cranes, etc, is at a peak during the project new building additions, new machinery installation phases &/or occasional major modifications. These stages are generally well-planned operations, & managed with all reasonable precautions taken & minimal public liability hazards.

1805 There are potential hazards in the event of derailment & catastrophic failure of critical wheel bearings, etc, especially for collisions between 2x oncoming locomotives.

1806 The overall the risk of impact damage is considered to be *Low-to-Moderate*.

1900 Public Liability & Third-Party Liabilities

1901 The entire OMT project is centered on mass transit of the general public, of all ages, most of whom have no conception of potential hazards &/or risk mitigation, semi-literate &/or underprivileged. An inordinately large percentage of these passengers display little understanding or consideration with respect to safety &/or SOPs, for themselves, or for others.

1902 With a 16h / 0615-2200h operational model, the system is designed to handle ~30,000 passengers/h. The Orange Line initially carried 250,000 passengers per day, with ridership of 500,000 passengers per day three years after commencement of service. The system is designed to operate with a minimum headway of two minutes. It is expected that the station will serve 24,520 passengers per hour in the Orange Line's first year of operations - a figure which may rise to 49,550 by 2025

1903 Each car has a nominal capacity of 200 seated & standing passengers at an average density of 5 persons per square meter with 20% of passengers seated & 80% standing.

1904 There are the additional hazards of equipment failure, malfunctioning sensors, doors that shut onto passengers, do not close automatically, or do not stay closed after shutting, passengers in a hurry taking unprecedented risks & falling out or falling onto tracks, brake & other dynamic failures that often have a lower probability & occurrence frequency, but relatively unacceptable severity of consequences.

1905 Staff members exposed to routine & repetitive procedures are inherently prone to human error mishaps.

1906 We recommend periodic staff rotation & realistic duty hours, coupled with poster & graphic visual reminders of commonly overlooked hazards & stress on the importance of maintaining strict adherence to established practice.

1907 There is limited emphasis & awareness of material-handling, machinery-handling techniques & related safety issues.

1908 We recommend establishing a Health-Safety-Environment [HSE] dept, with regular in-house training sessions, video presentations, & seminars covering all relevant procedural, safety & environmental issues.

1909 The hazards of public liability & 3rd-party concerns is considered to be *High-to-Critical*.

2000 Cash-in-Safe / Cash-in-Transit

2001 The current ticket sale turnover for the period 01-Mar-2021 to 29-Mar-2021 has been advised at PKR 80,200,000 [total for 29x days]. The min & max per day being PKR 2,400,000 & PKR 3,400,000 respectively.

2002 The hazards of Cash-in-Safe & Cash-in-Transit is considered to be *Moderate*.

2100 Terrorism

2101 We consider OMT to be a soft target for terrorist attack on the general public for demoralizing purposes & a potential venue for hostage situations.

2102 We recommend that the guards be specifically trained to note potential terrorist operations & developing situations.
2103 We consider TIH-KEP to be a soft target for terrorist attack & a potential venue for hostage situations.
2104 The risk from terrorism is considered to be *Substantial-to-High*.

2200 Security

2201 Details for security guard deployment are as under:

Security staff plan on each station from Security 2000 Co. details as follows;

Guards At Each Station					
A] Typical Elevated Station with 2 Entrances [Total Station = 21]					
	Morning		**Evening**		**Night**
	M	F	M	F	M
Both Entrances	1	1	1	1	3
Que Management	1	0	1	0	
Platform Both Sides	6	0	6	0	
Station Control Room	1	0	1	0	1
	9	**1**	**9**	**1**	**4**
B] Typical Elevated Station with 4 Entrances [Total Stations = 3]					
Both Entrances	2	2	2	2	3
Que Management	1	0	1	0	
Platform Both Sides	6	0	6	0	
Station Control Room	1	0	1	0	1
	10	**2**	**10**	**2**	**4**
C] Anar Kali Station [Underground]					
Parking & Main Access	14	0	14	0	3
Building Block, A	3	1	3	1	1
Control Room Block A	1	0	1	0	1
Platform Block A	3	0	3	0	1
Building Block B	3	1	3	1	1
Control Room Block B	1	0	1	0	1
Platform Block B	3	0	3	0	1
	28	**2**	**28**	**2**	**9**
D] GPO Station [Underground]					
Pedestrian Underpass Entrance 02	2	0	2	0	2
Channelized Entrance for Entrance 1 & 2	1	1	1	1	
Que at Ticket Office for Entrance 1 & 2	1	0	1	0	
Patrolling Pedestrian's Passageway from Entrance 4	1	0	1	0	2
Channelized Entrance for Entrance 3 & 4	1	1	1	1	
Que at Ticket Office for Entrance 3 & 4	1	0	1	0	
Platform Both Sides	6	0	6	0	2
Station Control Room	1	0	1	0	1
	14	**2**	**14**	**2**	**7**
Guards at 26 Stations					696
Guards For Patrolling					12
Guards at Under Ground Section Approaches					12
Guards dedicated for PMA Office					6
Backup for Quick Response & other Factors					20
Number of Guards					**746**
Additional Guards considering leaves					**124**
Total Guards					**870**

Security staff plan of Superior Security Co. for depot, Stabling yard & substations;

Sr	Location	Day	Night	Total
•	Depot [Dera Gujran]			
01	Main Gate	4 + 1 Lady	3	8
02	CMC Building	2	1	3
03	CMC Chowk	1	1	2
04	Isolation Driver Living	2	1	3
05	Training center	1	1	2

06	OCC Building	1	1	2
07	COB Building	3	2	5
08	Motorcycle Parking 1	1	0	1
09	Café	1	1	2
10	Masjid Chowk / Rail Crossing	1	0	1
11	Motorcycle Parking 2	1	1	2
12	Locomotive Building	1	1	2
13	Train Shed	2	2	4
14	Train Store	1	0	1
15	Supervisor	1	1	2
16	**Grand Total**	**24**	**16**	**40**
•	Stabling Yard [Ali Town]			
01	Main Gate	2	2	4
02	COB Building	1	1	2
03	Siding Building	1	1	2
04	Train Shed	1	1	2
05	Washing Area	1	1	2
06	Supervisor	1	1	2
07	**Grand Total**	**7**	**7**	**14**
•	Sub Stations			
01	UET	3	3	6
02	Shah Noor	3	3	6
03	**Grand Total**	**6**	**6**	**12**

2202 Security staff of Security 2000 Co., Superior Security, Police & Elite Force are available when it required in the event of house breaking.

2203 General security appears to be *Adequate*.

2300 Housekeeping | Material Handling | Standard Industrial Practice

2301 Material handling appears to be satisfactory

2302 Adherence to standard industrial practice appears to be maintained.

2303 The overall standard of housekeeping at the subject premises is considered to be *Satisfactory*.

2400 Loss History

2401 Events of 18-Apr-2021, resulted in riots where there was appreciable damage to glazing, facade & equipment at 2x stations. The full details & extent of loss is still awaited

2402 Details with respect to all the losses sustained by OMT from inception are awaited.

2500 Exposures | Hazard Rating Summary

Nature of exposure [1 = negligible | 2 = low | 3 = moderate | 4 = substantial | 5 = high | 6 = Critical]		Rating
2500.1	Fire | from any cause incl short-circuit, equipment, etc	3
2500.2	AD | Flood, Rain, Wind-storm, etc	3
2500.3	Earthquake	2
2500.4	Lightning	2-3
2500.5	Aircraft, falling aerial objects	2
2500.6	Malicious Damage	4-5
2500.7	Riot-Strike-Damage	4-5
2500.8	Machinery Breakdown | Plant & ancillaries	3
2500.9	Electronic Equipment failure	3
2500.10	Explosion	3

2500.11	Impact damage	2-3
2500.12	Theft, Armed Holdup | Marine transit	2-3
2500.13	Public Liability / Third Party	5-6
2500.14	Cash-in-Safe / Cash-in-Transit	3
2500.15	Terrorism	4-5

2600 Projected Sum-Insured Summary

2601 The estimated projected sum-insured / New Replacement Value [NRV] *for insurance purposes* is listed summarized head-wise as under:

	Generation Description	*PKR*
2601.1	Equipment-1 | 26x stations	103,025,000,000
2601.2	Equipment-2 | Depot	13,523,000,000
2601.3	Equipment-3 | Stabling yard	3,946,000,000
2601.4	Equipment-4 | Substations	1,290,000,000
2601.5	Track | Complete 27.10km	25,018,000,000
2601.6	Trains | 27x modules	46,092,000,000
2601.7	Spares | For all control, IT, misc equipment, track, trains & ancillaries	7,303,000,000
2601.8	Civil structures-1 [apart from track structures] | 26x stations	10,862,000,000
2601.9	Civil structures-2 [apart from track structures] | Depot	2,665,000,000
2601.10	Civil structures-3 [apart from track structures] | Stabling yard	1,240,000,000
2601.11	**Total New Replacement Value PKR**	**214,994,000,000**

2602 Relatively scant data was received to enable a with respect to deriving an accurate replacement value for the sums-insured. Some undated sums-insured figures were provided which indicate very large variances with generic replacement values & rule-of-thumb estimates. The above New Replacement Value [NRV] for 2021 is based upon the partial data sets shared with us by OMT, satellite photogrammetry, as well as other specific & generic valuations for similar projects.

2603 The estimated sum-insured is derived taking into account freight, import levies, engineering / supervision expenses for installation / commissioning, start-up, trials & commissioning costs. The figures do not include costs for physical contingencies, administration / management, forex losses, contractor's claims, performance guarantees, price adjustments, furniture, fixtures, interest, feasibility studies, project planning &/or financial charges.

2604 It must be understood & appreciated that the subject NRV-2021 estimation for the completed project has been made on the basis of construction / erection / installation / commissioning for the various components of the project being treated as single, independent jobs, to be implemented, progressed, & concluded as complete, stand-alone contracts, as would be the base scenario for probable losses & PML-class insurance claims in real terms, where only a few individual sections & components of the entire project are affected at any given time, & not the entire project. These insurance-focused costs will always be substantially higher than the scales-of-economy achievable for a one-time implementation of an identical project, & several factors greater than the original project costs.

2700 Probable Maximum Loss [PML]

2701 Probable Maximum Loss [PML] is the anticipated maximum property loss that could result given the normal functioning of protective features [firewalls, sprinklers, a responsive fire department, etc.], as opposed to MFL

[Maximum Foreseeable Loss], which would be similar valuation, but on a worst-case basis with respect to the functioning of the protective features.

2702 The most plausible scenario, involving a collision incident involving 2x trains at a typical station accident with extensive damage to the station & equipment, indicates a PML [property loss only] that is estimated at PKR 5,274,000,000. The PML as percentage of the total Sum-Insured is 2.45%.
There is insufficient data to compute the Public Liability & BI components for the said event.

Items	*Extent of Loss* *PKR*
	[All figures rounded up to nearest PKR 1,000,000 as applicable]
▪ Main equipment &/or structural damage	4,567,000,000
▪ Ancillaries & peripheral damage	707,000,000
PML PD component PKR	**5,274,000,000**

2800 Maximum Foreseeable Loss [MFL]

2801 Maximum Foreseeable Loss [MFL] is the anticipated maximum property fire loss that could result given unusual or the worst circumstances with respect to the non-functioning of protective features [firewalls, sprinklers, a responsive fire department, etc].

2802 The most plausible scenario, involving a massive & catastrophic fire incident at the main depot with extensive damage to the resident trains, station & equipment, indicates a PML [property loss only] that is estimated at PKR 23,019,000,000. The PML as percentage of the total Sum-Insured is 10.71%.

2803 There is insufficient data to compute the Public Liability & BI components for the said event.

Items	*Extent of Loss* *PKR*
	[All figures rounded up to nearest PKR 1,000,000 as applicable]
▪ Main equipment &/or structural damage	19,274,000,000
▪ Ancillaries & peripheral damage	3,745,000,000
MFL PD component PKR	**23,019,000,000**

2900 Annexure Summary

2901 Annexure-01 Layout plan.
2902 Annexure-02 Preventive maintenance, condition monitoring & NDT programs [data awaited].
2903 Annexure-03 Pakistan flood hazard map.
2904 Annexure-04 Pakistan seismic hazard map.
2905 Annexure-05 Photo file.

The above inspection was carefully carried out to the best of our ability & our responsibility is limited to an exercise of reasonable care. This report represents our findings on the date & at the place stated & is issued without prejudice to the rights of whomsoever concerned. It does not intend to relieve any party from its legal &/or contractual obligations. All relating documents that were provided to us will be preserved for 03 years from this day. Neither the whole nor any part of the report nor any reference thereto may be included in any published document or statement nor published in any way without our written approval of the form & context in which it will appear.

Eng Daniyal Abbas Rizvi Engineering
Eng Bakhat Ali Naper Engineering
Eng Muhammad Faisal Engineering
Yusuf Dossa Engineering Valuation Risk

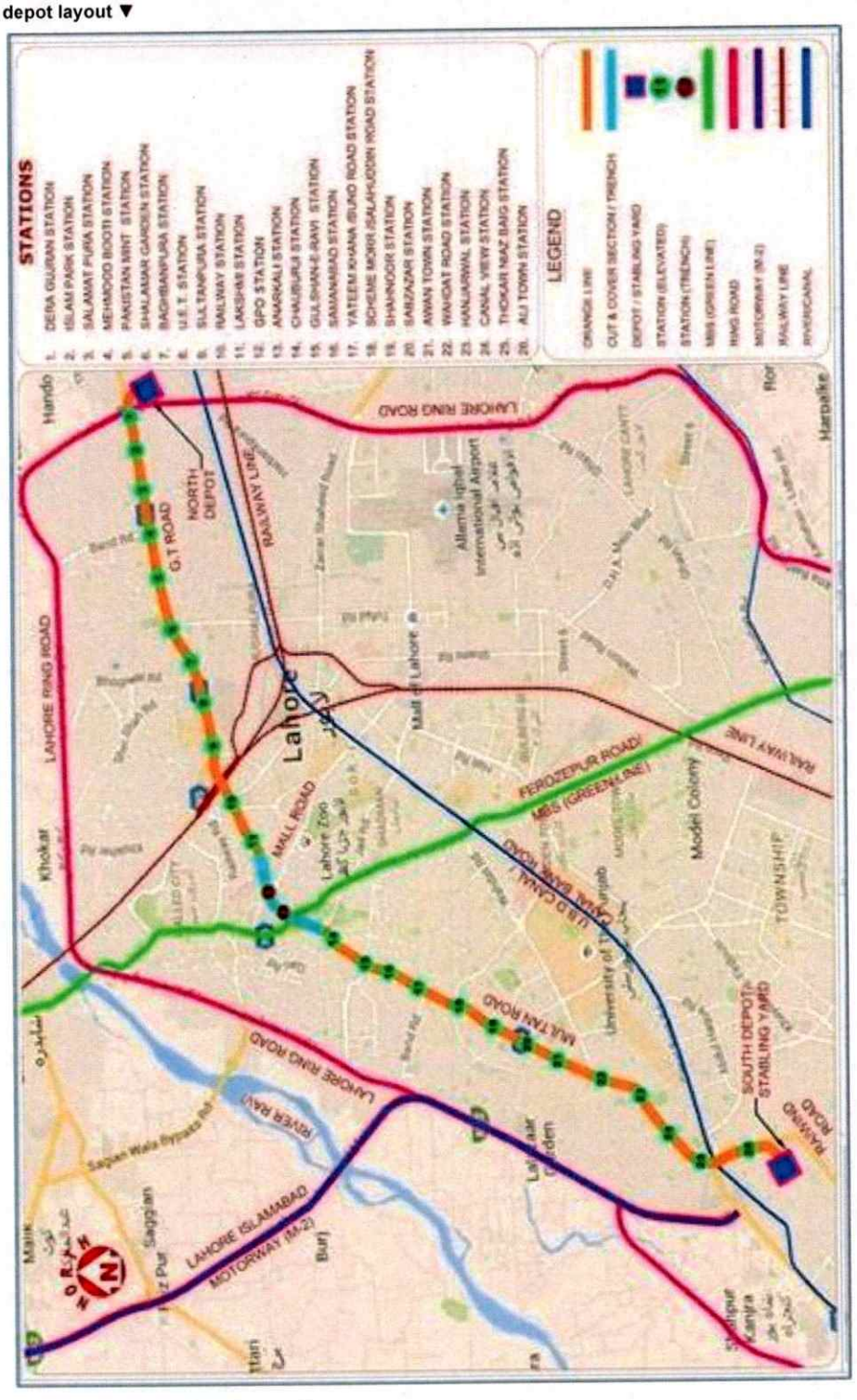
JOSEPH LOBO (PVT) LTD SINCE 1935

Cunningham Lindsey JOSEPH LOBO (PVT) LTD In association with Successors of Joseph Lobo Services established in 1935

Joseph Lobo are a professional firm of licensed Surveyors & Valuers, enlisted by the Pakistan Banks Association as class-A Valuers with no limit on the Asset value

Annexure 1 | Layout

1) Route, station & depot layout ▼



Annexure 2 | Preventive Maintenance Systems

Data awaited

Annexure-03 | Pakistan flood hazard map

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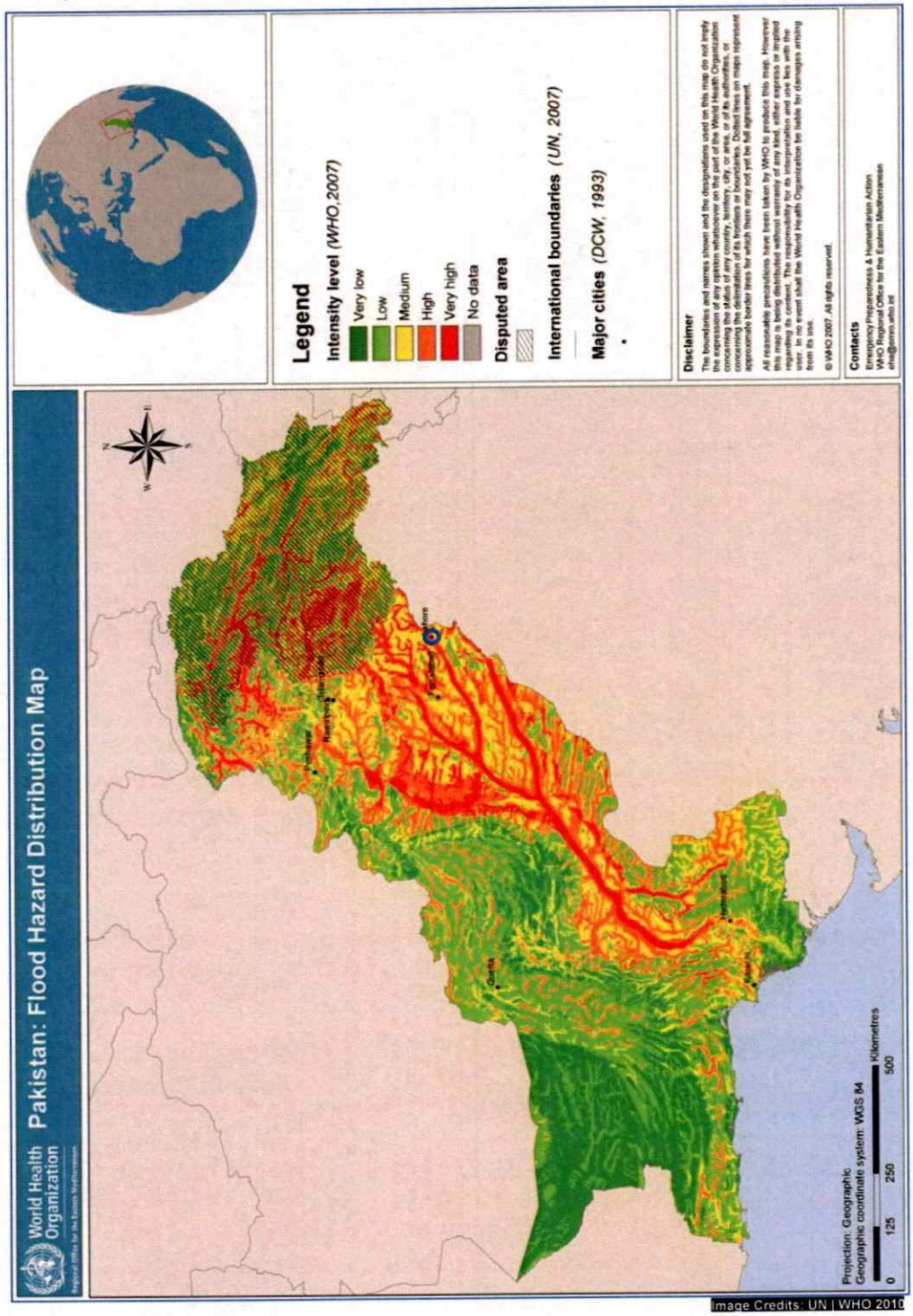
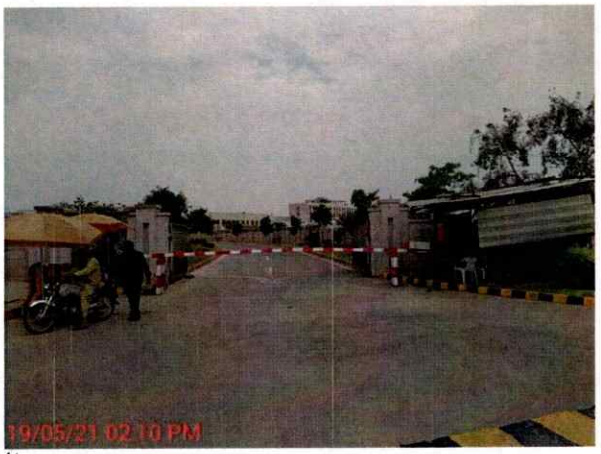


Annexure-04 | Pakistan Seismic Hazard Map

1▼ OMT location:

Image Credit: UN Habitat 2007

Annexure 05 | Photo File



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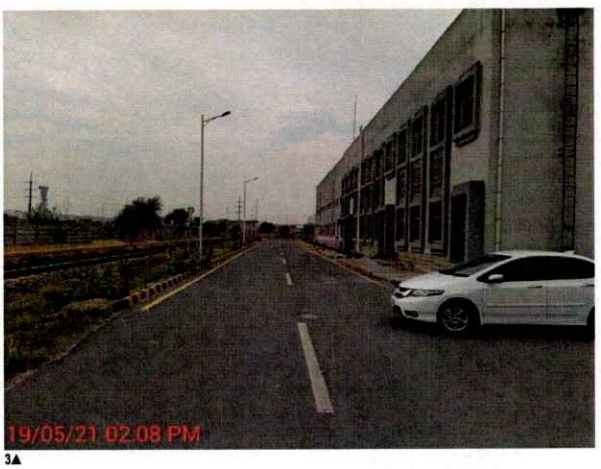

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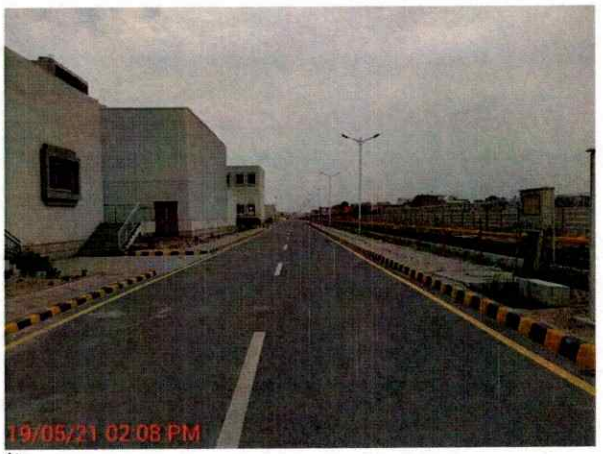

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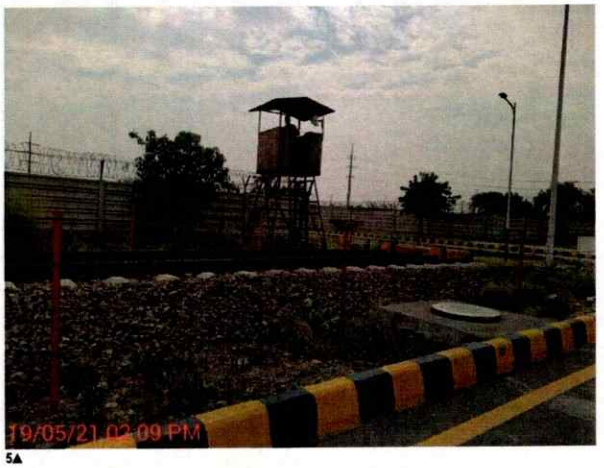

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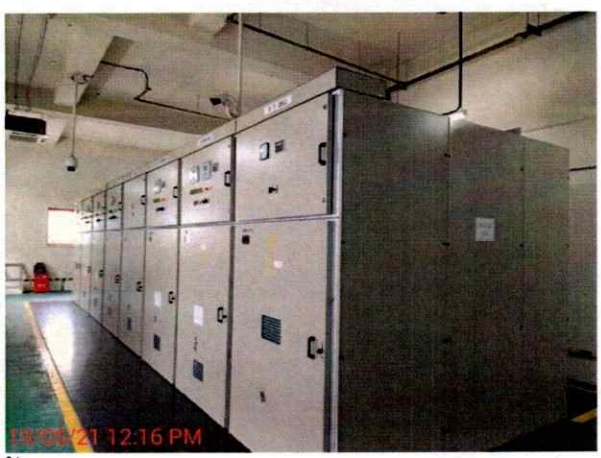

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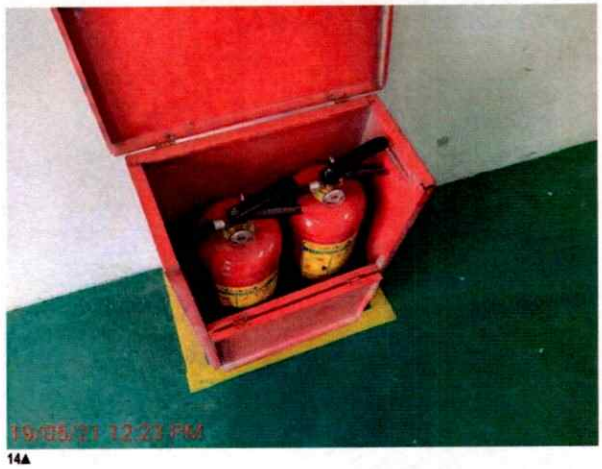

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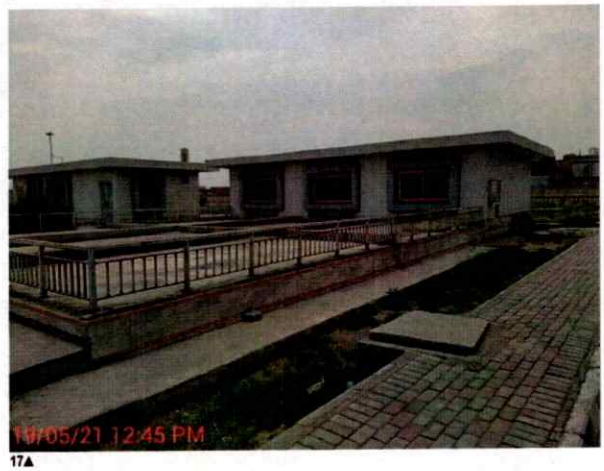

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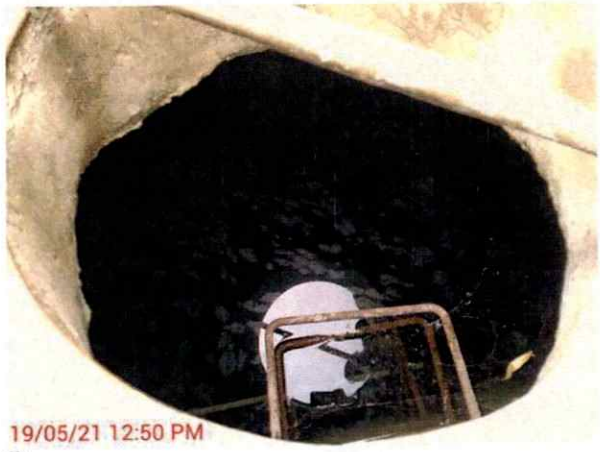

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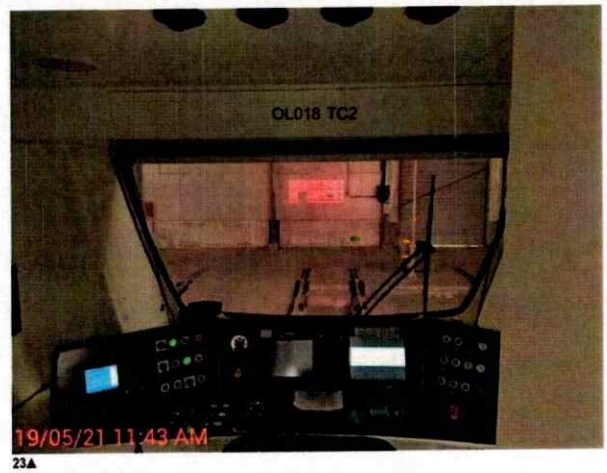

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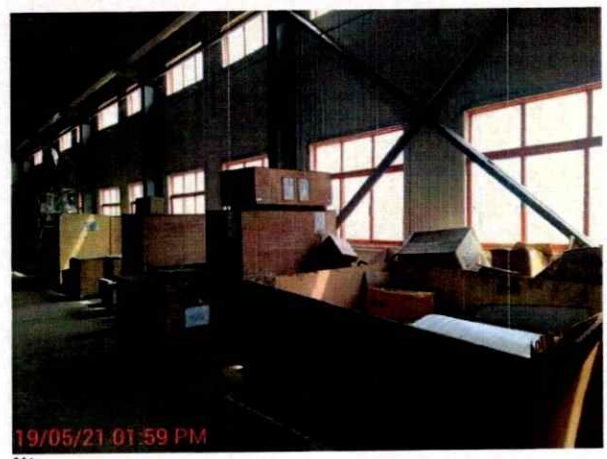

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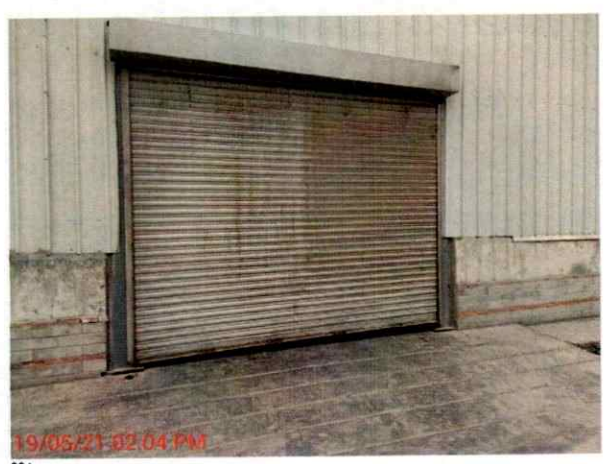

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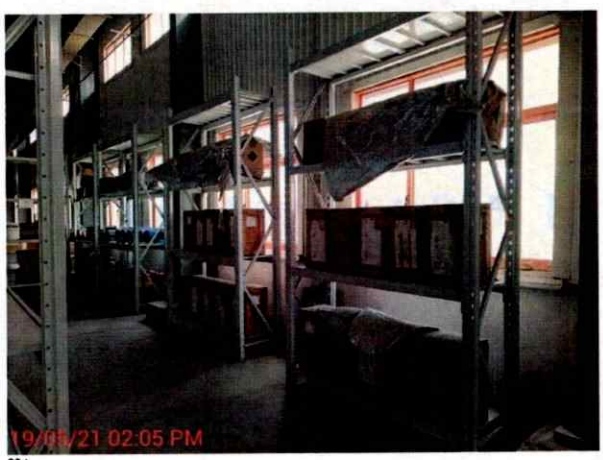

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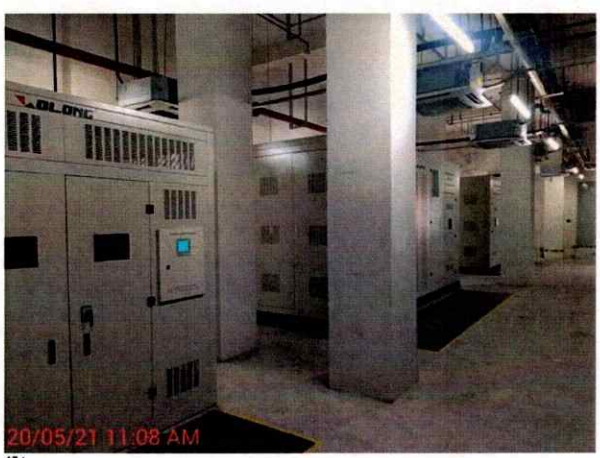

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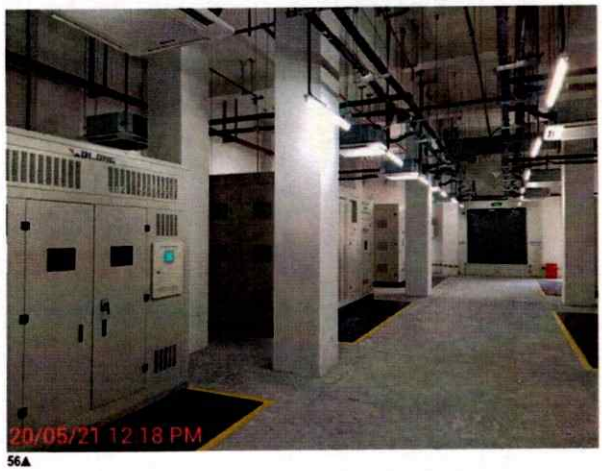

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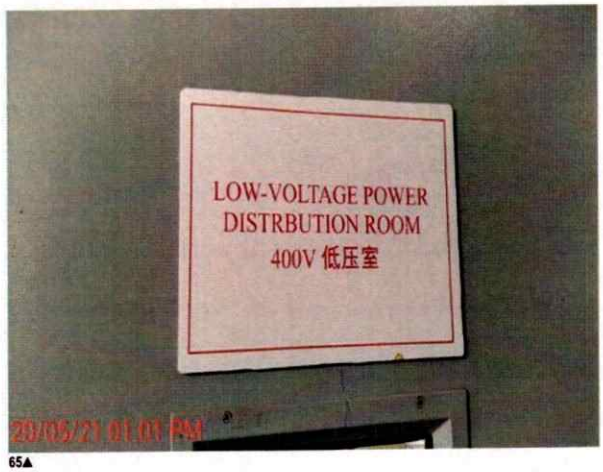

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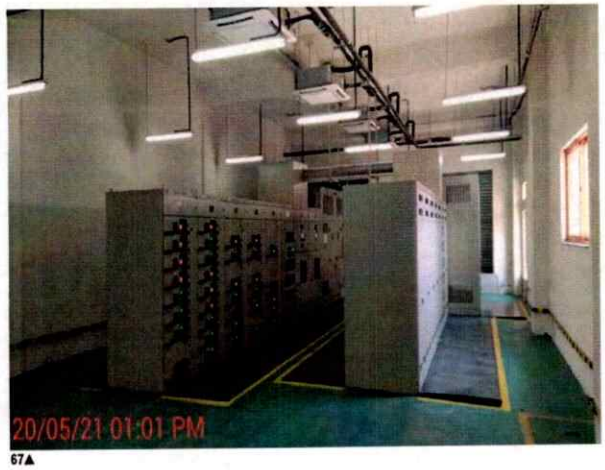

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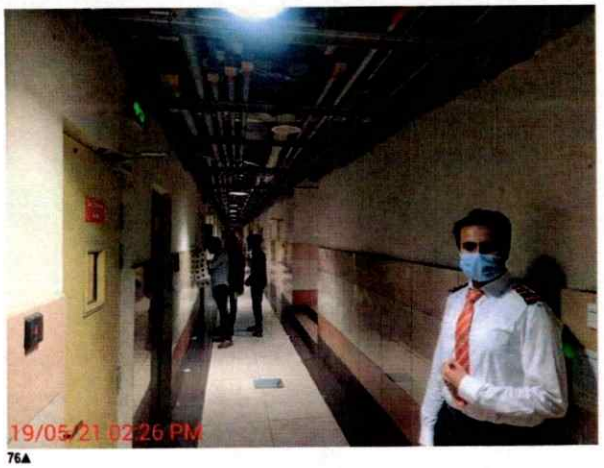

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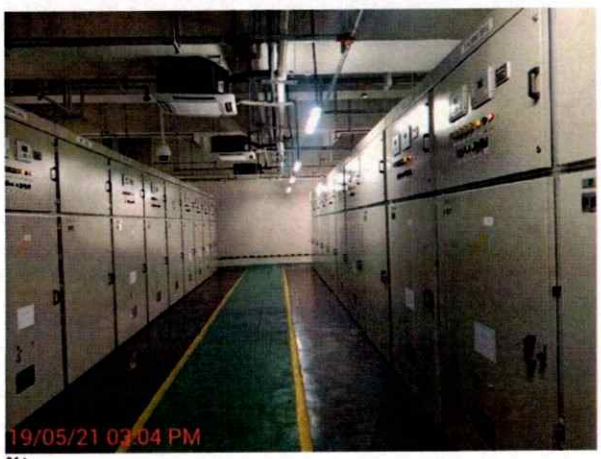

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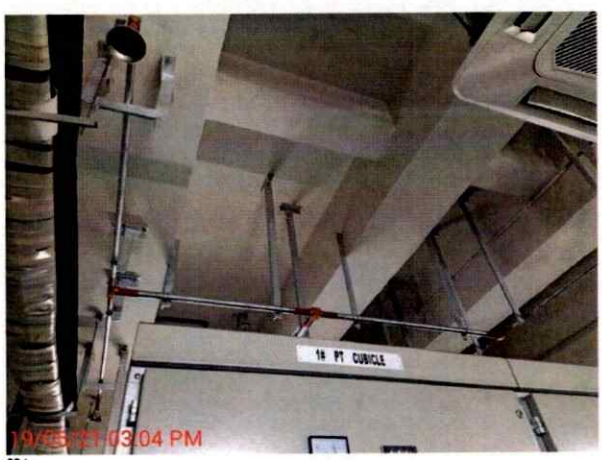

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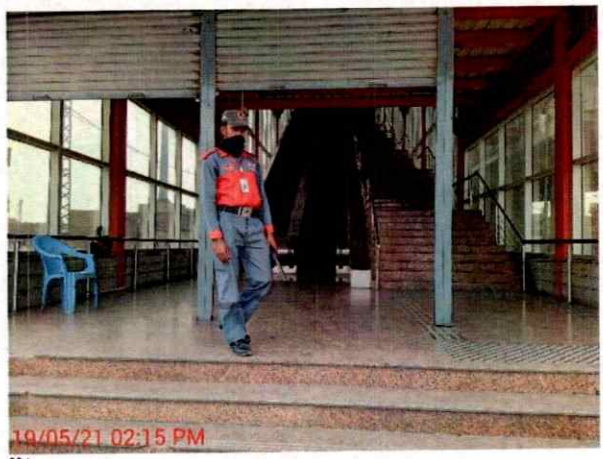

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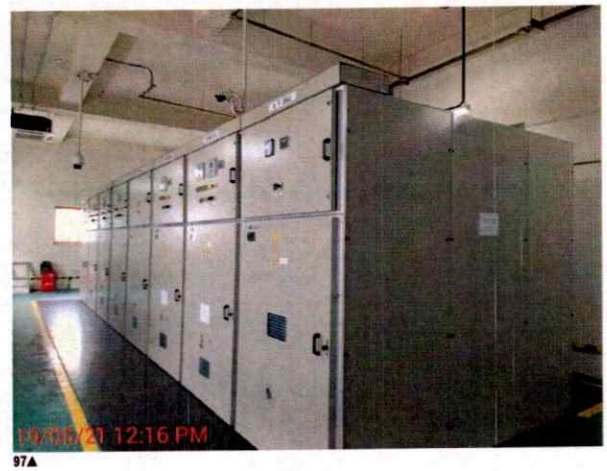

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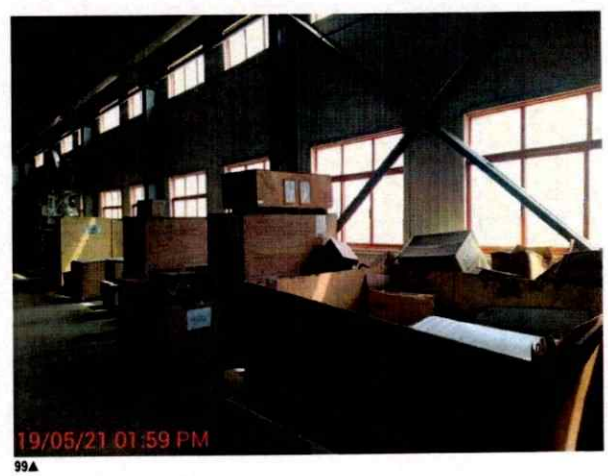

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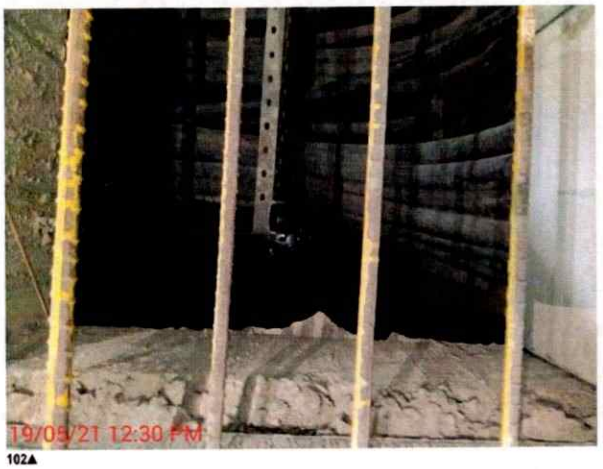

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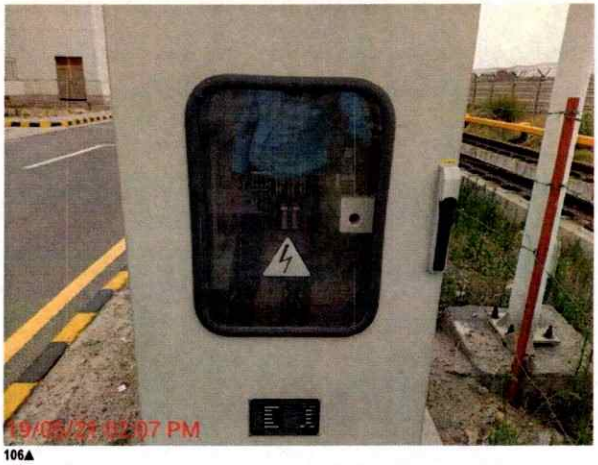

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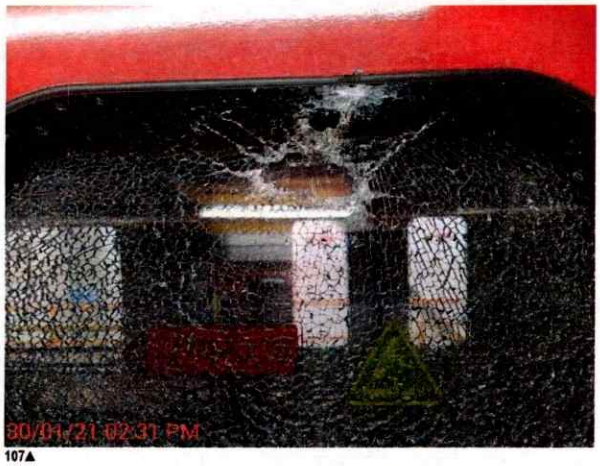

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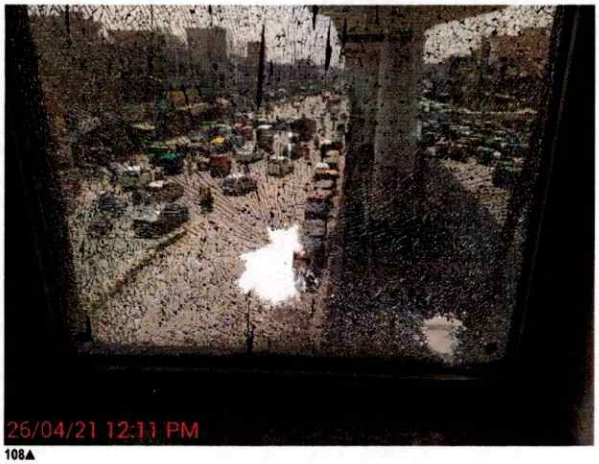

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