Ref. Ares(2022)4166309 - 04/06/2022

CONSTRUCTION OF
ÇERKEZKÖY INTERMODAL TERMINAL (IMT)

SECTION II – EMPLOYER'S REQUIREMENTS
DESIGN FOR CONSTRUCTION

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1 ROAD INFRASTRUCTURE DESIGN

The aim of these requirements is to define conditions for design of IMT access road and parts of the terminal intended for the road traffic (parking areas, storage areas, areas for traffic in the terminal).

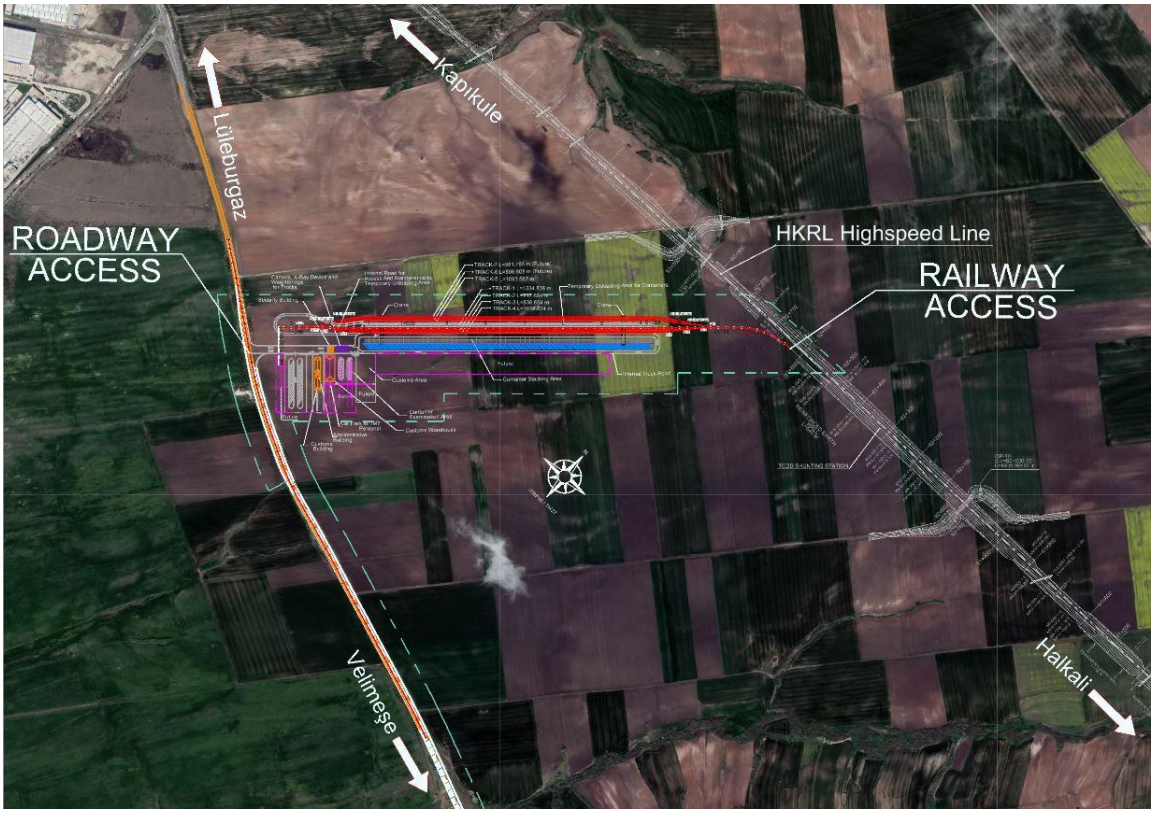


Figure 1. IMT Layout

Conceptual design drawings referred to subject and scope of the road design are:

WKS	102	IMT	CD	DWG	PRF	5-10
WKS	102	IMT	CD	DWG	PLN	6-10
WKS	102	IMT	CD	DWG	CRS	5-7

1.1 References and applicable standards

The road infrastructure shall be designed in accordance with applicable Turkish and EU standards:

- Highways Final and Preliminary Projects Engineering Services Technical Specification 2014
- Highways Technical Specification 2013
- Highways Design Handbook 2005
- Traffic Signs Handbook 2004
- Research Engineering Services Technical Specification 2014
- Highways Flexible Superstructures Project Guide 2010

- Technical Specification for Highways Terrestrial and Photogrammetric Mapping Engineering Services Works 2014
- Technical Specifications for Consultancy Services based on the preparation of Environmental Impact Assessment (EIA) and Project Presentation File (PTD) Reports for Material Quarries, Construction Sites and Storage Areas to be used within the Scope of Highways and Roads, and Crushing-Screening, Ready Mixed Concrete and Similar Facilities 2014
- Engineering Services Technical Specification for Construction of Traffic Safety and Traffic Safety Equipment Project 2018
- Road Lighting Project Design Engineering Services Technical Specification 2018
- Landscape Project Engineering Services Technical Specification 2018
- TCK Soil Research Technical Specification
- TCK Roads Technical Specification
- TCDD Environmental Impact Assessment (EIA) Consultancy Services Technical Specification
- Technical Specification for Preparation of TCDD Expropriation Plans and Documents, Determination and Marking of Expropriation Boundaries and Delivery Standard
- Technical Specifications for TCDD Route, Survey, Map and Application Works
- T.C. Ministry of Transport DLH General Directorate of Public Works General Specification
- Regulation for the Production of Large-Scale Maps (which entered into force after being published in the Official Gazette dated 30.01.1998 and numbered 19711)
- DSI Drilling and Injection Technical Specifications
- Highways Terrestrial and Photogrammetric Map, Project, Bridge, Landscape, Traffic and Environmental Engineering Services Works 2020 Unit Price Recipes
- Highways Terrestrial and Photogrammetric Map, Project, Bridge, Landscape, Traffic and Environmental Engineering Services Works Unit Price Analysis for 2020
- Other relevant standards.

1.2 Layout plan

Vehicles shall access the terminal using the access road derived from Atatürk Street in Velimeşe. The connection between this road and the road leading to the terminal shall be designed as a surface, three-point junction, whose precise layout will be subject to details of this design. Connection road shall be designed as a four-lane road 18m wide (4.5 m for each lane).

In the absence of accurate input data on the predicted traffic load on the access road and due to the very nature of the expected traffic (heavy trucks), the existing access road with two-lane 10m wide is turned into a divided four-lane road 23m. Truck lanes (5m wide) and a median (1m wide) are added to the existing roadway for both sides of the road. At the junction of the access road and the connection road, there exists a signalized three-leg junction. The truck lane added to the right side of the road while coming from Velimeşe is approximately 1500 m long and the truck lane added to the left side of the road is 500 m long. The expansion on the road is made between the Velimeşe and IMT since the expected traffic will occur between these two locations and the junction area.

According to IMT procedures, after entering the vehicles parking zone on the terminal, and before accessing the transshipment area, it is necessary to complete the specified procedures regarding delivery and/or pickup of containers. These procedures are performed in the gate (administrative control) building which shall be located at the end of the terminal parking zone. In addition, on the parking zone the customs building shall be located, whose main clients are the shippers who come to the terminal using passenger cars.

The parking area with an adequate number of parking places for trucks and passenger cars to customers and employees at the terminal shall be designed. For easier and faster access, the truck parking spaces are designed with an angle of 45º for the parking spaces and standard sizes for the semi-trailer truck. Parking lots for passenger cars shall be aligned, both with 90°C and 45º angle to the road, near the buildings in order to save space and allow easy access to buildings.

Near the control building the passing ramp near the control building shall be situated which allow the truck to be directed to the proper parking position. Total width of the lane is 7m of which is provided to reach necessary width for parking and driving.

Once the truck stopped at the dedicated parking position, the crane makes the transshipping of the containers on/from the truck to the train and the storage area. Maneuvering areas with width of 16m shall be provided which will allow mobile crane to operate. Next to this surface, in continuity temporary storage area for containers, 9.3 m wide shall be built to accommodate three rows of standard containers.

After loading/delivering the container, the truck leaves the terminal on the exit lane. Two exiting lines shall be provided, one of which shall be designed for quick evacuation of the terminal zone in the event of an accident, or for access for the fire brigade.

As the terminal is also a customs zone, the project shall meet the requirement of the customs for positioning of a mobile scanner for inspection of vehicles that leave the terminal (Phase II). The mobile scanner requires a fenced area in which the truck has the ability to drive in the direction. The location of this zone shall be at the end of the exit lanes from the terminal before the truck leaves the transshipment area, in order to allow him, if the scanner detects that something is wrong and instructed so by the customs staff, it can be returned through the semi-circular road to the maneuvering area in front of the customs warehouse, which shall be an integral part of transshipment zone.

In cases when cargo has to be sent for further inspection upon scanner control, the truck shall go back to the fenced customs storage plateau through a semi-circular road and the mobile crane shall then take the cargo off the truck and place it in the place specially designated for that purpose. Customs officers issue a certificate and give it to the truck driver and the truck must leave the terminal transshipment area.

If the truck at the scanner control received approval from the customs staff to leave the terminal, or if it has not been subject to this type of control, the truck leaves the transshipment area and after passing the terminal gate continues the exit to the Zafer road and its desired destination.

1.3 Functional and technical characteristics of the proposed solution

Boundary elements of layout and profile

Elevation of the terminal road infrastructure shall be conditioned by an altitude of the existing shunting station in Çerkezköy (in the connection point).

Boundary elements include minimum and maximum values for the site layout plan, longitudinal and transverse profiled depending of the design speed.

For the access road, the Contractor should adopt the following cross section:

- Existing road (10m wide) is expanded with truck lanes and a median;
- Truck lane width of 5m;
- Median width of 1m;
- Edge strip width 0.5m;
- Final access road width is 23m.

The terminal shall be a combination of a freight railway station and the flat area with parking and facilities on it. In this regard, the Contactor should adopt the following elements:

- The minimum value on the parking ramp at transitional cross-sections min irv = 0.385%
- Maximum value of ramp at transitional cross-sections on the road pavements max irv = 1%
- Maximum longitudinal slope of the temporary storage and maneuvering area i=0%.

The adopted design speed for defining the elements of the terminal is 30 km/h.

The representative vehicle for further design process is a heavy vehicle with five axles - Semi Tractor Trailer, or a car-train according to the local regulation, whose characteristics are:

- Number of Axles - 2+3 (total 5);
- Length – 15.40 m, max 18.35 m;
- Width – 2.50 m;
- Height – 4.0 m.

Embankment height at the most areas of the access road and the Terminal shall be within 0.90m and 3.25m range.

Access road longitudinal profile

Altitude of the access road in its initial part is conditioned by the existing access road profile since the only construction work for the purpose is the expansion of the existing road.

In addition, the technology of working conditions at the terminal in terms of a longitudinal slope require the terminal slab to be completely flat, so that the grade line throughout the length of the longitudinal slope shall be designed with a slope of 0%.

These two boundary conditions are the main restrictions on the profile of the connection area between the access road and terminal area. Between the access road and entrance gate of the terminal area, connection road is designed with a slope of 1%.

Levelling of parking zone

The parking area of the terminal cannot be seen as a linear object and therefore, for this area a detailed leveling plan is required. In addition, this area shall be a transitional zone between the requirements of the transshipment area and the access roads.

At the entry of the terminal part the longitudinal gradient adopted on the parking shall be 0.3% in order to maintain continuity with the entry access road. The part of the parking zone on which are located

buildings and parking spaces for passenger cars shall be designed with longitudinal gradient of 1.5% to provide good runoff of the surface waters with respect to the upper parking area that shall be designed with a transverse gradient of 0% which shall be again subject to the required geometry and processes within the working area of the intermodal terminals according to international practice.

The cross slope of the terminal shall be in the range of 0% to 2.5% depending on the position. Transitional cross-sections are placed on several positions with the adopted slope of ir = 0.4% to ir = 1%. Transition lengths vary in relation to the width and slope of the profile that are located in this transition zone.

1.4 IMT area

Manipulation area

The core of IMT operation shall be to provide a transhipment area from road to rail transport, and respectively requires an area particularly dedicated for vehicles (mobile cranes and trucks).

This area shall also be used for loading, unloading, and driving of trucks.

A Gantry Crane shall be used for transhipment in IMT, and the width of the main manipulative area shall be 75m. A 10m wide traffic area (next to loading/unloading rail tacks) commonly used for both the mobile crane and the vehicles, shall be designed next to it.

Railway

IMT shall include four loading/unloading tracks and one extra track. The length of the transhipment area shall be 750m.

Transhipment tracks

The design solution shall include four transhipment tracks, which are not electrified.

Usual operations are mainly done by the diesel locomotive inside the terminal. A shunter operating mainly in the terminal shall be to be used for entry and exit of trains to/from Çerkezköy Railway Station.

According to operational length of the European trains, the length of these tracks shall be 750m.

Storage

Storage capacity shall be calculated based on the storage lines. In this regard, the length of the loading tracks shall be equal to the length of the storage zone, meaning that in the first phase there will be five container lines with a length of 750m. Storage place required for one container shall be 12.03m, resulting in a capacity of 59 storage places per each line with maximum height of 4 levels.

The width of the container storage shall be 2.95m. In this regard, total storage area shall be at least 750m * 14.75m = 11,062.5m2. Part of container storage shall be designed for accommodation of removable transport containers.

Containers with dangerous goods require strictly defined special storage area. Depending on the type of dangerous goods, storage of certain types of goods close to each other is strictly prohibited.

Storage place shall have concrete surfaces, collecting tanks and water treatment installations. Terminal total capacity shall be 1180 storage places.

No additional area is required for terminal services - lifting and storage of containers. Storage of empty containers is considered additional service that an area outside the terminal shall be proposed for and is not to be included in terminal services.

Open storage area with smaller fence and space for storage and inspection of containers shall be reserved for the customs.

Prior inspection area

This shall be the area where the truck (terminal user) arrives after entering the terminal.

It shall include key elements such as parking for trucks, parking for passenger cars, gate building (administrative control building), customs building and local service roads.

Total number of parking places for trucks shall be to be determined based on the analysis of the expected number of trucks and their daily distribution, i.e., based on the expected number of trucks in terminal peak hours (minimum 24 spaces). Number of parking places for passenger cars shall be to be determined based on the number of terminal staff and expected number of forwarding agents and other terminal users (minimum 60 spaces).

Three buildings, one gate building (Administration building), Customs building and Customs warehouse are planned in the prior inspection area.

2 PAVEMENT DESIGN

The Contractor shall design pavement construction for all road and traffic areas within the terminal, as well as for IMT access road.

The pavement design, also, have to be adjusted to the requirements that come from a study of soil testing materials. This study shall cover field and laboratory testing of the soil materials, relevant to the design process.

During the design process, the Contractor should take into account all different vehicles representative to ones that will be used during the terminal operations. The basic characteristics of all vehicle types have to be presented. It is necessary to adopt optimal pavement construction(s) for all traffic areas needs which also have to be in line with other areas inside the terminal. The pavement construction has to be presented in form of type of component materials, their characteristics and minimum thickness.

2.1 References and applicable standards

The pavement design should comply with applicable Turkish and EU standards and in particular to:

- Highways Flexible Superstructures Project Guide 2010
- Highways Technical Specification 2013
- Highways Final and Preliminary Projects Engineering Services Technical Specification 2014
- Highways Design Handbook 2005
- TCK Soil Research Technical Specification
- TCK Roads Technical Specification
- T.C. Ministry of Transport DLH General Directorate of Public Works General Specification

2.2 Pavement areas

Pavement areas shall be divided into 3 different categories:

- Access road, parking area for cars and pavements of general use;
- Parking area for trucks and internal roads;
- Container stacking area and Gantry Crane area.

2.3 Pavement design solutions

The following sections provide description of the pavement construction that shall be designed for different traffic areas within IMT, the service road within IMT and parking area for heavy and passenger car vehicles.

Analysis of IMT traffic areas as well as intention to simplify and unify different pavement designs (especially regarding construction works and integration with other areas within IT) indicate to the need of adoption of two types of pavements:

- Flexible pavement structures (for access and service road, and parking area – part for passenger cars together with traffic portion and the contemporary parking area of trucks), and
- Rigid pavement structures (for maneuvering plateau and parking area for heavy duty vehicles).

2.4 Pavement design of the access roads, service road and parking area

IMT with access roads is located mostly on the ground loess soil for which was performed appropriate field and laboratory testing to determine the quality of the same. In this regard, the CBR value determined of the soil bed ranges from 3.4-10.1%, where as a critical value was recognized and adopted the value of CBR = 3.4% (soil testing).

The following data, given as reference make part of provided Conceptual design.

Due to the small capacity of fine-grained material in the sub-grade, it has been proposed to replace the sub-grade materials or building of embankment with the layer of sandy gravel/crushed stone 0/63mm material with minimum thickness of d=30cm in order to provide better conditions for future sub-grade bearing capacity. In this way, the expected value of CBR is 10% at the finishing layer of embankment/layer of replaced material.

The IT is an object along with its traffic areas located mainly on the embankment, predominant height of 0.9m to 3.25m. In one short section of access road near the parking area (exit lane), road construction is too close to the existing terrain where it is necessary to pay special attention to the replacement of materials in the sub-grade to meet the requirements of appropriate quality in the final layer on which the pavement construction will be placed. In addition to these requirements (replacement of sub-grade materials) it is necessary to use appropriate geotextile net (in contact between natural soil and the embankment/layer of replaced material in sub-grade), in order to improve the characteristics of "natural" soil quality for the future pavement construction.

During the operation of IT, it is considered that it will develop during the time, which will necessarily cause an increase in freight traffic. Regarding this, there are provided three development stages of IT. Analysis of traffic loads and network traffic flows in relation with IT, it is assumed that a competent number of trucks that will go to/from IT for different phases are:

- Phase I AADT - 125 trucks / day;
- Phase II, AADT - 250 trucks/ day.

The representative vehicle for further design process is a European type heavy vehicle with five axles - Semi Tractor Trailer. The following figure shows this vehicle as well as the characteristic axle loads:

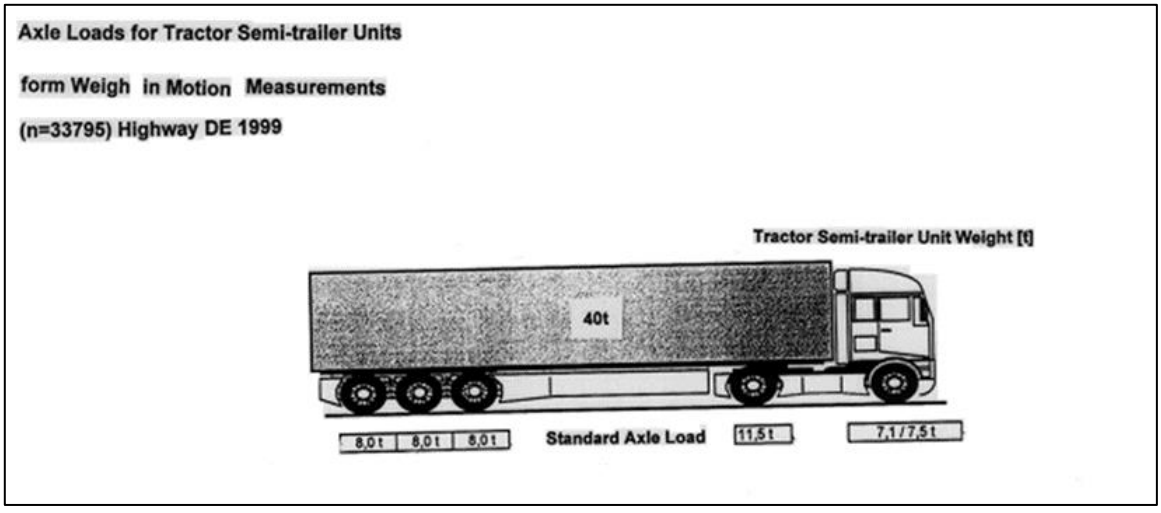


Figure 2. Semi-Tractor Trailer

In the absence of national regulations for the appropriate equivalence factor of the mentioned vehicle, the total traffic load for the design period of 20 years should be calculated using the equivalence factor taken from the Design Manual for Roads and Bridges, Vol 7 - Pavement Design and Maintenance, Section 2 - Pavement Design and Construction, Traffic Assessment, and is fe=4.4. Accordingly, the total traffic load for each development phase is given in the table below:

Table 1. Total Traffic Load

Phase	AADT	Lane distribution	Design period	Q	Total traffic	Total traffic category
	vehicle / day	%	year	*	x 10^6 vehicle	*
Phase I	125	50	20	28	2.8	**heavy**
Phase II	250	50	20	28	5.6	**heavy**

Based on the total traffic load from the previous table and bearing capacity of the sub-grade (CBR = 10%), the required thickness of pavement layers will be designed based on EN Norms and the phase.

The pavement thicknesses are given as a reference only (Volume 5).

In Europe, the usual structure of the wheels of mentioned heavy truck vehicle is that the middle axle has double wheels at their ends (dual wheel), while the triple rear axles have one wide wheel (super single wheel) at their ends, which gives a total number of 12 wheels. Based on this as well as on the axle load, the contact pressure and contact area for the critical axis are given in the following table:

Table 2. Axle loads

Axle	Axle load	Single wheel load	Contact pressure	Contact area
*	kN	kN	MPa	cm²
Middle (Dual wheel)	113	28.25	0.745	379.2
Rear (Super single)	78	39.2	0.716	547.5

According to the above-mentioned methodology, a model of pavement multilayer elastic system shall be established, structured of non-bound based layers and asphalt layers, placed over the sub-grade of certain characteristics, as shown schematically in the figure below:

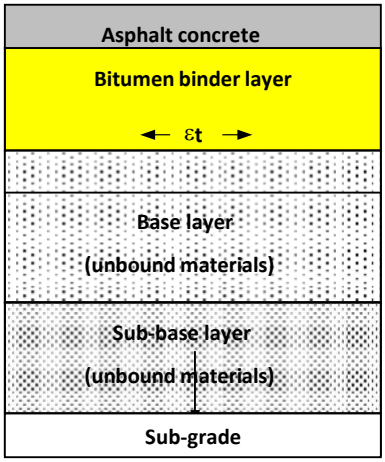
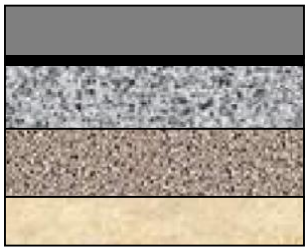


Figure 3. Pavement construction model for analytical calculation

2.5 Pavement design of the parking area for heavy duty vehicles

Parking areas shall be designed for parking of cars and heavy-duty vehicles (trucks). Each of these two groups of vehicles will have its own parking area that will be clearly marked and delimited. Parking area, designed for the heavy-duty vehicles shall have a pavement structure, whose dimension will be determined using the method based on material properties in the sub-grade and the subbase layers. Schematic view of the road structure is shown in the figure below:



Concrete slab
Plastic film
Subbase layer (crushed stone, 0/31.5mm)
Embankment/sub-grade replaced layer
(gravel/crushed stone, 0/63mm)
Geotextile net / existing ground, natural ground

Figure 4. Model of pavement structure for analytical calculation

The description of representative vehicle - Semi Tractor Trailer (Figure 2) is given in the preceding paragraph.

For the proposed thickness of the concrete slab, an analysis of tensile stress should be calculated at the bottom of the slab for the several characteristic load traffic positions – inside the slab, at the edge and at the corner of the slab, according to the EN Norms.

2.6 Pavement design of maneuvering area for the heavy vehicle type and container stacking zones

The following text provides a description of pavement design over the maneuvering area for the Heavy Vehicle Type and the Container Stacking Zones.

Schematic view of the road structure is shown in the figure below:

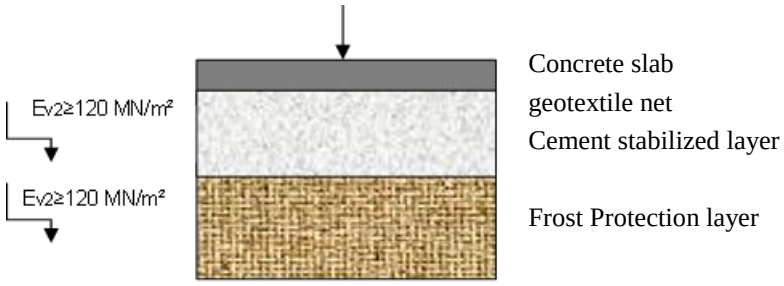


Figure 5. Pavement construction model for analytical calculation

The data for Conceptual design are given as reference only:

Characteristics of future concrete pavement slab are given in the table below and were used for design calculation:

Table 3. Concrete slabs characteristics

Type of Concrete	MB40
Min slab thickness*	18 cm
Modulus of elasticity (nat. standard BAB/52)	34 GPa
Fatigue strength fzs*	5 MPa

The concrete slab is laid over the layer of cement stabilization, which is placed over the subbase layer made of crushed stone 0/31.5 with minimum thickness of d=30cm. Based on the required level of quality of subbase layer (≥ Ev2 120MN / m), the expected value of the reaction modulus "K" at the top of the subbase layer is K=105MN/m³. Based on these values together with cement stabilization layer (thickness d=25 cm), as recommended by ACI (American Concrete Institute), the expected value of the reaction modulus at the top of the cement stabilization layer is K=230MN/m³.

Throughout the design process, the required thickness of the concrete slabs will be calculated. The calculations, tables, and the figures related with the pavement design are given reference only.

2.7 Container storage slabs

In the project Phase I, five lanes of containers with a length of 750,0 m shall be provided. Needed space for one container is 14.75 m with a capacity of 59 storage places per lane, with the maximum height up to 4 levels. The width per container storage is 2.95 m. Therefore, the total storage area is 750,0 m x 14.75m = 11,062.5 m².

For standard containers is proposed to allocate 59 storage places per lane. For reefer containers is proposed to allocate 15 storage places per lane.

Part of the storage area can be allocated to swap bodies instead of containers. It is proposed to allocate 20 storage places per lane of the area for this.

For dangerous goods containers is proposed to allocate 6 storage places per lane. This special storage area is strictly defined. Dangerous goods include materials that are:

- Radioactive;
- Flammable;
- Explosive;
- Bio hazardous;
- Others dangerous goods.

Dangerous goods are differing from one to another type and therefore it is prohibited to store certain goods next to others. Concrete surface, collecting tank and water separation installations are the most important technical requirements for the storage. Joints for plates for storage of dangerous goods shall have rubber internal expansion joint waterstop.

Due to the provided service of the terminal – lifting and storage of containers – no extra area is defined. Empty container storage is a value-added service, to be proposed outside of the terminal, and not as a service of the terminal itself.

A limited fenced open storage is reserved for the customs, with space to store 10 containers for inspections. It is located near the custom building, and on recommendation of the customs expert, has been kept small on purpose.

3 TRAFFIC SIGNALIZATION AND EQUIPMENT DESIGN

3.1 References and applicable standards

This design is aiming to define installations of road equipment and traffic signalization on the terminal and terminal access road.

The road traffic signalization and equipment design should comply with applicable Turkish and EU standards and in particular to:

- Highways Final and Preliminary Projects Engineering Services Technical Specification 2014
- Highways Technical Specification 2013
- Highways Design Handbook 2005
- Engineering Services Technical Specification for Construction of Traffic Safety and Traffic Safety Equipment Project 2018
- Road Lighting Project Design Engineering Services Technical Specification 2018
- TCK Roads Technical Specification
- T.C. Ministry of Transport DLH General Directorate of Public Works General Specification

Contractor's obligation is to provide a design of IMT traffic system according to provided Conceptual design (making part of this Tender Dossier) of the access roads and IMT internal service roads.

In addition, the Contractor should obtain a consent from Tekirdağ Municipality and all approvals and necessary permits for a construction.

IMT relates to a wider network of urban roads through access road coming from Velimeşe to O3 European Motorway. This access road is derived from existing road by expand it with truck lanes from both sides. It shall be a four-lane with 5 m truck lanes and 3.5 m car lanes with a speed limit of 50 km/h that leads to terminal area.

Two parking areas shall be provided in the parking zone, one for the cars of terminal / customs administration staff and visitors, and one specific for the trucks.

Speed limit within IMT is 20 km/h.

Three barriers will be placed for the control of the entrance to the terminal, one at the entrance of the pre-access zone (parking area), at the entrance of the terminal and at the exit of the pre-access zone (parking area).

3.2 Organization of truck vehicle circulation

The truck drivers will be obliged first to enter in the pre-access zone at the parking space, in front of the gate and park the truck. If all conditions are satisfied (pre-check process, the customs procedure and paying the terminal ticket) the driver can collect his vehicle and drive to the terminal entrance, the access barrier to access the terminal shall be opened on presentation of the ticket and the driver can enter the terminal.

The parking space for the trucks will be free in the first two hours, and after this period fee shall be charged.

Only trucks with a complete documentation shall receive the entrance ticket and have access to the terminal, otherwise the truck drivers will be ordered to leave the terminal.

Once the truck is inside the terminal, and has been loaded/unloaded; it can be stopped at the customs scanner on the exit road and if there are no irregularities detected the truck shall turn right and leave the terminal. In case otherwise ordered by the customs administration, it shall need to go back to the loading zone to unload goods for inspection at the customs warehouse).

3.3 Organization of car circulation

To reach the parking for the cars, the driver will need to pass through the parking zone for the trucks and to turn right. The speed limit at the pre-access zone is 20 km/h.

The cars shall access the car parking through the outer traffic lane, and shall be allowed to drive in one direction only in area between the parking spaces and the service roads.

Circulation around the car parking shall be done in clockwise movements, so as to avoid conflicts between cars and trucks at the exit of the truck parking area and the trucks circulation from the parking toward the entrance to the terminal (the only section with the two-way circulation – shall be marked by the horizontal signalization).

3.4 Vertical signalization

The vertical signalization shall consist of standard, directional and special traffic signs for referral and guidance of the participants in the traffic.

The traffic signs shall be manufactured according to the applicable Traffic Signs Rulebook.

Suitable and sufficient measures shall be taken during construction to ensure that traffic signs are sufficiently robust to prevent them from being displaced during any windy conditions likely to be encountered on site or by buffeting from passing vehicles.

The erection of the traffic signs enables 3-5° deviation from the normal axis of the road. The single signs posts need to be secured from rotation with crossbars in the foundation. The length (height) of the sign posts shall be determined by the number of plates/signs attached on them.

All signs shall be reflective, and it is obligatory to use reflective films with characteristics of the national standards.

At the terminal zone, at the truck parking place, additional plates with instructions shall be added on the standard traffic sings. The additional plates indicate that only trucks with correct documentation and possessing a terminal ticket can enter at the terminal.

The same additional plate shall be added at the exit of the terminal indicating that trucks can leave the terminal except in case otherwise instructed by the Customs.

The directional signs indicating the access to the terminal from the public road network and particularly from Velimeşe have to be presented on the layout plan. As for indicating the location of the terminal on the motorway, the signalization i.e. the traffic signs from Velimeşe Node have to be used and additional sign for the terminal have to be added on the existing traffic boards.

Also, a directional sign for Velimeşe settlement has to be included in the layout plan.

All metal parts of the traffic sign posts as well as the post structure of the presented tables and elements must be protected with hot treated zinc coat and thickness of 60 μ. The posts need to be protected with anticorrosive paint from artificial resin or plastic coating without staining in dark gray colour.

The top of the posts needs to be protected from rain, closed with a plastic plug or welded.

3.5 Horizontal signalization

The marking of the horizontal signalization needs to be performed according to the plan for horizontal and vertical signalization.

The horizontal signalization on the terminal shall be aligned with the Traffic Signs Handbook (2004).

3.6 Traffic guardrail

According to the Turkish standards, guardrails are required on road curves, embankments higher than 3m.

None of these conditions refer to the access road to the parking zone and therefore guardrails are not required.

4 RAILWAY INFRASTRUCTURE DESIGN

4.1 References and applicable standards

Railway infrastructure shall be designed in accordance with applicable Turkish and EU standards:

- Research Engineering Services Technical Specification 2014
- Technical Specifications for Consultancy Services to be based on the Preparation of Environmental Impact Assessment (EIA) and Project Presentation File (PTD) Reports for Material Quarries, Construction Sites and Storage Areas to be used within the Scope of Highways and Roads, and Crushing-Screening, Ready Mixed Concrete and Similar Facilities 2014
- Landscape Project Engineering Services Technical Specification 2018
- TCK Soil Research Technical Specification
- TCDD Environmental Impact Assessment (EIA) Consultancy Services Technical Specification
- Technical Specification for Preparation of TCDD Expropriation Plans and Documents, Determination and Marking of Expropriation Boundaries and Delivery Standard
- Technical Specifications for TCDD Route, Survey, Map and Application Works
- T.C. Ministry of Transport DLH General Directorate of Public Works General Specification
- Regulation for the Production of Large-Scale Maps (entered into force after being published in the Official Gazette dated 30.01.1998 and numbered 19711)
- DSI Drilling and Injection Technical Specifications

The aim of the railway infrastructure design is to define the programme and conditions for designing of the connecting (access) railway track and the loading tracks of the terminal.

The connecting (access) railway track and the loading tracks shall be designed as industrial tracks for a maximum permissible axle load of 22,5 t/axle and a maximum allowable load of 8t per linear meter.

During design process, it is necessary to ensure that connection between terminal and Çerkezköy shunting station does not, in any respect, hinder the operation of the station or affect its continuity.

IMT connection to Çerkezköy station network shall be realized as a connection between two parallel tracks (existing railway tracks and new terminal connecting (access) tracks) by developing one turnout at the station part of the railway tracks toward IMT area and the other turnout at the connecting track. It is necessary to envisage turnout track with buffer stop aiming to enable smooth traffic operation and forcing open of routes.

The technical design for terminal infrastructure must not hinder drainage of the roadbed of the existing railway line.

The design of the connecting track embankment width shall take into consideration the embankment height, the required width for drainage (mandatory drainage channels on both sides), the minimum free zone of 1m on both sides, as well as the boundary of the adjacent land.

TCDD is considering redevelopment, modernization and construction of a double track railway connecting Halkalı – Kapıkule and the state border, with a maximum train speed of 200 km/h. Çerkezköy Shunting Station construction is supposed to be completed before IMT construction works

commencement. Therefore, IMT technical documents must comply with Çerkezköy Shunting Station design.

Contractor's obligation is to obtain TCDD consent on the Design for Building Permit prior to submission to the Employer, and consent on the Design for Construction.

Conceptual design drawings referred to subject and scope of the railway infrastructure design are:

WKS	102	IMT	CD	DWG	PLN	1-5
WKS	102	IMT	CD	DWG	PRF	1-4
WKS	102	IMT	CD	DWG	CRA	1-4

4.2 Design elements

Railway

Cross-section design for the railway lines inside and outside IMT shall include the following elements:

Superstructure

- UIC60 rails
- Concrete cross ties (from Çerkezköy Shunting Station exit and on entire IMT), L=2.60m
- Crushed stone track ballast of volcanic origin

Substructure

- Formation width shall be 6,90m
- Formation cross-slope shall be 5%
- Track formation shall be designed with a protection layer and an intermediate layer

Bounding elements of layout and section

Bounding elements imply minimum and maximum values for layout, longitudinal and cross section based on the calculation speed. The connecting railway line shall be designed for a design speed of 30 km/h.

IMT railway plateau, shall be considered as a freight station, therefore the elements corresponding to station shall be adopted as follows:

- Station shall be located on a straight alignment
- Longitudinal inclination shall be 0‰

Layout

Design of the intermodal terminal implies specific combination of rail and road traffic integrated in one joint zone. Having that in mind, the most important conditioning parameter in establishing the layout was functionality and technology of operation within the terminal.

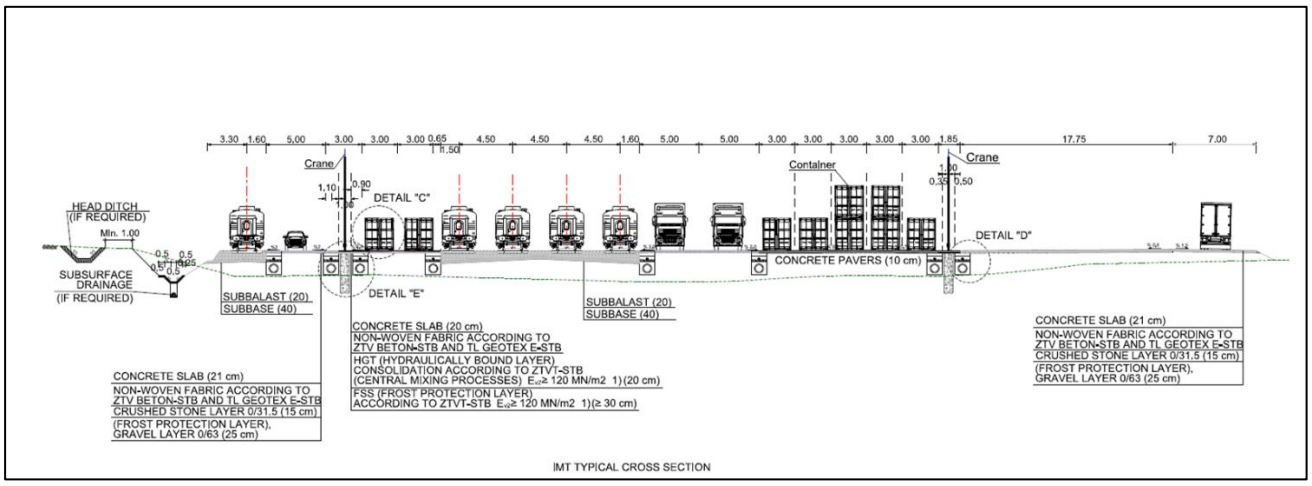


Figure 6. IMT typical cross section

The single track connecting the terminal with Çerkezköy shunting station shall be treated as an industrial track with a design speed of 30 km/h.

Shuttle trains arrive at a dedicated track of Çerkezköy shunting station. In Phase I of terminal operation, electrification is not envisaged, so after the locomotive is uncoupled, the set shall be hauled to the terminal plateau using the shunting locomotive.

The terminal railway plateau shall be located on a straight alignment and will consist of four handling tracks at a distance of 4.5m between (between the centre line of the first and the second track) and an additional maneuvering track. Between the handling tracks and the maneuvering track a rail-mounted gantry crane shall be installed.

At the railway line intersection with the existing drainage channels, the appropriate pipeline shall be designed.

Typical cross section

Typical cross sections shall be provided for the connecting track and the handling tracks at a 1:100 scale.

The connecting line shall be designed as a single track which located on both cut and embankment. Tracks within the terminal shall be designed on a straight alignment. Track formation width varies, depending on number of tracks and location of terminal lighting poles. Track formation shall be designed with a slope of 0%.

Longitudinal section

The elevation of the connecting line is determined by the elevation of the connecting point to Çerkezköy Shunting Station track.

Terminal tracks shall be designed with a longitudinal inclination of 0‰.

Superstructure

The superstructure of the connecting line and the railway tracks within the terminal consists of UIC60 type rails with elastic fastenings on concrete sleepers, based on crushed stone ballast.

Turnouts in the terminal are simple turnouts, type R=300 m 1/9, with manual setting mechanisms.

Welding of tracks and turnouts into long welded rail (LWR) shall be envisaged on the entire section.

Elements of the railway superstructure shall be in line with Technical Specifications for TCDD Route, Survey, Map and Application Works.

Substructure

Railway cross section slopes and the railway formation shall satisfy the conditions of carrying capacity, elasticity and stability, in accordance with the load model category, the planned volume of traffic and the determined geotechnical characteristics and conditions of the terrain and available materials. The structural elements of the railway formation shall be designed with a protective layer and intermediate layer. The new embankment shall be built on the previously well-prepared foundation ground. The method of laying the foundation ground shall be determined by the geotechnical study.

Geometry of the railway formation cross section shall be in line with Technical Specifications for TCDD Route, Survey, Map and Application Works.

Drainage

Hydraulic and Hydrological Studies will be completed before starting drainage design. All studies and designs related with drainage will be done according to the General Directorate of State Hydraulic Works (DSI) and the relevant authorities. Following values and evaluations are given as reference only.

Drainage of roadbed shall be through longitudinal and cross slopes of the formation, as well as by construction of drainage channels and drainage system.

Along the drainage, envisage standard manholes at distance of maximum 100 m.

Type and the location of the drainage channels and drainage system, including pipe beginning, end and bottom elevation, shall be shown in the cross-section drawings and other graphic documentation.

5 RAILWAY TRAFFIC AND TECHNOLOGY DESIGN

Railway design shall comply with the commonly used standards and requirements for railway transport according to the technical conditions issued by the TCDD.

Conditions issued by the TCDD for the Conceptual design, are given in Volume 5 of this Tender dossier as reference only.

TCDD is considering redevelopment, modernization and construction of a double track railway connecting Halkalı – Kapıkule and the state border, with maximum train speed of 200 km/h. Çerkezköy Shunting Station construction is supposed to be completed before IMT construction works commence. Therefore, IMT technical documents must comply with Çerkezköy Shunting Station design.

Contractor's obligation is to obtain consent from TCDD on all designs provided.

5.1 General information

Access railway track for IMT shall be divaricated from the main railway line infrastructure inside Çerkezköy Shunting Station.

IMT will include 5 rail tracks:

- 4 handling tracks (Tracks 1, 2, 3, 4) for loading/unloading of the ITUs
- 1 additional passing track (Track 5) for manoeuvring of the shunting locomotive

Schematic view of IMT is presented in Figure 7.

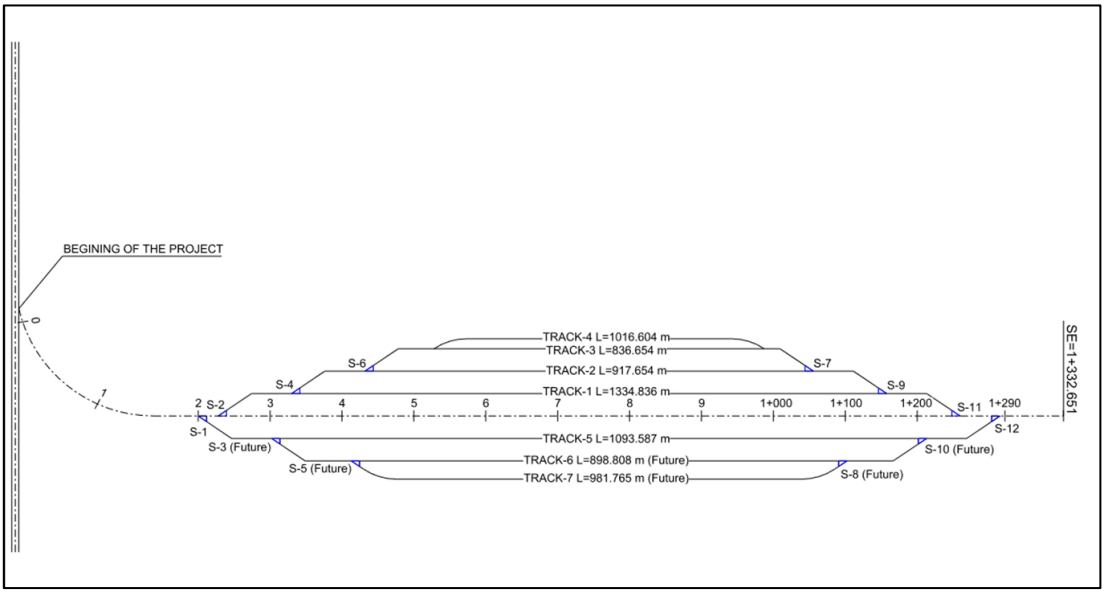


Figure 7. IMT layout

Length of the tracks

Usable length of the transhipment tracks inside IMT will be approximately 750 m.

The total length of the additional track for the shunting locomotive is approximately 830 m from the first entry switch of the terminal up to the buffer stop on its opposite end.

A shunting neck of 45m must be available for the maneuvering of the locomotive.

Electrification

Tracks of IMT are not electrified. Electrification of these tracks is planned for later stages of terminal development.

5.2 Construction elements of IMT's tracks

Switches

According to the Conceptual design, an industrial single-track connection to IMT is envisaged immediately after the Shunting Station by installing a diverting turnout.

Switches inside the terminal are S-1, S-2, S-4, S-6, S-7, S-9, S-11 and S-12. These switches (8 in total) are simple switches, type 1/9 R=300, with devices for a manual switching of positions.

Positions of all switches are shown in Figure 7, as presented above.

Interlocking devices for IMT tracks

Terminal switches, S-1, S-2, S-4, S-6, S-7, S-9, S-11 and S-12 will be manually controlled by the employees of the Terminal operating company.

Other equipment

An access gate, for the train exit/entry control to IMT from Çerkezköy Shunting Station will be installed in the starting point of the connecting (access) track.

This electrically controlled gate will be regularly closed and opened only when freight trains enter or exit IMT.

A suitable "RESTRICTED ACCESS / AUTHORIZED PERSONNEL ONLY" sign shall be placed on a gate.

Communication devices

Communication devices shall be defined during the design stage, according to the conditions issued by TCDD.

5.3 Servicing of IMT tracks

Description of operations

Train arrival/departure procedure and servicing of IMT tracks from the Shunting Station is as follows:

- IMT will be operated as part of the Shunting Station, in terms of signaling and telecommunications;
- Trains from all directions, loaded with ITUs for IMT, will terminate their trip in the Shunting Station on the tracks inside the freight tracks group (dedicated for such operations according to the Station Rule Book);
- Setting up and hauling back of manoeuvring composition (or group of wagons) on and off IMT tracks shall be done from the Shunting Station (from tracks dedicated for such operations according the Station Rule Book) by forming a riding path over the switches with engagement

of the shunting locomotive owned by the terminal operator and manoeuvring team from the Shunting Station;

- Train dispatcher of the Shunting Station will have to be informed about all manoeuvring movements for servicing IMT tracks. Communication procedures during IMT manoeuvring operations will be done the same way as regular manoeuvring operations, as defined in the Shunting Station Rule Book;
- Train departure (loaded with ITUs from IMT) will be done according to the procedures for departing directions from the Shunting Station, which will be defined in the Design for Construction Permit and in compliance with relevant Manuals and Ordinances of TCDD;
- Traffic, transport and technical-wagon operations will be done by the Shunting Station staff in accordance with the procedures for arriving and departing trains, which shall be subject of the Design for construction permit; Çerkezköy Shunting Station is not envisaged for such or similar operations at the moment;
- Customs procedures will be handled by IMT Customs services.

Technical and technological requirements

Technical and technological requirements must be in line with technical conditions issued by TCDD.

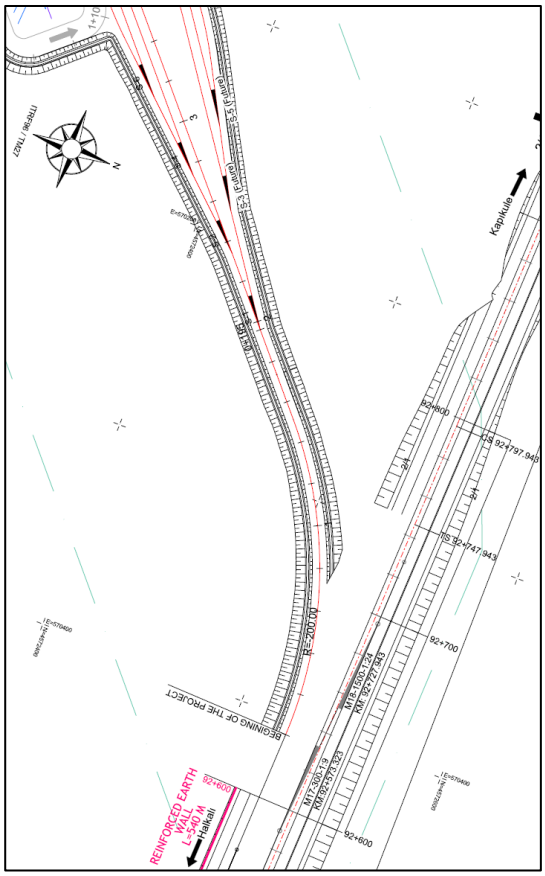


Figure 8. Schematic view of depart from Çerkezköy Shunting Station

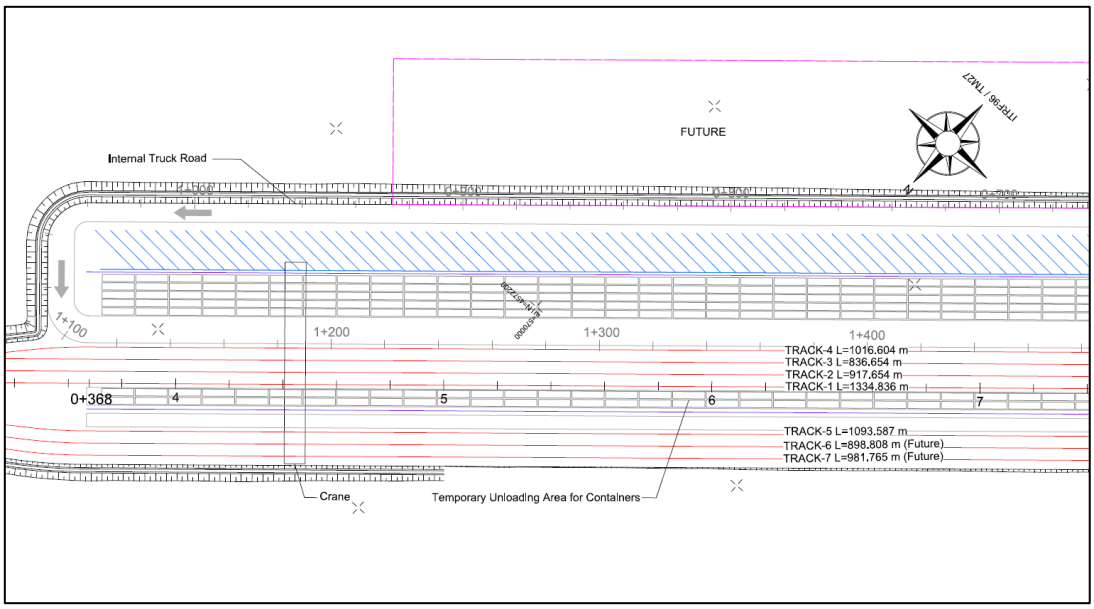


Figure 9. Lanes and future expansion lanes (IMT phase II)

6 ENERGY EFFICIENCY and SUSTAINABILITY

Global warming effects and security of energy supply created an obligation and urgency for energy efficiency construction. Paris Climate Agreement defined the master goal and responsibilities across regions and countries worldwide. Consequently, an application of the Paris Agreement resulted in frame regulations for building sector.

EU defines the goals with Green Deal frame and Turkey has updated its Building Energy Performance Regulation and nZEB definitions.

Energy efficiency for buildings and terminal operation sector for EU and Turkey are provided in following chapters of these ER.

6.1 Codes and regulations

6.1.1 EU perspective

Nearly zero-energy (emission) building (NZEB) means a building that has a very high energy performance, while the nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby. The Energy Performance of Buildings Directive (EPBD) requires that EU countries had to ensure that all new buildings were nearly zero-energy by the end of 2020 while all new public buildings had to be nearly zero-energy after 31 December 2018.

Energy performance is defined as 'the amount of energy needed to meet the energy demand associated with a typical use of the building which includes, inter alia, energy used for heating, cooling, ventilation, hot water and lighting'.

Under Annex I to the Regulation, the calculation of energy performance starts with the calculation of final energy needs for heating and cooling, and ends with the calculation of the net primary energy. The 'direction' of the calculation goes from the building's needs to the source (i.e. to the primary energy). The end objective of the energy performance calculation is to determine the annual overall energy use in net primary energy, which corresponds to energy use for heating, cooling, ventilation, hot water and lighting. This annual balancing is consistent with the current EPBD framework.

Considering the ongoing revision of the EPBD to sustain all new buildings zero-emission by 2030, The total annual primary energy use of a (new zero-emission) building shall comply with the maximum threshold of < 70 kWh/m2 year [1].

Total Primary Energy Use = ∑ [(Energy Demand / Efficiency) * PEF]

6.1.2 Turkish perspective

Turkey first defined energy efficiency in buildings with the Energy Efficiency Law (Law Nr. 5620/2007). This law defines the basic structure of the energy efficiency application strategy and should be applied with additional sectoral regulations:

[1] On 15 December 2021, the Commission presented a proposal for a revised directive of the European Parliament and of the Council to align the rules for the energy performance of buildings with the European Green Deal and decarbonise the EU's building stock by 2050. To harness the potential of faster action in the public sector, all new public buildings must be zero-emission already as of 2027.https://ec.europa.eu/energy/sites/default/files/annex-proposal-recast-energy-performance-of-buildings-directive.pdf

- Building Energy Performance Regulation 27075-2008 – First Release
- Building Energy Performance Regulation 27539-2010 – Revision 1
- Building Energy Performance Regulation 31755-2022 – Revision 2
- Building Energy Performance National Calculation Methodology 30227-2017 – First Release

With the latest revision of the Building Energy Performance Regulation following definitions have been added/revised;

- nZEB Definition added,
- nZEB buildings shall have min. B class Energy Performance Label,
- nZEB buildings shall be supplied with Renewable Energy Sources at least %10 of primary energy demand.

These definitions and applications follow the EU regulatory structure. Existing EU regulatory requirements are more stringent than the Turkish ones. EU regulations will be the base of these ER.

6.1.3 Terminal and crane operation efficiency

There is no specific legislation for intermodal terminals. However, the container handling operation is being defined under the port activities. According to OECD, environmental challenges of the ports include ship generated emissions, port activities and hinterland transportation. Following international legislation are defining limits of port emissions.

- 1964 Harbours Act
- 1972 London Convention
- 1973 MARPOL
- 1990 Environmental Protection Act
- 1994 ESPO Çevresel Uygulama Tüzüğü
- 1995 EMAS I
- 1996 ESPO-Ecoport
- 2001 EMAS II
- 2004 ISO 14001:2004
- 2009 EMAS III
- 2012 ESPO Green Guide
- 2015 ISO 14001:2015

The main energy consumption of the terminal is the crane operation. Limiting the emissions of the crane operation mainly depends on its operation philosophy. There are some main measures for energy efficiency, such as non-diesel motor usage, Eurocode compliance, etc. Those are already defined in the Gantry Crane output specifications.

The rest of the measures include optimizing the traveling distance of the crane, hoisting time and distance and container handling philosophy [2]. With these measures there is opportunity to cut ~%45 of energy consumed by the cranes per container[3].

[2] Container Loading Optimization in Rail–Truck Intermodal Terminals Considering Energy Consumption, Wang and Zhu, *Sustainability* 2019, *11*, 2383; doi:10.3390/su11082383
[3] Energy consumption and container terminal efficiency, Bulletin FAL, Issue Nr. 350-Number 6/2016

6.2 Energy efficiency goals

Reaching regulative energy efficiency requires some measures for construction material preferences and dynamic electro-mechanical system designs. Both material preferences and electro-mechanical system design are subject of design section but these preferences should cover below given requirements.

6.2.1 Building envelope prerequisites

Recommended U-Values (W/m2K) for IMT building components;

- Roofs - 0,10
- Walls – 0,13
- Windows – 0,80
- Floors to ground – 0,15
- Basement ceiling – 0,15 (if the basement is not conditioned),
- Basement ceiling - 0,35 (if the average temperature of the outside air is not below 15°C and there is temperature difference between basement and conditioned space above)

Insulation materials should be incombustible unless they are covered by min. 5 cm thick concrete (Fire Safety Regulations and Noise Control Regulations should be respected)

6.2.2 Efficiency target

As per above regulatory requirements the energy demand for total lighting, heating, hot water production, ventilation and cooling of the conditioned buildings in ITM should not exceed 30 kWh/m² year[4]. Above this limit, the demand shall be covered by local installed renewable energy systems.

6.3 Renewable energy

The energy used by the technical building systems is from delivered energy to the building or from onsite renewable energy (without fuels). 'Technical building system' means technical equipment for space heating, space cooling, ventilation, domestic hot water, built-in lighting, building automation and control, on-site electricity generation, or a combination thereof, including those systems using energy from renewable sources, of a building.

6.3.1 Renewable investment prerequisite

Building on the 20% target for 2020, the recast Renewable Energy Directive 2018/2001/EU established a new binding renewable energy target for the EU for 2030 of at least 32%, with a clause for a possible upwards revision by 2023. To meet the higher climate ambition, as presented in the European Green Deal in December 2019, further revisions of the directive are needed.

The Commission presented Europe's new 2030 climate targets, including a proposal for amending the Renewable Energy Directive, on 14 July 2021. It seeks to increase the current target to at least 40% renewable energy sources in the EU's overall energy mix by 2030. Following detailed impact assessment and public consultation, today's proposal outlines the following new targets at national level aimed at stimulating change for buildings, a new benchmark of 49% renewables use by 2030.

[4] *https://passivehouse.com/
*Multi-Comfort Houses Moderate & Hot Climate https://www.izocam.com.tr/en/sustainability/multi-comfort-houses

6.3.2 Renewable energy target

Considering the proposed changes for the new EU targets in renewables by 2030, the target for the share of renewables should be **above 40%** in the energy mix of IMT's buildings for which energy is used to condition the indoor climate[5].

This sets the requirement for renewable energy sources to a min 40 % share of the total final energy used for both crane operation and the building operation (which corresponds to energy demand for heating, cooling, ventilation, hot water and lighting).

6.3.3 Renewable systems

Solar Thermal and PhotoVoltaic systems shall be used for achieving Renewable Energy target for this project. Building Roofs will be used for application of both Solar Thermal and PV panels.

Solar Thermal Collectors:

Solar Thermal Collectors (STC) shall be used to support hot water production from renewable energy. Solar thermal supply system shall be used as pre-heater of DHW. The solar power system shall be designed according to a simulation software report, such as TSol. Total Solar Thermal Hot Water production shall cover min. %80 of Domestic Hot Water production on yearly basis. TSCs shall be placed on the roof of the buildings.

Flat-plate collectors shall be designed into the thermal collector system. The proposed collector active solar surface area shall be 2.25m2 and conversion factor is %77. Specific heat capacity of the collector shall then be 5,050J/(m2K).

The heat transfer medium shall be water with Polypropylene glycol. A dry cooler shall be added to the collector loop to prevent over-heating of the loop system for summertime with lower consumption.

Photo voltaic panels:

A grid-connected photovoltaic solar power plant system with a minimum installed power to adapt renewable energy target, will be installed at the facility. The solar panels will be placed on the campus building's roofs. Solar panels value(s) Standard Test Conditions will be minimum: 1000 W/m² radiation, 25°C module temperature and AM=1.5 spectrum conditions or similar equivalent. The efficiency of solar panels shall not be less than 20%. All equipment to be used within the scope of solar power plants will be compatible with each other. The solar power plant will be integrated into the facility SCADA system for remote monitoring and evaluation by the facility administration. All information about the solar power plant can be monitored from the SCADA system.

6.4 Energy consumption simulation and verification

6.4.1 Dynamic energy simulation

Consultant must use a dynamic energy simulation software (ASHRAE Guideline 14 verified, i.e. Carrier HAP, EnergyPlus, IESV, etc.) for simulating the yearly energy demand of the facility including crane and IMT operation. With this simulation approach, limitations of the Renewable Measures shall also be defined. The Consultant must use annual energy use hourly simulations. Guidance and requirements for

[5] *On 21 July 2021, the Commission presented a proposal for a revised directive, as part of the package to deliver on the European Green Deal. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021PC0557

modelling done with annual energy use hourly simulations can be found in the ASHRAE 90.1-2016 Appendix G.

6.4.2 Measurement and verification

The M&V period covers 12 months, starting on the date of building commissioning.

Conduct required measurements to prepare the M&V Report. Measurement and verification of savings will be made in accordance with TS ISO 50006 and IPMVP Option C (full facility renovation) the consultant should compare the baseline and final energy bills and adjust for degree days (HDD and CDD), changes in operating use, changes in energy prices, occupancy rates, etc.

Prepare M&V reports for all buildings renovated in one year after the renovation works are completed. The M&V reports need to be consistent with the format to be published by MENR[6].

The M&V report shall demonstrate the amount of savings realized by comparing the actual energy consumption with the reference energy consumption in which the necessary adjustments are made according to the TS ISO 50006 standard and IPMVP[7] will be calculated.

[6] Ministry of Energy and Natural Resources
[7] International Performance Measurement and Verification Protocol

7 MECHANICAL DESIGN

These ER aim to clarify the standards, regulations, assumptions and informative documents that mechanical building systems shall rely on.

ER have prioritized meeting local codes and guidance as a minimum requirement followed by a directed effort to meeting Eurocodes and international best practice. In that respect throughout the technical elaboration there are referrals to Turkish codes and Eurocodes in the mechanical design criteria noting that the selected criteria meet local guidance at all times but may be more stringent for installations.

There are also mechanical systems, where design approach is selected to be fully compliant with the local guidance and codes such as firefighting, as these types of installations vary widely among countries and standards or may be partial creating confusion. Under such circumstances, it is recommended to follow the local codes as a minimum. (e.g. Turkish norms for firefighting systems).

7.1 Functional areas of IMT for mechanical design consideration

Functional areas that form the basis of the mechanical design approach of IMT are listed below:

Building	**App. Area (m2)**
Administration building	1815
Customs building	1925
Customs warehouse	1650
Security building	18
Transformer building	112

Table 4: IMT functional areas for mechanical design

7.2 Climatological data

The building shall be located in Tekirdağ climatological zone. Based on the following location specifics, climatological data input presented in Table 5: Construction Location Climatology Data has been identified and used.

- Latitude: 41 North
- Longitude: 27 East
- Elevation: 10 meters

Summer and Winter Design Criteria Research

	MMO, Tekirdağ, 2001	ASHRAE CORLU, TURKEY (WMO: 170575) 2007	TS 3419 Tekirdağ, 1980	**Selected Weather Design Conditions**
Dry Bulb Temperature – Winter (°C)	-3,8	-5,8	-6	**-6**
Dry Bulb Temperature – Summer (°C)	29,1	32,9	33	**33**
Wet Bulb Temperature – Summer (°C)	22,9	20,6	25	**23**
Temperature Range (K)	9,1	10,8	9	**10**

Table 5 Construction location climatology data

Building cooling/heating loads and energy calculations shall be evaluated using a Conduction Transfer Function (CTF) methodology, which is widely used across the practice globally. The benefit of utilizing the CTF is that it can conveniently fit into any load and energy calculation technique to perform conduction heat transfer calculations. CTF based software alternatives have been used to calculate heating & cooling loads of the building to achieve realistic and year-long data.

CTF calculation method does not only use one max or min temperature level data during the year but it takes into consideration daily changes in a Typical Methodological Year (TMY). The simulation weather data shall be taken from ASHRAE resources. In that respect, it is considered more efficient than the static calculation approaches using one min and one max data to model the full year operational criteria.

7.3 External thermal insulation and air tightness of buildings

The thermal conductivity coefficients of the building construction elements shall be determined based on local guidance. On the other hand, we have identified the following target Thermal Conductivity (U) values for the envelope of the building, as per Energy Efficiency and nZEB measures. Please refer to 6.2.1 Building Envelope Prerequisites of this document.

We further note that limiting thermal bridges is a key consideration. There are two pillars to achieving this. First, by ensuring the continuity of the layer thermal insulation and secondly by thermal protection of all penetrations in the thermal envelope of the building. In that respect, the average value of the linear thermal transmittance shall be limited to $\psi med < 0.15$ W / (m.K) in the further developed design.

Design criteria is to meet a level of air tightness of the tire: $n50 \leq 0,6$ h-1. In that respect, all different construction elements shall be fixed with elastic elements and all gaps shall be filled with proper isolation material to achieve that.

7.4 Utilities

7.4.1 Natural gas connection

IMT shall be connected to the Municipality Natural Gas Network. Connection point is designed to fall within the premises through the pressure regulator. The consumption pressure shall be set at 1 bar.

Natural Gas supplied heating shall be the main heating system of the building. All gas infrastructure shall be designed/installed based on Natural Gas connection possibility. LNG facility may be implemented via build & operate model with LNG suppliers at the site if Natural Gas infrastructure may not be completed at the day of operation.

7.4.2 Water connection (City network)

City domestic water network will be used and connected to IMT facilities.

7.4.3 Sewage system - Wastewater

Site wastewater system shall be connected to the proposed municipality network.

7.4.4 Sewage system - stormwater and drainage

Excess rainwater drainage residual from gray water usage shall be connected to the proposed municipality network.

7.5 Aim, scope and guidance of the Mechanical Systems design

7.5.1 Aim

The design approach and aim of the mechanical building systems is to create safe and comfortable working conditions for the staff and an overall safe and healing environment for the patients.

7.5.2 Scope

Mechanical Building System design comprise the following components;

- Heating and Cooling Energy Supply
- Heating, Ventilating and Air Conditioning System
- Domestic Water Supply
- Drainage and Wastewater System
- Fire Fighting Systems
- Smoke Management

7.5.3 Technical standards and design code guidance

At the beginning of each system design section relevant codes and technical standards that shall guide the design have been provided. The mechanical system design approach has been based on the following Turkish norms, regulations and technical standards that are in force at the time of concept elaboration, as a minimum. Throughout this document, there are also references to international standards.

7.6 Heating, ventilating and air-conditioning system (HVAC)

There shall be two different HVAC systems in IMT. These are all-air system and terminal unit system. All air system shall be preferred for the zones thar requires more ventilation. Rest shall be designed with terminal units + outdoor air ventilation.

Shelters shall have their own packaged ventilation system. Outdoor air supply of this system shall be filtered by three staged filtering (Rough filter, Radioactive filter, Active Carbon banks). High pressure centrifugal fans that are capable of manual operation in case of electric power cut shall be used.

7.6.1 Standard and rules

The HVAC design is based on the following Turkish norms, regulations and technical standards:

- TS 825 Binalarda Isı Yalıtım Kuralları
- TS 1499 Kalorifer Radyatörlerini Tespit ve Yerleştirme Şekilleri
- TS 2164 Kalorifer Tesisatı Projelendirme Kuralları
- TS 2192 Kalorifer Tesisatı Yerleştirme Kuralları

- TS 3419 Havalandırma ve İklimlendirme Tesisleri – Projelendirme Kuralları
- TS 3420 Havalandırma ve İklimlendirme Tesislerini Yerleştirme Kuralları
- TS 3500 Tesisat Projeleri İçin Semboller
- TS3818Isıtma Sistemleri -Gazlı Merkezi Yakma Tesislerinin Tasarımı, Yerleştirilmesi ve Güvenlik Kuralları
- TS13384-1 Bacalar – Isı ve akışkan dinamiği hesaplama metotları – Bölüm 1: Tek ısıtma tertibatına bağlı bacalar
- TSEN 14336 Isıtma sistemleri - Binalar için - Su esaslı ısıtma sistemlerinin tesisi ve işletmeye alınması
- Makina Tesisat Genel Teknik Şartnamesi, T.C. Bayındırlık ve İskân Bakanlığı
- Tesisat Mühendisliği Uygulama Kitabı, Türk Tesisat Mühendisleri Derneği
- Kalorifer Tesisatı, TMMOB Makina Mühendisleri Odası
- Havalandırma Tesisatı, TMMOB Makina Mühendisleri Odası
- Klima Tesisatı, TMMOB Makina Mühendisleri Odası
- ASHRAE Standard 170-2013 Ventilation of Health Care Facilities
- EN ISO 16484 Building automation and control systems (BACS)
- EN 13384-1 Chimneys - Thermal and fluid dynamic calculation methods - Part 1: Chimneys serving one heating appliance.
- EN 13384-2 Chimneys - Thermal and fluid dynamic calculation methods - Part 2: Chimneys serving more than one heating appliance.
- EN 13779 Ventilation for non-residential buildings - Performance requirements for ventilation and room-conditioning systems.

7.6.2 Software and calculations

All calculations carried out shall be based on Thermal Resistance Values of the exterior surfaces that are specified in Section 7.3. Ventilation rates.

Conduction Transfer Function (CTF) based software, (i.e. Carrier HAP - Hourly Analysis Software) have been used for capacity calculation of the rooms and the Air Handling Unit systems.

ASHRAE Transfer Function method has been used for cooling calculations.

7.6.3 Supporting information

Ventilation shall be done through Galvanized Steel Air Ducts.

Design criteria shall be as provided in Table 6.

Velocity limits inside the air ducts;

Location	Max. Velocity (m/s)
Supply/return Diffusers / Grills	2,5
Air Ducts / Branchs	6,0
Air Duct / Mains	10
Air Duct / Smoke exhaust	15
Outdoor Air Intake / Exhaust grills	4

Table 6 Air Duct velocity limits

7.6.4 Design criteria

Following standards shall be used to determine ventilation rate and indoor air temperature/humidity limits. TS 2164 Kalorifer Tesisatı Projelendirme Kuralları & ASHRAE Standard 55 Thermal Environmental Conditions for Human Occupancy.

Locally used Recknagel referenced temperature and relative humidity limits are comparable to the other local code values. ASHRAE references are more detailed with respect to listed functions of each room, therefore selected to guide the design process.

7.7 Heating and cooling energy supply

Heating and cooling Energy shall be produced on site. Heating and cooling energy shall be produced with the combination of multiple sources listed below;

Source	Energy Output
Boilers (Natural Gas)	Heating
Solar Thermal Collectors	Heating (DHW only)
VRF (Centralized Air Conditioner)	Cooling

Table 3 Energy sources

7.7.1 Hot water boilers

Heating energy shall be produced by Natural Gas Boilers. Boiler room shall be placed at the basement floor of the related building/s. The circulation pumps, distribution collectors and all main equipment shall be stored in the same room.

Floor Type Steel Boilers shall be used. Operation pressure shall be 6 bars. Pressurization of the heating media shall be done via Packaged Expansion (Pressurization) System with frequency drive pumps. The closed pressurized tanks shall be designed with low return temperature protection valves, expansion tanks, safety valves to ascertain safe operations.

Each boiler shall have its own stainless-steel chimney, shall rise above the related building's roof independently. Boilers shall be fitted with Chimney Heat Recuperators to collect chimney condensation and to recover the waste energy. Burners shall be capacity controlled.

All heating and cooling system media (water) shall be produced at the boiler room/s by softening and filtering. Heating system shall also have Ph control and automatic dosing system against corrosion.

7.7.2 Domestic hot water system (DHW)

Domestic Hot Water (DHW) shall be produced by plate type heat exchangers with heating energy. Produced hot water shall be stored in accumulation tanks to balance instantaneous excess usage.

The DHW shall be produced by heater exchangers and shall have tanks storage to supply peak consumptions.

DHW network shall be provided with a return pipe to circulate by means of a circulating pump which shall sustain water pressure. DHW network shall be fitted with a temperature regulator, piping insulation and balancing valves to avoid loss of heat and maintain the DHW circulating in every pipe of the system for immediate access to hot water facility.

The design and calculation of hot water installations must guarantee in all circumstances a drinking water and adequate supply. Also, the design and materials used must ensure a proper functioning and durability of facilities during the lifetime of the facility.

The quantities of hot water for bed consumptions and kitchens accumulation are indicated in the standard "TS1258".

7.7.2.1 Solar thermal collector (STC)

Solar Thermal Collectors (STC) shall be used to support hot water production from renewable energy. Solar thermal supply system shall be used as pre-heater of DHW. The solar power system shall be designed according to a simulation software report, such as TSol. TSCs shall be placed on the roof of two technical penthouses above the main hospital building except where the helipad is and at a safe distance to it.

Flat-plate collectors shall be designed into the thermal collector system. The proposed collector active solar surface area shall be 2.25m2 and conversion factor is %77. Specific heat capacity of the collector shall then be 5,050J/(m^2K).

The heat transfer medium shall be water with Polypropylene glycol. A dry cooler shall be added to the collector loop to prevent over-heating of the loop system for summertime with lower consumption.

7.7.3 nZEB (Near Zero Energy Building) requirement & energy efficient design criteria

An energy efficient design criteria definition has been created in parallel with the development of the architectural, structural and MEP output specifications of IMT. This is to address the requirement to reduce the overall carbon footprint of the proposed development and to identify solutions towards the improvement of its energy efficiency as the design further develops. Please refer to the Section 6 Energy Efficiency and Sustainability.

7.7.3.1 Building insulation, shading and glass selection

The exterior envelope insulation type, characteristics and the thicknesses of the building have a major effect on the overall energy demand of the main hospital building. In that respect, one of the most important elements of reducing energy demand shall be to create a high thermal resistant building. Selected thermal insulations and targeted thermal conductivity values are given in 7.3 External Thermal Insulation and Air Tightness of The Building.

7.7.3.2 Efficient heating & cooling energy production & distribution and control

A combined heating and cooling energy production strategy shall be used for achieving nZEB requirements. More than one source shall be designed with a harmony and controlled via a capable Building Management System (BMS).

Natural gas and electricity shall be the main sources of energy for IMT. The efficient heating and cooling energy production systems shall be used in developing the project. Additionally, waste heat of the

production systems (i.e. chimneys) shall be recovered to the system. All heating/cooling energy production equipment shall be selected with high efficiency.

All Air Handling Units (AHU) with outdoor air supply shall use a heat recovery system with more than 80% efficiency.

Frequency controlled circulation pumps shall be used to deliver cooled water to the main hospital building. Capacity control of the consumers shall be controlled via two-way motorized valves. So, the cooling hydronics shall have variable flow to suppress circulation pumps electric energy consumption.

Additionally, at Terminal Unit systems outdoor air supply to the common rooms (i.e. halls, waiting rooms, meeting rooms, etc.) shall be controlled via VAV (Variable Air Volume) boxes with the reference of the rooms IAQ (Indoor Air Quality) sensors to supply adequate air to the room.

A Building Management System (BMS) shall be designed to control building's mechanical functions.

BMS should be capable of deciding the priority of the energy production methodologies as per instantaneous production efficiency considerations.

7.8 Domestic water supply system

Domestic water and domestic hot water shall be supplied to the all-user points in the building.

7.8.1 Standards and rules

- TS EN 806 Bina içi tesisatı – İçme ve kullanma sularının taşınması için özellikler
- TS 1258 Temiz su Tesisatı Hesap Kuralları
- Makine Tesisat Genel Teknik Şartnamesi, T.C. Çevre, şehircilik ve İklim Değişikliği Bakanlığı
- Sıhhi Tesisat Proje Hazırlama Teknik Esasları, TMMOB Makina Mühendisleri Odası
- Tesisat Mühendisliği Uygulama Kitabı, Türk Tesisat Mühendisleri Derneği
- EN 806 - 1 Specifications for installations inside buildings conveying water for human consumption - Part 1: General.
- EN 806 - 2 Specification for installations inside buildings conveying water for human consumption - Part 2: Design
- EN 806 - 3 Specification for installations inside buildings conveying water for human consumption - Part 3: Pipe sizing. Simplified method
- EN 806 - 4 Specifications for installations inside buildings conveying water for human Consumption - Part 4: Installation
- EN 805 Water supply- Requirements for systems and components outside buildings
- ISO 9459 - 1 Solar heating - Domestic water heating systems-Part 1: Performance rating procedure using indoor test methods
- ISO 9459 - 2 Solar Heating-Domestic Water Heating Systems-Part 2: Outdoor Test Methods For System Performance Characterization and Yearly Performance Prediction of Solar-Only Systems
- ISO 9459 - 3 Solar heating domestic water heating systems part 3: Performance test for solar plus supplementary systems

7.8.2 Filtration and softening

All building water system shall be filtered and softened.

The treatment plant shall comprise two softeners. These are to remove the elements of water hardness and cause fouling (calcium and magnesium). These softeners shall be connected in parallel, with the

possibility of simultaneous and alternating operations. Each shall have a capacity of 100% of the estimated need. They shall be to the following material specification as a minimum:

- Columns: The resin columns shall be constructed of fiber reinforced internally coated glass and polyethylene essential to maintain water free of contaminants. It shall have upper and lower manifolds for even water distribution inside.
- Resin: It shall be a polymer of styrene and divinylbenzene. The polymer resin gives a high mechanical resistance to both water flows as osmotic shock produced during regeneration with sodium chloride.
- Valves: In order to direct water through the different circuits necessary for service operations and regeneration, each column shall have its own multi-way valve.
- Salt intake system: A brine tank shall be incorporated for storing the brine needed for the regeneration. It shall be equipped with all the accessories for the aspiration of the brine.
- Automation: installation programming shall be from the electronic control unit which controls the multivalve. This let manually or automatically activate the unit and programing the cycle time during each phase of regeneration.

7.8.3 Water storage

There shall be 4 separate water tanks. These are:

- One raw water from city network, concrete
- One main tank for daily usage softened & filtered as potable water, stainless steel
- One for irrigation
- Two identical for firefighting purposes 7.11.9 Fire Water Tank.
- Storm water collection tank for irrigation purposes, buried underground on the site, concrete.

Domestic water shall be supplied from the city water network. There shall be one raw water tank (which the city network water shall be stored) and one softened water tank as potable water (which the water shall be stored after softening & filtering treatment).

Once the water is softened it shall be stored in the domestic water tank for daily usage.

Potable water shall be taken from the main manifold and pumped to the system for distribution. A separate pump system shall support chlorination and recirculation for each tank.

Chlorination:

All tanks of domestic water shall be provided with a chlorination and recirculation system to guarantee brackish water.

- System description: stored water recirculation, measurement and chlorine dosing automatically.
- Chlorine dosing: with storage tank and dosing pump, to adjust a concentration in the water to achieve proper water to legionellosis prevention.
- Recirculation considered: 5% of total stored water.

7.8.4 Booster sets

Number of booster sets between the raw water tanks and softening system shall be provided. Additionally, there shall be booster sets for main building distribution, irrigation, and other water distribution systems. All booster sets shall follow the following guidelines.

Each system shall be provided with 3 pumps, each sized to 50% of the total estimated demand. Pumps shall be alternated to work sequentially so that the wear and expected useful lives of each pump are equal and extended.

The pumps shall be feed from the suction manifold of the storage tank and pump to the delivery manifold in which different supply networks shall be connected.

Pumps shall be designed with variable speed function to always approximating as closely as possible to the pump flow. In addition, the supply shall be achieved with a stable pressure.

In the switchboard shall be a processor, display on the front, for programming and operating parameters. This processor shall, by a sensor installed on the delivery manifold, receive information continuously supply pressure. Depending on this parameter and the programmed set, it shall maintain, increase or decrease the frequency of the electric current supplied to the pump controlled by varying the speed and consequently the flow rate provided.

In case of failure of variable frequency system, a pressure switch system shall be installed to operate the pumps independently.

7.8.5 External irrigation system

The irrigation areas and water requirements shall be defined according to the ultimate landscaping design and site layout.

The system shall be fully automatic and all components shall be selected to ensure even distribution without overspray or run off waste. The system shall provide correct quantities of water to promote optimum plant growth.

From the water storage building, an independent piping shall be installed to provide water to each irrigation area. Irrigation booster set will supply the water to the irrigation pipes from the raw water tank. This piping shall go through the technical gallery and if necessary, also buried to reach the supply point.

Additionally, rain water from the roof will be collected in an underground buried concrete tank before discharging to drainage. This tank will include two submersible pumps for supplying the irrigation line also.

From the irrigation stations one pipe network of Low-Density Polyethylene for a nominal pressure of 10 atmospheres where piping lines shall be located with the droppers.

The piping lines are made on Low Density Polyethylene, 20 mm diameter, and shall be provided along the grass in 50 cm pattern. Self-compensating drippers with filter incorporated to prevent clogging. Its design flow is 2 litres / hour. Drippers shall be integrated into the pipe, resulting a continuous pipe.

Depending on the water needs of the garden, it shall be established the irrigation time on each area. The irrigation shall be programmed during the night time.

7.9 Grey and rain water

For the usage of wastewater and rain water, re-use shall be foreseen.

The supply of irrigation water and water consumption is necessary for the survival of the plant material. The establishment of automatic irrigation and drip irrigation systems should lead to reduce the water consumption for irrigation.

For all buildings and for entire IMT, the contractor is expected to provide hydraulic calculations for maximum re-usage of grey and rain water through irrigation system and sanitary installations. It is expected that the Contractor's design shall assure 95% re-usage of grey and rain water.

For this purpose, rain water and grey water, shall be stored in tanks and transferred to the irrigation and closets reservations systems.

It is also necessary to establish of a waste management facility within IMT, and placing the glass, paper, plastic waste containers, at certain collection points.

The Contractor shall take in to account in his design that rain water will be used for irrigation of IMT green areas.

Treated greywater shall be also used for toilet flushing, general washing and irrigation. However, the use of treated greywater for general washing at markets and food establishments is not allowed.

Applicable standard for drainage is EN 12056.

7.9.1 Treatment process

Greywater treatment system should be designed with a biological & filtration (microfiltration, ultrafiltration or membrane filtration) steps and disinfection processes capable of producing a stable final treated greywater quality that comply with the required quality standards.

7.9.2 Sizing

Depending on the type of greywater system, the optimum storage capacity for treated greywater should be determined by the following factors

- the peak treatment rate & capacity of the plant;
- the demand, usage or behavior patterns.

The storage of treated greywater shall be minimized to that needed for immediate use. As there is generally a ready supply of untreated greywater, storage equal to a 1 day's use is normally considered sufficient.

7.10 Drainage and sewage system

Drainage and the sewage system of IMT shall be designed to its battery limits, ie. the first manhole outside the main hospital building, as per the guidance provided in this section.

7.10.1 Standards and rules

- EN 12050-1 Wastewater lifting plants for buildings and sites - Principles of construction and testing - Part 1: Lifting plants for wastewater containing fecal matter
- EN 12056-1 Gravity Drainage Systems Inside Buildings - Part 1: General and Performance Requirements
- EN 12056-2 Gravity Drainage Systems Inside Buildings - Part 2: Sanitary Pipework, Layout and Calculation
- EN 12056-3 Gravity Drainage Systems Inside Buildings - Part 3: Roof Drainage, Layout and Calculation
- EN 12056-4 Gravity Drainage Systems Inside Buildings - Part 4: Wastewater Lifting Plants - Layout and Calculation

- EN 12056-5 Gravity drainage systems inside buildings. Part 5: Installation and testing, instructions for operation, maintenance and use
- EN 752-1 Drain and Sewer Systems Outside Buildings - Part 1: Generalities and Definitions
- EN 752-2 Drain and Sewer Systems Outside Buildings - Part 2: Generalities and Definitions
- EN 752-3 Drain and Sewer Systems Outside Buildings - Part 3: Planning
- EN 752-4 Drain and Sewer Systems Outside Buildings - Part 4: Hydraulic Design and Environmental Considerations
- EN 752-5 Drain and Sewer Systems Outside Building - Part 5: Rehabilitation
- EN 752-6 Drain and Sewer Systems Outside Buildings - Part 6: Pumping Installations

7.10.2 Design

Internal sewage system definition includes the building sewage and drainage points of IMT. All drainage points of the buildings shall be collected via vertical risers. All vertical risers shall have their own vent through roof to the atmosphere. All horizontal risers more than 4m long shall have their own vent with automatic vent equipment.

The sewage flow of ground floor and above shall be diverted to the city sewage network directly, from the first basement floor ceiling level of the main hospital building.

The sewage flow of the basement floors shall be diverted to the Packaged Sewage Tank for pumping the sewage to the city network. Flowrate (Q) shall be calculated with the above given formula.

7.10.3 Storm water system

A complete rainwater pipe work system shall be provided to intercept all water collected from each building. All roof and paved areas shall be designed and graded to avoid ponding. The storm water drainage system shall be designed to allow self-cleansing fluid velocities and provide a non-clogging system.

Residual building storm water discharge shall be connected to external storm drainage network after gray water usage. With a flexible conduit to absorb the movement of earthquakes. It is forbidden to discharge rainwater into the sewer pipe.

7.10.4 Treatment of drainage and sewage

From the building, the following sewage categories shall be discharged through the sewage collector into the city's sewerage network and the related treatment shall be applied:

- uncontaminated domestic sewage arising from the operation of sanitary objects; shall be directly connected,
- wastewater filled with grease from the kitchen and the canteen; these waters shall be passed through the grease separator before being discharged into the sewerage network;
- wastewater filled with petroleum product (oil, diesel, etc.) from the site; these waters shall be passed through the petroleum product separator before being discharged into the sewerage network.

7.11 Firefighting systems

IMT is classified mainly as an office and warehouse buildings and container handling area.

The following components of the mechanical installations are considered part of the firefighting system;

- Automatic Sprinkler System

- Fire Hoses (Internal) & External Hydrants System
- Portable Extinguishers

7.11.1 Standards and rules

The following are the local codes that are related to firefighting system installations:

- 2015 / 7401 Binaların Yangından Korunması Hakkında Yönetmelik
- TS EN 12845 Sabit yangın söndürme sistemleri – Otomatik sprinkler sistemleri – Tasarım, montaj ve bakım
- TS EN 12101-6Duman ve ısı kontrol sistemleri – Bölüm 6: Basınç farkı sistemleri için teknik özellikler - Kitler

There are supportive European Codes that shall be considered. These are:

- EN 671-1 Fixed Fire Fighting Systems - Hose Systems - Part 1: Hose Reels with Semi-Rigid Hose
- EN 671-2 Fixed Fire Fighting Systems - Hose Systems - Part 2: Hose Systems with Lay-Flat Hose
- EN 671-3 Fixed Fire Fighting Systems - Hose Systems - Part 3: Maintenance of Hose Reels with Semi-Rigid Hose and Hose Systems with Lay-Flat Hose
- EN 15004 Fixed Firefighting Systems – Gas Extinguishing Systems.
- EN 3 Portable Fire Extinguisher

Furthermore, the following international codes are imperative to achieve best practices in hospital firefighting design. Supportive international codes can be listed as follows:

- NFPA 1 Uniform Fire Code™
- NFPA 10 Standard for Portable Fire Extinguishers
- NFPA 13 Standard for the Installation of Sprinkler Systems
- NFPA 14 Standard for the Installation of Standpipe and Hose Systems
- NFPA 17A Standard for Dry Chemical Extinguishing Systems
- NFPA 20 Standard for the Installation of Stationary Pumps for Fire Protection
- NFPA 22 Standard for Water Tanks for Private Fire Protection
- NFPA 90A Standard for the Installation of Air-Conditioning and Ventilating Systems
- NFPA 92AStandard for Smoke-Control Systems Utilizing Barriers and Pressure Differences
- NFPA 92BStandard for Smoke Management Systems in Malls, Atria, and Large Spaces
- NFPA 101 Life Safety Code
- NFPA 110 Standard for Emergency and Standby Power Systems
- NFPA 204 Standard for Smoke and Heat Venting

7.11.2 Automatic sprinkler system

Wet pipe sprinkler system shall be designed. Table 7 provides criteria to be respected during design elaboration.

Automatic Sprinkler System Design Criteria		**Based on Standard/Article**
System type	Wet pipe Sprinkler System	-
Areas to be applied	Warehouse	-
System flow	shall be determined by hydraulic calculation	-
System pressure[1]	At the Sprinkler outlet min. 0.35 bar	

			EN 12845 Article 13.4.4
Design type	With hydraulic calculation - Area/Density Method		-
Minimum pipe diameter[2]	DN20		EN 12845 Article 13.4.5
Sprinkler-Ceiling Distance[3]	Min. 2,5 cm, Max. 45 cm		EN 12845 Article 12.4.2
Pipe type	Black Steel Pipe		-
Pipe joining method[4]	Screwed (forDN50 and smaller diameter pipes)		-
	Welded (for DN65 and bigger diameter pipes)		-
Hazard Class and water design density	Shall be determined as per stored material	tbd	EN 12845 Table 3
Sprinkler area of operation		tbd	EN 12845 Table 3
Coverage area per sprinkler		tbd	EN 12845 Table 19
Distance between two sprinklers		tbd	EN 12845 Table 19 and
		tbd	Article 12.3
Sprinkler between wall and sprinkler		tbd	EN 12845 Table 19
Duration		tbd	EN 12845 Article 8.1.1
Coverage area per Alarm Valve[5]			
		tbd	EN 12845 Table 17

Table 7 Sprinkler system specifications

After the entire building sprinkler design is completed, the exact capacity of the required flow shall be calculated.

7.11.2.1 Possible types of sprinklers

Sprinkler Type	RTI	K	Temp. ºC
Upright sprinkler	Quick response	80	93
Upright sprinkler	Standard response	80	93
Upright sprinkler	Standard response	80	93
Pendent sprinkler	Quick response	80	68
Pendent sprinkler	Standard response	80	93
Pendent sprinkler	Quick response	80	79

Table 8 Possible types of sprinklers

7.11.3 Landing valve system

400 lt/min. capacity Landing valve system shall be designed. Valves are placed in fire escape stairs. It shall be considered that one valve shall be open in case of fire for 1 hour.

Water can be sprayed directly after opening the FS valve at a rate of 400 lt/min, which shall be the design flowrate criteria. The system details are depicted in Table 9.

Design standard	
User	Trained Staff / Fire Department
Hose flow	400 lt/min
No. of hose to be used	1 each
System flow demand	400 lt/min
System pressure	
min.	400 kPa
max.	900 kPa
Flow demand duration	60 min

System type	Dry Pipe / Shall be supplied from Fire Brigade (Truck)
Piping	EN10255 Galvanized Black Steel, Coupling connection
Water supply	Fire Truck – Syamesee connection

Table 9 Landing valve system design criteria

7.11.4 Fire hose system – Internal Hydrants

In addition to the sprinkler system, the firefighting system shall be supported by fire hose cabinets. Each fire hose cabinet shall contain 30 meters of hose with 25 mm diameter, and 6.0 kg dry type fire extinguisher. Water can be sprayed directly after opening the FHC valve. The design flowrate shall be 126 lt/min for each point.

Moreover, the car park floors shall be furnished with Dry Pipe Fire Hose system due to risk of frost. Since there is no risk of frost on the main hospital interior floors, wet pipe fire hose system shall be implemented. The system details are depicted in Table 10 and Table 11.

Design criteria standard	EN 671-1
Design standard	Local Codes shall be applied.
User	Staff
Hose flow	100 L/min
No. of hose to be used	2 each
System flow demand	400 L/min
System pressure	min. 400 Pa, max.700 kPa (at the inlet)
Flow demand duration	tbd
System type	Wet Pipe
Piping	EN10255 Painted or Galvanized Black Steel Pipe
Water supply	Fire Fighting Pumps via Fire Water Tank

Table 10 Fire hose system design criteria

Hose length	30m
Hose type	DN25 Semi-rigid Rubber Hose
Hose carrier	Hose Reel
Hose cabinet hardware	Portable Extinguisher (6 Kg, ABC-Dry Chemical)
Hose connection	DN 65 Storz over Angle Valve
Nozzle	Adjustable 3 position nozzle
Approval	EN 671

Table 11 Hose cabinet specifications

7.11.5 External hydrant system

Firefighting installations system shall be supported by external hydrant system to suppress possible facade fire or roof fire. The hydrants shall be designed for the purpose of intervention of the fire department. The hydrant system shall be wet piped, the system shall be activated when any hydrant is opened. Hydrant system will cover all IMT area not only buildings. Container handling area may include underground hydrants. When connecting the hydrant line from the main fire collector, a butterfly valve with monitoring key shall be used.

The system design criteria are depicted in *Table 12*.

Design criteria	EN 12845

User	Trained Staff / Fire Department
System Flow demand	1,900 lt/min
System pressure	
min.	700 kPa
Flow demand duration	tbd
System type	Wet Pipe
Piping	EN10255 Painted or Galvanized Black Steel Pipe
Water supply	Fire Fighting Pumps via Fire Water Tank

Table 12 Hydrant system design criteria

The fire hydrant cabinet specifications shall be as depicted in *Table 13*.

Hose length	30m
Hose type	DN65 Flat Hose
Hose carrier	Hose Reel
Hose connection	DN 65, Nozzle (2 each)

Table 13 Fire hydrant cabinet specifications

7.11.6 Automatic gas suppression system

Archives, Server and Data Cabinet Rooms, and the rooms with valuable information, shall be protected with Gas Suppression system. Gas Suppression system shall serve the rooms, suspended ceiling and raised access floors as well. Gas suppression cylinders shall be stored inside the rooms. Automation panel and control shall be jointly assembled with the cylinders. When activated, an alarm shall be displayed in the Fire Alarm Panel.

System specifications shall be as depicted in Table 14.

Design criteria	NFPA 2001
System type	Total Flooding
Combustible	Electrical and Solid Material Fires
Suppression agent	Clean Agent
Piping	Seamless Steel Pipe
Gas release	By nozzles

Table 14 *Automatic gas suppression system*

Actuation System specifications shall be as depicted in Table 15.

Automatically initiated	Electrically automatic
Manually initiated	Mechanical
Manually initiated	Electrical

Table 15 *Actuation system*

7.11.7 Portable fire extinguishers

Portable extinguishers shall be provided to maintain fast manual intervention in case of a fire in the buildings.

Portable extinguisher type shall be selected depending on the expected type of fire. Extinguishers shall be located inside the cabinets.

Capacity and the quantity of the extinguishers shall be chosen according to the occupancy. A minimum of one 6 kg extinguisher per 250m2 closed area shall be provided.

20 mobile 12 kg fire extinguishers with wheels shall also be placed at each floor.

Selected Fire Extinguisher specifications are depicted in Table 16.

Device Type	Portable
Fire extinguisher S6, ABC powder	3 each
Type of extinguishing agent	Powder ABC
Extinguishing media quantity	6 kg
Standard	EN 3

Table 16 *Fire extinguisher specifications*

Selected 12 kg Wheeled Fire Extinguisher specifications are depicted in Table 17.

Device Type	Portable – Wheeled
Fire extinguisher S6, ABC powder	3 each
Type of extinguishing agent	Powder ABC
Extinguishing media quantity	12 kg
Standard	EN 3

Table 17 *12 kg Wheeled fire extinguisher specifications*

7.11.8 Firefighting system pumps

Horizontal split-case (or end suction) 2 electric, 1 set jockey pump shall be used and pressure tank & controllers shall be used. The capacity of the fire pumps shall be determined in accordance with the results of hydraulic calculations.

As per NFPA 20 combined system can be applied. Fire pumps, electric panels and connected components shall be UL listed and FM approved.

Supervisory Power (primary, secondary) shall be supplied.

7.11.8.1 Valves

OS&Y valves that come with supervisory switches at suction side and butterfly valves that come with supervisory switches at the discharge sides shall be used. All supervisory switches shall be connected to fire alarm system for supervision.

7.11.9 Fire water tank

ire water tanks shall have two compartments to enable maintenance.

Fire water tanks shall be refreshed with potable water system, and it shall use a free flow outlet to avoid bacterial contamination of the potable water. Chlorine adding and water tank recirculation pumps shall be used as well.

Please refer to the Section 7.8.3 Water storage

7.12 Smoke control system

7.12.1 Smoke exhaust system

The main smoke exhaust system shall be designed for the storage buildings. Additionally, there shall be dedicated minor smoke exhaust systems for garbage rooms, archives and battery rooms. Local code guidance shall be followed for these rooms (i.e. ATEX Fan, H2 sensor, etc.). Smoke exhaust system shall be designed according to architectural zoning plan and sprinkler coverage.

There shall also be a make-up air supply to the compartments where smoke is being exhausted. There shall be dedicated make-up air fans and smoke dampers that shall control each supply zone.

7.12.2 Pressurization system

Emergency staircases and elevators shall be pressurized for preventing smoke penetration as per Turkish Fire Protection Regulation. For the calculation of these systems EN 12101-6 standard, System Class C shall be used. Pressurization shall be done with a frequency-controlled fan placed on the roof, near to the staircase/elevator. Each fan shall have a smoke sensor at fresh air intake and run based on a differential pressure logic.

7.12.2.1 Standards and rules

The main standard applicable to the works shall be EN 12101-6 Smoke and Heat Control Systems Specification for pressure differential systems. This European Standard, a part of the BS EN 12101 series, specifies pressure differential systems designed to hold back smoke at a leaky physical barrier in a building, such as a door (either open or closed) or other similarly restricted openings. It covers methods for calculating the parameters of pressure differential smoke control systems as part of the design procedure.

7.13 Building Management (Automation) system

A state-of-the-art computerized system shall be designed to achieve all energy management functions and to monitor, operate and control all mechanical and electrical equipment within the buildings.

The system shall utilize "open" communication protocols, such as BACnet, to minimize the costs of providing full integration and to allow interoperability between buildings and control vendors. The Building Automation System (BAS) shall also have energy management and monitoring software. The system shall consist of series of direct digital controllers by a local area network. The BAS system shall be accessible through a web browser. The system shall have a graphical user interface and must offer trending, scheduling, downloading memory to field devices, real-time "live" graphic programs, parameter changes of properties, set point adjustments, alarm/event information, confirmation of operators, and execution of global commands

7.13.1 Level of integration

A high level of integration shall be provided between controls systems throughout the buildings. Fire alarm, security, and other miscellaneous systems shall have independent control panels and networks. The Izmir complex BAS central control and monitoring station shall be located in the technical building, which shall be networked with the local control stations within each building and/or block.

7.13.2 Energy management and conservation

HVAC control algorithms shall be included to optimize start/stop for terminal unit systems, air handling units and all associated equipment and feed forward controls based on predicted weather patterns. For

spaces with occupancies less than 24 hours per day, optimal start/stop shall calculate the earliest time systems can be shut down prior to the end of occupancy hours and the latest time systems can start up in the morning with the aim of minimizing equipment run time without letting space conditions drift outside of the comfort set points. Weather prediction programs store historic weather data in the processor memory and use this information to anticipate peaks or part load conditions. The BAS shall have the capability to allow building staff to measure energy consumption and monitor performance, which is critical to the overall success of the system. The BAS shall measure key points in the buildings system to monitor part-load operation and adjust system set points to match system capacity to load demands. Energy management measurements shall be totalized and trended in both instantaneous and time-based numbers for chillers, air handling units and pumps. Energy monitoring data shall be automatically converted to standard database and spreadsheet format and transmitted to a designated workstation. Energy points are those points that shall be monitored.

7.13.3 Maintenance and scheduling

The BAS shall include programs for control that switch selected equipment from operating mode to standby on a scheduled basis. Also, programs that provide maintenance schedules for equipment in every building system shall be included, complete with information on what parts and tools are needed to perform each task.

7.13.4 System sonfiguration

The BAS shall be designed to have a supervisory centralized concept along with Distributed Intelligence.

Such configuration shall have the advantage of maintaining a standalone configuration for the different building systems that can function even if the main computer fails. It also has the power of distributed intelligence, which frees the main computer from the tasks, and which can be handled by the localized

7.13.5 Control and monitoring points

The following outlines the minimum control and monitoring points for typical HVAC equipment:

Air handling Units

- Start/Stop
- Heating Control
- Cooling Control
- Humidification control
- Supply Air Reset
- Static Pressure reset
- Building and Zone
- Pressurization Control
- Damper Position
- Supply Air Discharge Temp
- Return Air Temp
- Supply Air Flow Rate
- Filter Differential Pressure
- Air Flow Measuring Station

Pumps

- Start/Stop

- Discharge Pressure Reset
- Differential Pressure
- Flow

Terminal Units

- Start/Stop
- Discharge temp reset
- Supply Volume Reset
- Heating control
- Zone Temp Reset
- Minimum Volume Reset
- Zone Temp
- Supply Air Reset

8 ELECTRICAL DESIGN

8.1 General

The Electrical systems shall be able to support the current state-of-the-art for facility with additional capacity and flexibility for future advancements in technology.

In design and implementation, it will be set out with the aim of making a highly efficient, sustainable facility that can produce its own energy.

POWER SUPPLY:

Incoming power supply and connection will be provided by Contractor at 34,5kV and 50 Hz according to the official "Power Supply Permission Letter".

Liaise with the local power Authority to confirm:

- Characteristics of supply and system earthing.
- Location of incoming supply as described in official "Power Supply Permission Letter" to be submitted by the Authority.
- Space requirements and associated builder's work for the Authority's installations.
- Make necessary arrangements at the earliest opportunity to ensure connection as and when required, and inform the engineer in the event of any foreseen delay.

kW-h-METERING:

Liaise with the local power Authority and provide necessary instrumentation, enclosures and accessories required by them to effect a complete kW-h-metering installation. kWH-metering will be at medium voltage level unless otherwise required.

Nominal characteristics of power supply and distribution are as follows:

- Medium voltage: 34,5 kV, three phases, 3 wire impedance neutral earthing.
- Low voltage: 400/230 V, three phases, 4 wire, solidly earthed neutral.
- Frequency: 50 Hz.

COMMUNICATION CONNECTIONS

The local telephone authority will bring telephone public exchange lines into the premises to the location shown on the drawings and/or to be agreed with the Authority. Liaise with the local telephone authority to confirm location of connection of public telephone exchange lines into the premises.

CLIMATIC CONDITIONS

Equipment, including transformers, switchgear, cables, relays, lighting fixtures, motors etc., is to be designed and de-rated for continuous and trouble-free service under the following climatic conditions:

- Altitude: 200 m above sea level.
- Maximum ambient temperature: 35 degrees C (in the shade).
- Minimum ambient temperature: -10 degrees C.
- Maximum relative humidity: 95 %.
- Atmospheric conditions: Wet and corrosive.

8.2 Reference codes, regulations and standards

The minimum standard for this project is Turkey's (local) norms and standards. In case European/International standards are higher than Local standards, European/International standards shall be used. This will be decided by the Project Management Team and responsible experts of the Ministry.

All of the standards and rules for design, construction, maintenance, repair, and backup shall be implemented as their updated versions.

The contractor should follow and implement all of the changes and updates made on specifications and legislations.

Local standards shall be taken into consideration for this project but at the same time EU Standards (updated and revised ones) shall be based on as a minimum quality.

Applicable portions of the following standards, codes, regulations, and recommendations shall be observed in the design of the electrical systems:

Turkiye's Local Standards

European Standards (EU)

International Electro-technical Commission (IEC)

International Industry Association/Electronics Industry Association (TIA/EIA)

Local authorities Other Regulations/Standards (Electricity, Telecommunication, Fire, etc):

General Regulation for Electric Installations issued by Ministry of Civil Works

Regulation for Electric Indoor Installations issued by Ministry of Energy

Regulation for Electric Power Installations issued by Ministry of Energy

Regulation for Indoor Communication Installations issued by Local Telecom

Protection of Buildings Against Fire published by Government

8.3 General electrical design concepts

Electrical design concept shall be based on the following targets:

- Electrical systems should support the high technological equipment with flexibility and capacity to meet the developments in technologies
- All system should be designed to be enlarged by min 10% unless otherwise stated
- To comply with applicable codes and standards
- To meet the specific power and communications requirements of all systems and equipment
- To achieve reliability and durability of networks and components
- To implement safety measures for the protection and safety of people and equipment.

While achieving the design objectives, the following factors shall be considered:

- Cost effectiveness,
- Efficiency and energy conservation
- Coordination with other design elements
- Simplifying installations, operation & maintenance

- Utility service continuity and avoiding operation disruption
- Allowing for future expansions

8.4 Scope of work

The scope of electrical services will include the following systems:

Power Systems

- MV Distribution System and MV Cubicles
- Main and Emergency Power Supplies
- UPS (Uninterruptible Power Supply) System
- LV Main and Sub-Distribution System
- Lighting and Lighting Control System
- Exit and Emergency Lighting System
- Power Socket Outlet System
- Cable Containment System
- Grounding and Lightning Protection System
- Snow Melting/Heat Tracing System

Extra Low Voltage Systems

- Communication Systems
- Fire Alarm System
- Music Broadcasting and Public Address System
- Security Systems:
  CCTV,
  Intruder Alarm,
  Access Control and
- SMATV-IP TV Systems
- Master Clock System
- Queue Management System
- A/V Systems

8.5 Utility Connection, Power Center and MV cubicles

MV cables will be provided with the capacity to support the whole load of the facility.

Steel wire armored type MV cables will installed dedicated cable trenches.

Regarding with telecommunication lines, Incoming telecommunication cables from the utility company will installed in dedicated trenches from the telecommunication company tie-in point(s) to the main site telecommunication room. Coordination shall be made with local telecommunication utility company to identify tie-in points and other specific design requirements.

Power center which includes; MV Cubicle rooms, transformer station, generator room/rooms and Main LV Panel room, shall be located dedicated building called "Technical Service Building" adjacent to the

main loads. The location of the power center will be determined with administration during design phase. Power center shall be designed to be expandable to allow for future building expansions.

LSC2a (metal enclosed) type MV Cubicles as defined at IEC 62271-200 will be used in the system. All MV Cubicles will equipped with circuit breakers instead of disconnector or fused load breakers. All selected equipment will be suitable to the local electrical supplier company requirements. The system will be designed to allow for future expansions.

8.6 Space requirements

Electrical and telecommunication equipment rooms must be designed with adequate aisle space and clearances around equipment to accommodate maintenance and replacement. Doors and corridors to the building exterior must be of adequate size to allow installation and replacement of equipment.

Main electrical and telecommunication rooms shall not be located below toilets or other wet areas. If the electrical and telecommunication rooms are located in the basement, provisions shall be made to prevent water from flooding the electrical room in the event of a pipe breaking.

8.7 Main and emergency power supplies and power distribution

8.7.1 Main power supplies - Transformers

Medium/Low voltage transformer shall be made as dry type cast resin coil and both medium and low voltage windings shall be casted as vacuumed and fixed with heavy epoxy resin.

Cast Resin Dry Type Distribution Transformers should be manufactured according to ISO 9001 and ISO 14001 international quality standards. Transformers should be dampproof and have the feature of operating in humid environment more than 95% as well as at low temperatures up to -20 °C.

Each transformer shall have air forced cooling system with the multiple fans placed under the transformer coils.

Transformers shall be equipped with the following:

- Bi-directional wheels
- Lifting hooks
- Pull rings
- Earthing stations
- Nominal value plate
- Heat-control sensors
- Low circuit tap-changer

The transformers shall be designed to be expandable to allow for future buildings expansions and with a minimum of 10% spare capacity.

Transformer (power center) location will be determined at the design phase with the requirement and approval of the employer. Hermetic type transformers applicable only if prefabricated type transformer station usage will be decided by administration.

8.7.2 Emergency power supplies - Generator sets

The emergency electrical system will be designed to ensure continuity of electrical power to electrical loads of the facility during disruption of normal power.

Upon failure of a utility feed or transformer, the tie switch of the main switchboards will load the generator(s) up to 100% of rated capacity to supply 100% of facility load.

Prime type, diesel fueled emergency generator(s) located within power center will be used to provide 100% backup power supply for all of the buildings. Each generator will be furnished with a day fuel tank that will be sized to operate the engine generator for a minimum of 6 hours continuous operation at full load. The day tank will be located within the same room as the generator. In addition to the day fuel tank, a bulk fuel storage tank sized for 24 hours will also be provided with associated piping and pumps.

If facility actual (demand) power included 10% spare for future expansions will be calculated greater than 1.000 kW, 2 separate generator sets will be provided instead of single generator. (ie instead of single 1.600 kVA, use 2 sets 800 kVA). At this case, generator sets will be equipped with synchronization panel and automatic transfer switch.

The generators shall be designed to be expandable to allow for future buildings expansions and with a minimum of 10% spare capacity. Generator system will be equipped with automatic transfer switch.

8.7.3 LV Main Power distribution system

The LV electrical supply distribution will be at 400/230V, 50 Hz, 5 wire.

The LV main distribution boards will be self-contained free-standing modular cubicle type, readily expandable for future requirements and manufactured to (IEC 61439-1) Form 2-A. The main incomer will be a motorized type 4 Pole Air Circuit Breaker (ACB). Outgoing circuit breakers will be of the triple pole Molded Case Circuit Breaker (MCCB) or ACB type (For rated Amperage more than 1.250A) with appropriate rating.

The main LV panels will be equipped with automatic power factor correction system that will improve the power factor up to min. 0.99. Power factor correction system will be equipped with not only capacitor banks but also with harmonic filter and inductive reactors. The total reactive power and total harmonic distortion values throughout the facility shall be kept between the values required by the local electricity distribution company and which shall not damage or interfere with the operation of technical devices throughout the facility. In this context, the contractor is responsible for any financial and legal penalties to be applied by the local distribution company during the operation phase for 1 year.

Electrical power will be distributed from the main distribution boards to distribution panelboards and/or floor distribution panels located throughout the buildings. Distribution/floor panel boards with Molded Case Circuit Breakers (MCCB's) will be located in dedicated electrical rooms located within each floor area. Distribution/floor panelboards will be manufactured to (IEC 61439-1) Form 2-B.

Motor Control Centers (MCC's) will be used in mechanical plant rooms or other areas with numerous motor starter, protection and control requirements.

Main LV Panelboards and MCC/DDC Panels will have min IP54 rated. Other panels can be IP 2X type.

All panel boards will comply with international standards and TTA (tests according to IEC 61439-1) Tested (Short circuit resistance, temperature increase verification, impact resistance, during any failure/explosion, etc. the panels are protected to prevent human health, EMC etc. tests).

All panel boards shall be designed to be expandable to allow for future buildings expansions and with a minimum of 20% spare capacity. (10% of it equipped with CB's, 10% will be left as an empty space)

8.8 Uninterruptible Power Supply (UPS) system

UPS systems will be used in areas where no interruption in power supply can be tolerated. This battery stand-by backup system will ensure continuity of power until the emergency generators are on line.

The UPS system will be complete with all accessories including: batteries, protective devices, by-pass switches, inverters, rectifiers, control and monitoring modules, etc.

Each building will have their own UPS Device and UPS Distribution system. All computers and electronic devices, all extra low voltage (ELV) system main control unit and other ELV devices, all devices which should continue to operate during electrical/cuts and similar loads/equipment which cannot tolerate momentary power outages will be fed from UPS system. UPS Devices will have 10 min battery back-up.

UPS devices will be located at dedicated room in the basement or ground level adjacent to building main LV panel room. UPS batteries will be located in a separate room adjacent to the UPS room. All UPS units shall be designed with a minimum of 10% spare capacity.

All UPS devices shall have at least 95% efficiency for 25%, 50%, 75% and 100% loading.

8.9 LV distribution system

Distribution technique and cable containment system

In the Low Voltage Distribution System, vertical connections shall be made with cable ladders in the rooms and shafts and horizontal distributions shall be made with cable trays.

Cable trays and ladder principles are as follows:

- Hot dip galvanized type cable trays and ladders will be provided.
- Separate cable trays are proposed for low voltage and extra low voltage systems.
- Containment system dimension calculations will be provided by contractor during design phase.
- Support system installation intervals and containment system thickness will be calculated considering cable weights during design phase.
- Connection to the equipotential grounding system will be provided.

8.9.1 Distribution system of main risers

All risers and mechanical system power, control and signaling cables shall be halogen-free, N2XH type cables which do not produce any toxic gas when exposed to fire.

The supply and control cables of the fire-pumps, fire lifts, fire alarm system, voice alarm system, etc., which must remain operational for a long time during a fire shall be fire-resistant type (FE180)

The panelboards that supply energy to the fire related loads (the equipment that will be remain operated in case of fire such as; fire pumps, pressurization fans, smoke exhaust fans etc.) will have two independent fire resistant (FE180 E90) feeder cable and equipped with automatic transfer switch.

If bus-bars (busducts) are to be used for power distribution, then they shall be Aluminum, 4 conductors + grounded body type. Bus-bar plug-in units (tap-off units) shall be of the molded case breaker type.

All cable/bus-bars shall be designed to be expandable to allow for future buildings expansions and with a minimum of 10% spare capacity.

8.9.2 Distribution system of lighting and socket outlet system

The insulation materials used in all current carriers such as risers, feeders, distribution cables and cables for lighting and socket outlet circuits in the internal installations will be halogen free, not generating any toxic gases when exposed to fire. The cables of NHXMH type will be used for this purpose.

The installation items for electrical systems such as all pipes, junction boxes, cases, etc. will be selected such that they will not generate any toxic gases when exposed to fire.

All lighting and socket outlet circuits are 2,5 mm² in cross section unless otherwise specified.

All lighting and socket outlet circuits will be equipped with a grounding conductor.

NHXMH type cables will be used for all circuits to be laid through the cable trays in locations with suspended ceiling as well as those in mechanical installations spaces without suspended ceiling.

Basic installation principles shall be as follows:

- In suspended ceilings with cable trays on main routes
- At the points where the cables leave from the cable trays (at inside the room, at inside the wall): With HF flexible pipes,
- In technical spaces without suspended ceilings, etc.; Surface mounted with HF rigid pipes,
- Parking spaces, mechanical rooms, etc. in places without suspended ceilings; with cable tray, with HF rigid pipes at points cables leave from the cable trays,
- The conductors are installed inside to steel pipes in locations exposed to mechanical impacts.

Distribution throughout the facility will be done with terminal boxes. In other spaces where no terminal box is used, connection points shall be made in deep socket/switch boxes. (No junction boxes will be located at visible area)

At least one recharging kiosk for electric vehicles shall be required to install, as well as the recessed piping for electrical cables for at least 20 % of the parking spaces provided for, in order to allow the installation, at a later stage, of recharging kiosks.

8.10 Lighting system

8.10.1 Lighting levels

Minimum lighting levels will be as recommended by TS EN 12464-1 for interior and TS EN 12464-2 for exterior lighting.

Illumination level calculations will be supported by programs that make lighting simulations.

Lighting systems will be selected to provide flexibility of illumination levels for multiple tasks, minimize glare, and are suitably integrated with the surrounding finishes.

8.10.2 Lighting fixtures

Although decorative lighting principles will be evaluated together with architectural fiction depending on interior decoration projects, the general characteristics of lighting fixtures of typical areas recommended for use in the facility are as follows.

LED Type Lighting Fixtures and luminaires with LED bulbs will be preferred as much as possible in the interior and exterior lighting throughout the facility.

Decorative fittings will be used in social areas such as cafeterias in places such as entrances of buildings, waiting areas, meeting-seminar halls, resting rooms and similar.

Decorative luminaires will be preferred in the corridors depending on the suspended ceiling structure.

Lighting fixtures with opal glass/prismatic diffuser will be used in all office areas.

In all technical spaces and electrical/mechanical rooms, waterproof luminaires with min IP54 protection will be used.

LED's used in indoor lighting luminaires shall have at least 50.000 hours lifetime and shall be LM79-LM80 certified.

The proposed luminaires shall have relevant information for calculating the luminous level on the calculation program (such as ldt, elumdat files)

LED luminaires; will have EN, CE and Dekra Certified.

Glonophotometric reports of LED luminaires should be obtained from accredited organizations.

The LEDs will be soldered automatically with SMD technology on the aluminum-based printing circuit without any touching.

Optical lenses to be used in luminaires shall be manufactured from acrylic or polycarbonate with ultra-violet protection additives.

Luminaire light output efficiency should be minimum 125 lm/W.

The CRI of the luminaires used in clinical areas shall be minimum 90.

The CRI of the other luminaires shall be minimum 80.

The power factor of the drivers used in the luminaires shall be at least 0.95.

The operating temperature range of the LED will be between -10 and 85°C.

8.10.3 Lighting control system

Lighting control systems should optimize use of natural light to reduce overall power consumption and respond to the environment through the use of sensors, without affecting life safety or operational effectiveness.

Unless otherwise stated at the local norms, basic principles of Lighting control system will be as follows:

Areas which will be controlled by Lighting Automation:

- Daylight-dependent dimmable lighting automation in areas such as general circulation areas, corridors and entrance halls which are exposed to the natural day-light. Control via daylight sensor and manual override and from main control unit.
- Lighting automation capable of switching on and off at internal corridors which are not often exposed to daylight. Control via manual override and from main control unit.
- Outdoor lighting systems will be controlled by photoelectric sensor and lighting automation.

The scenario of the lighting automation will be determined according to administration requirements.

Preferential Control with Presence Sensor:

In areas such as office rooms and meeting rooms, lighting control will be done by presence sensors and conventional lighting switches.

Motion and presence sensor control:

At the public WC's lighting control shall be provided by presence sensors in inside the cabinets and by motion sensors in WC general areas. Mirror top luminaires can be controlled by standard lighting switches.

Meeting rooms, conference halls or similar places where projection machine will be operated, lighting system will be controlled by conventional type dimmer switches.

Other areas will be controlled by conventional lighting switches.

8.10.4 Emergency lighting system

Emergency Lighting system will be provided according to requirements of TS EN 1838, IEC EN 60598-2-22, EN 50172 and local standards.

Emergency egress lighting and exit signs provided with general lighting luminaires with self-containing batteries and sperate EXIT lighting fixtures with self-contained batteries.

Emergency lighting will provide minimum one hour function after power outage Unless otherwise stated at the norms.

Emergency lighting fixtures will be dedicated non-maintained lighting fixtures (will come on upon mains failure). Emergency lighting fixtures will be distributed throughout the facility including, but not limited to, the following areas:

- Public / Escape corridors
- Covered car park
- Escape
- Lift lobbies
- Stair cases
- Technical rooms / Plant rooms
- Every change of direction of corridors
- Every intersection of the corridors
- Any level change lines at the areas that should be equipped with emergency lighting
- Next to fire extinguishers and other firefighting equipment
- Next to each first aid posts
- Next to each fire related equipment such as; fire extinguishers, manual call points, fire alarm panel and other
- Other selected areas
- And other required areas specified at the standards

In the case of escape routes up to 2m wide, the average illuminance level on the floor along the center line of the route should be at least 1 lx, and in the central band of the route, covering at least a half of the width, it should be at least 50% of the value.

Wider escape routes can be treated as a number of 2m strips or they should meet the requirements for open areas.

The ratio of the maximum illuminance to the minimum illuminance along the center line of the escape route should not exceed 40:1.

8.10.5 Exterior lighting system

External, façade, roads, parking and landscape lighting shall be provided to emphasize the project's architectural design and enhance the security to provide safe access to all gates.

External lighting shall be designed in accordance with TS EN 12464-2 and other relevant codes for external lighting.

The design for external lighting shall include a combination of functional and landscape lighting elements. The functional lighting shall include decorative post top lighting poles with LED lamps for pathways and internal roads. The landscape lighting shall include in-ground fittings to illuminate trees and shrubs and low height bollards for pedestrian walkways.

External lighting control shall be achieved via photoelectric sensor control integrated with override from the lighting automation system.

8.11 Grounding and lightning protection

The building distribution system will utilize a TN-S grounding system, in which the neutral and earthing bars are connected at the main distribution switchboard, and a separate protective conductor will be extended with each circuit.

The grounding systems to be constructed in the plant are listed below according to their purposes:

- Protection earth: earthing a conductor part not existing in operation current circuit in order to protect the people from the hazardous contact voltage.
- Operation earth: earthing a point of operation current circuit in order to be operated the devices and facilities normally
- Functional earth: is the earthing of a communication facility or an operating element in order to perform the desired function.
- Low-noise earth: Low Noise earthing provides protection and reduction from unaccepted impacts to Interference signals transmitted from external sources which causes information losses on the data processing and similar equipment.
- Grounding against lightning: In case of lightning, to prevent jumps/induction to conductors under voltage due to operation and grounding the conductive/metal parts which do not relate to the operating current circuit for transmitting the lightning current to ground.

Under these classifications following grounding/earthing systems will be provided:

- Transformer substation earthing,
- Earthing of main distribution boards, panelboards, lighting installations and wiring accessories
- Generator plant earthing
- Mechanical plant rooms and fixed machinery earthing
- Exterior lighting
- All non-current carrying metal parts

Separate grounding systems will be provided for the Telecommunication, Data (ICT) and selected/required equipment and will be bonded to the main electrical grounding system.

Component parts of earthing system are to include the following:

- Earth electrode (rods, tapes etc.)
- Main earthing terminals or bars.
- Earthing conductors.
- Protective conductors.
- Equipotential bonding conductors.
- Electrically independent earth electrodes for special systems.
- Accessories and termination fittings, bonding, welding kits and other materials.

Supplementary Equipotential Bonding: Connect all extraneous conductive parts of the building such as metallic water pipes, drain pipes, other service pipes and ducting, metallic conduit and raceways, cable trays and cable armor to nearest earthing terminals by equipotential bonding conductors. Cross-section of protective bonding conductor shall not be less than half of the protective conductor connected to respective earthing terminal with a minimum of 4-mm².

Main Equipotential Bonding: main incoming and outgoing water pipes and any other metallic service pipes are to be connected by main equipotential bonding conductors to main earth terminal or bar. Bonding connections are to be as short as practicable between point of entry/exit of services and main earthing bar. Where meters are installed, bonding is to be made on the premise side of the meter. Cross-

sections of conductors are not to be less than half that of the earthing conductor connected thereto, and minimum 16 mm².

Equipotential earthing bar is to be provided at point of service entrance, main distribution MV, LV or generator rooms, electrical substations, low current & communication rooms and floor electrical and ICT rooms, lift wells, plant rooms and other required areas. Connect all earthing conductors, protective conductors and bonding conductors to the main earthing bar. Provide two insulated main earthing conductors, one at each end of the bar, connected via testing joints to the earth electrode. Conductor is to be sized to carry maximum earth fault current of system at point of application with final conductor temperature not exceeding 160 deg. C for at least 5 seconds. Main earthing conductors are to be minimum 120 mm² or as required by local authorities.

Use exothermic-welded connections shall be used at points in contact with air and soil. Other connections shall be done with earthing clamps, screws and bolts.

A lightning protection system will be provided to help protect the buildings from fire and damage to equipment by directing lightning discharge to ground (earth). The system will include air terminals, cable connectors, and down connectors with connection to the building grounding electrode system. Air terminals will be included on mechanical equipment and other building elements that extend above the roof.

Lightning protection installations shall be made according to the project to be made as a result of lightning risk report to be prepared according to IEC 62305 standard and protection level shall be determined by being based the lightning risk report and protection system will be classified as installation of protection from lightning and surge protection.

Installation of lightning protection shall be composed of the following parts:

- Air terminals,
- Roof conductors, down conductors and bonding conductors,
- Earthing rod and earthing installation,
- Connecting to earthing system

Mesh system will be provided for lightning protection including inspection (earth) pits and test links.

Surge protection devices will be provided according to requirements of EN 61643-11.

8.12 Snow melting / Heat trace system

Electric self-regulating heat trace will be provided as a minimum on roof drains, on skylights, and in rain gutters. The trace will be turned on/off automatically by thermostat and moisture sensors.

An electrical type snow melting system shall be used for car park ramps, entrance ramps, external staircases and similar areas.

8.13 Extra Low Voltage (ELV) systems

ELV systems to be installed in the facility are as follows:

- Information and Communication Systems
- Fire Alarm System
- Music Broadcasting and Public Address System
- Security Systems:
  CCTV,

Intruder Alarm and
Access Control

- SMATV-IP TV Systems
- Master Clock System
- Queue Management System
- A/V Systems

8.14 Information and communication systems

System infrastructure

In the infrastructure of institutional structures; It is aimed to meet all communication needs (data, voice, video, security systems, building automation systems, etc.) with a standardized and universal communication protocol (IP) operating with the structured cabling system.

Except for Fire Alarm and evacuation system and SMATV System all systems will be provided as IP based.

In this way, the whole structure will be controlled by a manageable, scalable and measurable traffic on an expandable infrastructure. The communication requirements of the facility such as telephone/voice, computer/data, video conferencing/video, camera security system/video, building automation/data can be carried over IP and with a single copper+fiber system installed in the building, it is possible to use the equipment in any technology at every point.

Sufficient number of Network Switches to be positioned to serve the facility and Internet Access Systems connected to these switches, Wireless Network Devices, Network Security Systems, Desktop Virtualization System equipment, End User Equipment, Printer/Scanner/Fax Systems are part of Data Infrastructure and Information Systems.

The data communication system includes all hardware required to capture, store, transmit, and display information. The work shall include structure cabling system, passive and active network components such as patch panels, switches, data processing equipment, storage equipment and application servers.

The backbone cabling of the data communication network will be multi-strand multimode and single mode optical fiber cables where necessary. The fiber optic cabling will be routed in star configuration, with redundant cores.

The horizontal cabling shall be a home run from each telecommunication outlet to each respective patch panel at the relevant telecommunication room. All horizontal cabling shall be a minimum of 10 Gigabit, 4 pair, CAT7 S/FTP type with 90-meter limitation distance from the outlet to the termination point at the telecommunication room.

All passive equipment, (racks, cabinets, terminations, couplers, patch panels, and cross connects) and active equipment (switches, backbone switches, software, servers, storage devices, and liciences etc) shall be provided.

Allowance shall be made for private and public Wireless Facility (Wi-Fi) Interface in selected areas of the facility based on DGII needs and local telecommunication companies' requirements.

The data system shall be designed to have a minimum of 20% spare capacity.

8.14.1 Communication systems

The telephone system will include both a digital Private Automatic Branch Exchange (PABX) and a Voice over Internet Protocol (VoIP) system. The PABX system will provide wired voice service to

selected telephone extensions throughout the facility. The location of PABX telephone outlets and instruments will be located in all determined rooms and selected staff. The PABX system will be primarily used as a backup to the primary VoIP system, and as the main telephone system for the offices who will be provided with touchtone telephone sets.

The PABX system will include copper cabling from the main distribution frame (MDF) located at the main telecommunication room. It will also require separate horizontal cabling to support conventional voice communications.

In addition to the PABX system, the facility will have VoIP communication system, which will have capabilities provided in the PABX system. The VoIP system will allow voice communication to take place over the data local area network (LAN). The VoIP system will include call processors, gateways, and other ancillary applications such as messaging, paging and multimedia conferencing. VoIP telephone sets will be provided and connected to dedicated port/PC at the user station.

The cabling for the conventional voice communication system will be multi-pair UTP copper that will run from the main telecommunication room to telecommunication room/closets distributed throughout the facility, and will be terminated in wall mounted connection terminal blocks.

The telephone system active and passive equipment shall be designed to have a minimum of 20% spare capacity.

The radio system to be provided to the security personnel shall ensure the rapid communication between the personnel and the center and increase the mobility.

8.15 Fire Alarm system

An effective, interactive analogue addressable, fire detection and alarm system will be installed in the buildings separately which will take rapid reaction and manage the behavior of mechanical devices during the fire in addition to make detection and alarm.

Although all buildings will have separate fire alarm control unit, these control units will be interconnected to each other so that all fire alarm inputs can be visualized by main control room. The location of the main control room will be determined designer with the requirements of the administration.

8.15.1 Detection

- Multi-sensor detectors will be used in MV Cubicle rooms, transformer, generator, LV Panel rooms, floor electrical distribution rooms, ELV main and floor rooms, mechanical main plant rooms, areas with particle density, lift m/c rooms and similar areas.
- Heat detectors will be used in kitchen, service and kitchenette etc. areas.
- Optical type smoke detectors will be provided in the remaining spaces, in the suspended ceiling and raised floors where necessary.
- Detectors mounted in suspended ceilings/raised floors can be visually monitored with LED indicators indicating status information.
- Beam-type detectors will be installed in areas which has a height above 11m.
- Duct mounted smoke detectors in ducts for air handling units and large exhaust fans.

8.15.2 Manual Alarm buttons

In accordance with the requirements of fire regulations, all escape routes and floor fire stairs entrances and exit points of fire escape stairs shall be equipped with manual alarm buttons based on the information provided by fire escape plans.

Manual alarm buttons shall be installed in such a way that the maximum distance from any point on a floor to any bot on that floor does not exceed 50m. In other words, the distance between the fire warning buttons will be max 50m unless otherwise required by norms.

8.15.3 Automation modules

In accordance with the fire scenario,

- The monitoring modules for receiving information about the operating/non-operating/fault/alarm/on/off/full/empty etc. of the relevant devices and systems during normal operation and in case of fire,
- Control modules will be installed to provide on/off/run/stop etc. controls.

Fire automation will primarily be done by fire panels, and the system will be integrated with BMS and will be monitored by BMS.

In areas where fire extinguishing system installed, extinguishing panels and fire alarm panel shall be integrated so that related alarm and monitoring can be made from the main fire dispatch center.

8.15.4 Alarm and evacuation announcement

Audible and visual annunciating units: Flasher and Horns will be located no further than 5m from ends of corridors and spacing between devices will not exceed 30m.

A voice evacuation system will be provided throughout the buildings where local fire regulations require. System will be integrated with the fire alarm system to function as one system where applicable. The voice evacuation will provide one-way communication in the form of paging from the main control panel to any floor or group of floors or areas. The system will be capable of manual or automatic operation initiated by the fire alarm system. The voice evacuation system will incorporate speakers in all public areas, to provide alert and evacuation messages. The voice alarm speakers will be grouped into different circuits and zones consistent with the building's smoke zones and fire compartments. Speakers will have fire dome housing according to regulations and all zones can be supervised from main control unit.

A main fire alarm panel will be located in main control / Fire Command Room (Fire Dispatch Center) at ground level of one of the selected buildings. The Fire Command Room shall have natural lighting with direct access from the outside and easily accessible from the inside. A number of remote annunciator and repeater fire alarm panel/panels will also be located at security room and required areas determined by the local norms.

A fire alarm signal shall be sent from each fire alarm panel to the central fire alarm panel located at the dispatch center. A communication auto-dialer shall be provided to send a signal to the municipal fire department via dedicated telephone lines to indicate alarm condition.

The fire alarm system will be interfaced with the BMS, CCTV, access control/security and elevator control systems. In addition, the fire alarm system will be interfaced with building's air-conditioning and ventilation system for appropriate shutdown/operation during fire alarm condition.

Different shafts/routes will be used for the loop cable installations of fire alarm system.

Graphical monitoring and control software will be provided at the dispatch center.

The fire alarm and voice evacuation system shall be designed to have a minimum of 20% spare capacity.

Designated lifts for fire department use will remain operational in the event of a fire condition where applicable.

8.16 Digital music broadcasting and public addressing system

Digital audio public address and 1 channel music broadcasting system will be provided throughout building. The system will be used to play background music, broadcast public messages, and page staff.

System will be installed the buildings where evacuation announcement system required by local fire regulations. The system will consist of ceiling mounted speakers distributed throughout the buildings, paging, and head-end equipment located at ELV technical room. Speakers will be distributed into zones and will be located in entrance halls, lift halls, lift cabinets, public corridors, lounges, waiting rooms, dining areas, public WC's. Paging stations with zone selectors will be located at the main control room and reception desk. Head end equipment will be rack mounted and will include CD/DVD players, AM/FM tuners, amplifiers, etc.

8.17 Security systems

Following security systems will be provided;

- CCTV
- Intruder alarm
- Access control

8.17.1 IP CCTV system

CCTV and Video Recording system and related infrastructure will be installed at the facility for monitoring, recording and management.

The CCTV System to be installed will be IP based to operate on the network in accordance with today's technology.

The CCTV security system will be an IP video-based system that uses at least 4 megapixel internal and external IP cameras that can send digital video signals to a remote point from a dedicated IP LAN network and store the video on the hard drive.

IP camera feeds will not require a power supply cable other than the signal cable, and the cameras will be powered from a single signal cable with the PoE feature. This signal supply cable shall be of halogen-free minimum CAT7 type. Network digital video recorders (NVR device or recording platform capable of recording camera images in the whole system for at least 60 days), video monitors shall be located in the central security room and other related/required rooms.

CCTV cameras will be located in the following locations where applicable:

- All entrances,
- Main entrance lobbies,
- Elevator lobbies and stair entrances,
- Parking lots,
- Main Security Room,
- Financial offices, cashier areas etc,
- Loading docks,
- Main Material storage areas,
- Service corridors,
- General corridors,
- At site through track lanes,
- At site entrances and exits,

- At site for general surround monitoring and
- Areas required by administration.

Generally internal or external, fixed, day&night cameras will be provided with mini dome housing. At main entrances, main entrance halls and large areas, which have circulation and at site, areas determined by administration PTZ (Pan/Tilt/Zoom) type cameras will be provided.

8.17.2 Intruder Alarm system

An IP Based Addressable intrusion detection system will consist of wall or ceiling mounted passive infrared (PIR) sensors, magnetic contacts and security alarms. PIR sensors will be provided in specific areas within the buildings including all entrances of the buildings, main storage, financial offices and required areas by user. Door position switches monitors intrusion of doors. Example locations of position switches include perimeter doors, all entrance and exit doors to the buildings, critical utility areas, access-controlled doors, roof access and fire stair doors. System main control unit will be located (or integrated with remote panel) at main security room.

8.17.3 Access control system

An IP Based access control system shall be installed; in order to limit/control the entrance and exits of security-critical spaces throughout the facility, to ensure Personnel Attendance and Control and to ensure the records of entry and exit of critical areas.

The access control system will include proximity card readers, key pad or a combination of both at selected entrances to the building and to areas/rooms within the building. At doorways the system will include readers, sensors, and locks. The card technology used will be a smart card technology allowing information to be encoded on the access card using read write capability. All users of the facility will be issued an identification badge (ID) with photographs in order to facilitate entry. These badges in conjunction with the access control system components will be used to gain entry to restricted areas. Examples where card readers or other access control devices are used include:

- Entrances of buildings,
- Turnstile entrance and exists (if exists) - integrated type
- User and customer interfaces,
- Public area and administration interfaces,
- Locker rooms,
- Main storage areas,
- Main archives,
- ELV System main control and monitoring rooms,
- Financial office areas,
- And doors determined by user.

The system is used in standard doors, with card reader only at the entrances, the exits to be opened by manual buttons, in main warehouses, main archive, server and similar sensitive areas; to work with card reader at both entrance and exit, photocell doors, card reader at the entrance, door sensor at the exit.

Glass doors and double leaf doors will be operated with magnetic door holder, standard doors with electric lock (strike) against the door, photocell doors will work with door contacts.

System will be integrated with Personnel Attendance and Control system which will be located at personnel entrance areas.

1.000 Card will be provided with card writer equipment.

SMATV and IP TV SYSTEMS

A central satellite system with satellite dishes and a multi switches with DVB Standard will be provided for buildings. The satellite dishes will be provided on the roof of the buildings.

Cable TV and radio programs will also be provided to the building through a cable system supplied from the local cable provider. The cable TV signal will be combined with the satellite TV signal and transmitted together on the same coaxial cabling that will be located in core risers.

Coaxial cables, line amplifiers and multi-switches will be used for signal distribution. System site devices will be located within telecommunication closets.

TV outlets will be provided at all waiting areas, lounges, meeting rooms, conference rooms, director/manager rooms, dining rooms, similar social areas and areas required by administration.

Also, IP based TV System infrastructure will be provided for future developments. The signal supply cable used in the system shall be halogen free CAT7 type. All kinds of passive equipment will be covered under the system with dedicated f/o backbone.

Information monitors will be provided at lift cabinets, main entrances, department entrances, waiting halls and similar areas which will give information about ministry and news.

8.18 Master Clock system

A central master clock system will be planned in the facility. The central master clock system will be completely IP based. In addition, the signal supply cable used shall be of minimum Cat 7 HF type with halogen free characteristics.

A master clock with GPS receiver will receive the time information and transmit the time signal to the clocks using Cat 7 HF cables with facility data network. The master clock will also serve as an NTP server for synchronized operation of all systems that require a time signal on facility.

All clocks will be PoE-powered. Clocks will be provided to; entrance halls, elevator lobbies, cafeterias, waiting areas, reception desks, corridors, general circulation areas, other similar places and areas required by administration.

8.19 Queue Management system

The areas determined by administration will be designed with queue management system for customer ranking and daily reporting.

The system will provide the ticket number with the ticket machine in the desks and will have the opportunity to make calls with the software to be found on the computer located at the booth.

17"/19" LED screens will be installed above the door at the corridor side as a secondary monitor, with 42"/47" LED screens will be used as the main monitor which will be provided at waiting areas and main corridors.

Control of the operation of the system should be possible with the master device without computer or with computer.

8.20 A/V systems

The audio-visual system requirements will vary based on the envisaged facilities and functions related to training, education, conferencing, and entertainment in the facility.

Following systems will be provided:

- Meeting rooms

- Dimmable lighting
- Video projection m/c and motorized screen and related cabling and terminations (ups, data and HDMI)
- Local sound system connected to projection system
- Video Conference Call System to selected meeting room.

8.21 Other installations

8.21.1 Seismic precautions

Seismic Precautions for non-structural electrical materials shall be taken. These measures shall be in full compliance with the applicable local/international regulations and standards. Seismic Precautions of non-structural electrical materials will be fully implemented in the project design and manufacturing phase.

8.21.2 Fire stopping

The gaps arising from the electrical installation infrastructure in the fire zone transitions, fire resistant wall or floor passages shall be closed with fire stop material in accordance with the criteria determined by local and international standards.

8.22 Solar energy

For all buildings and for entire IMT, the Contractor is expected to provide engineering calculations to define the areas of the buildings roofs where solar panels will produce maximum energy.

The roof area shall have appropriate slope and solar panels shall be placed to get the maximum sun ray at the efficient period of the day. In accordance with that, some IMT building's roof shall be planned to have solar power-based electricity generation facilities.

The electrical energy obtained from solar panels with solar energy can be used for lighting.

In accordance with the Energy Market legislation, the roofs of the buildings planned to be established within the scope of IMT are intended to be considered as solar power-based electricity generation facilities.

9 ARCHITECTURAL DESIGN

Architectural design for buildings shall include:

- Administration building;
- Customs building;
- Customs warehouse;
- Security building;
- Transformer building.

Conceptual design drawings referred to subject and scope of the building design including mechanical electrical and architectural design are:

WKS-102-IMT-CD-DWG-ADM-(A-S-M-E) for Administration building,

WKS-102-IMT-CD-DWG-CB-(A-S-E) for Customs building,

WKS-102-IMT-CD-DWG-CW-(A-M-E) for Customs warehouse,

WKS-102-IMT-CD-DWG-SEC-(A-S-M&E) for Security building,

WKS-102-IMT-CD-DWG-TRF-(A-E) for Transformer building.

9.1 References and applicable standards

Design for buildings shall be developed by the Contractor in accordance with Turkish and EU standards.

- Fire Protection of Buildings
- General Technical Specification of the Ministry of Environment and Urbanization
- TS 88: Technical Drawing - General Rules
- TS 1844: Construction Drawings - Projection Methods
- TS 2317: Building and Architectural Projects Terms and Definitions
- TS 3532: Technical Drawing – Scales
- TS 10551: Urban Roads - Parking Lot Design Rules for Automobiles
- TS 9111: Accessibility Requirements in Buildings for Persons with Disabilities and Mobility Restrictions
- TS ISO 299 Auxiliary Products for the Visually Impaired or Visually Impaired – Sensible Walking Surface Signs (Version June 2012)

All relevant TSE, EU and DIN NORMS will be included along with those mentioned above.

All buildings shall be designed as environmentally friendly, considering latest energy saving methods thus contributing to sustainable development and providing better services to IMT users and nature.

For this purpose, all buildings were also planned according to AASHE and LEEDS benchmarks while taking into a consideration:

- Regulations and guidelines for sustainable architecture (maximizing use of solar energy, use of rain water in recycling, use of prevailing wind and sunlight in heating and ventilation and other applicable design instruments),
- Current architectural and engineering standards for sustainable architecture,
- Recommendations of Employers and users,
- Recommendations of designers and associates participating in the project.

IMT shall be designed and constructed according to **Energy Efficiency Goals defined in Section 6 of this document,** making it more energy efficient and once in operation, reducing the rate of carbon emissions

For all buildings: to optimize energy efficiency as defined in Section 6, the Contractor should, in particular, consider the following design elements:

- Lighting:
- Walls and roof;
- Glazing;
- Heating and ventilation;
- Air conditioning system;
- Renewables;
- Building usage;
- Behaviors of the occupants.

9.2 Orientation of buildings

With proper orientation of buildings, the Contractor is expected to assure energy efficiency through wind and sun power.

The facade openings shall provide a natural ventilation and with the adequate facade elements (sun breakers, organization of buildings, ventilation shaft) a natural ventilation inside the building can be achieved, that minimize the use of mechanical systems and leads to minimize the carbon footprint and energy save.

9.3 Form and composition of facades

The building shall be designed according to the local climate conditions and sustainability. The number and positions of the openings are derived from functional needs of the employees and users. Segments of the facade shall be accentuated by color and materialization.

9.4 Materials

Minimum carbon footprint material shall be chosen for all IMT materials. In design stage, recyclable materials should be chosen as much as possible.

9.5 Administration building

The Administration building shall be used for waiting, preparation and implementation of all the necessary administrative activities for the users of the terminal, and as an office building for the company that manages the terminal.

- Approximate dimensions of the building: 15m x 40.5 m.
- Number of floors: basement floor, ground floor and first floor
- Planned number of employees: 25 in the Phase I, up to 50 in the Phase II

The design of the building shall be compliant with the conditions for free and easy movement of disabled persons.

Also, the design shall be according to LEED Certification.

The following designed surface shall be considered as a minimum for each of building elements:

BASEMENT FLOOR		
NO	**ROOM**	**APPROXIMATE AREA**
B-01	Shelter	139 m2
B-01 A	Storage	18 m2
B-02	Electrical room	30 m2
B-03	CCTV room	32 m2
B-04	Water reservoir room	75 m2
B-05	Mechanical room	34 m2
B-06	Hall	84 m2
B-07	Ladies shower	56 m2
B-08	Gents' shower	46 m2
B-09	Gents' masjid	12 m2
B-10	Ladies' masjid	10 m2

GROUND FLOOR		
NO	**ROOM**	**APPROXIMATE AREA**
Z-00	Wind wane	14 m2
Z-01	Atrium	38 m2
Z-01 A	Security	10 m2
Z-02	Custom transaction office	73 m2
Z-03	Cafe area	40 m2
Z-04	Cafe service	22 m2
Z-05	Gents' room	30 m2

Z-06	Ladies room	19 m2
Z-07	Internet cafe	24 m2
Z-08	Office	33 m2
Z-09	Office	30 m2
Z-10	Office	30 m2
Z-11	Drivers' lounge	65 m2
Z-12	Corridor	81 m2
Z-13	Storage	5 m2
Z-14	Stair	15 m2
Z-15	Supply room	10 m2
Z-16	Accessible WC	5 m2

FIRST FLOOR		
NO	**ROOM**	**APPROXIMATE AREA**
1K-01	Office / IMT staff	71 m2
1K-02	Office / IMT staff	73 m2
1K-03	Office	26 m2
1K-04	Photocopy	7 m2
1K-05	Archive	26 m2
1K-06	Office	34 m2
1K-07	Ladies' room	23 m2
1K-08	Cleaning room	4 m2
1K-09	Men' room	26 m2
1K-10	Corridor	92 m2
1K-11	Meeting room	66 m2
1K-12	Kitchenette	10 m2
1K-13	Office	30 m2

TOTAL NET AREA – BASEMENT FLOOR	**536 M2**
TOTAL NET AREA – GROUND FLOOR	**544 M2**
TOTAL NET AREA – FIRST FLOOR	**488 M2**
TOTAL NET AREA	**1568 M2**

9.6 Customs building

The customs building shall be used for preparation of all the necessary customs activities for the terminal users including future supply of equipment for customs operations (X-Rays and others), and eventually by other users of the customs facilities.

Approximate dimensions of the building: 34m x 49.50 m.

Number of floors: basement floor, ground floor, first floor

The design of the building shall be compliant with the conditions for free and easy movement of disabled persons.

Also, the design shall be according to LEED Certification.

The following designed surface shall be considered as a minimum for each of building part:

BASEMENT FLOOR		
NO	**ROOM**	**APPROXIMATE AREA**
B-01A	Hall	20 m2
B-02A	Shelter	100 m2
B-05A	Archive	36 m2
B-06A	Server / IT room	16 m2
B-07A	Electrical room	25 m2
B-08A	Mechanical room and Water reservoir	48 m2
B-09A	Storage	8 m2

GROUND FLOOR		
NO	**ROOM**	**APPROXIMATE AREA**
Z-00	Windwane	20 m2
Z-01	Hall	30 m2
Z-02	Recess area	50 m2
Z-03	Ladies room	22 m2
Z-04	Men' room	20 m2
Z-05	Accessible WC	6 m2
Z-06	Customs clearance room	103 m2
Z-01 B	Warehouse	1188 m2
Z-02 B	Control laboratory	29 m2
Z-03 B	Result preparation room	28 m2

FIRST FLOOR		
NO	**ROOM**	**APPROXIMATE AREA**
1K-01	Personnel break area & cafe	88 m2
1K-02	Corridor	17 m2
1K-03	Ladies room	20 m2
1K-04	Men room	20 m2
1K-05	Accessible WC	6 m2
1K-06	Hall	12 m2
1K-07	Meeting room	25 m2
1K-08	Open office	64 m2

TOTAL NET AREA – BASEMENT FLOOR	**253 M2**
TOTAL NET AREA – GROUND FLOOR	**1496 M2**
TOTAL NET AREA – FIRST FLOOR	**252 M2**
TOTAL NET AREA	**2001 M2**

9.7 Customs warehouse

The customs warehouse shall be used for the control of selected goods by the customs authorities. Inside the fenced area, employees shall open the container, and transfer goods from the container into the warehouse using a forklift.

Approximate dimensions of the building: 60m x 24m.

Number of floors: ground floor, first floor

Design of the building shall be compliant with the Turkish and EU standards for warehouse buildings.

The design of the building shall prevent humidity condensation.

The following designed surface shall be considered as a minimum:

GROUND FLOOR		
NO	**ROOM**	**APPROXIMATE AREA**
Z-01	Main entrance	9 m2
Z-02	Male personnel lockers	90 m2
Z-03	Female personnel lockers	31 m2
Z-04	Ladies room	28 m2
Z-05	Men' room	28 m2
Z-06	Ladies accessible WC	6 m2
Z-07	Cleaning room	6 m2

Z-08	Warehouse	1300 m2

MEZZANINE FLOOR		
NO	**ROOM**	**APPROXIMATE AREA**
M-01	Manager room	29 m2
M-02	Secretary	24 m2
M-03	Manager room	29 m2
M-04	Office	27 m2
M-05	Office	27 m2
M-06	Office	27 m2
M-07	Corridor	56 m2

TOTAL NET AREA – GROUND FLOOR	**1500 M2**
TOTAL NET AREA – MEZZANINE FLOOR	**219 M2**
TOTAL NET AREA	**1719 M2**

9.8 Security building

The security building is a point of entry to IMT area and it shall be used as the control check point of the vehicles which get in to IMT.

Approximate dimensions of the building: 3m x 7m, moreover, the structure covers the entrance road with a planar roof structure and this covering area dimensions are: 17m x 7m.

Number of floors: ground floor

Design of the building shall be compliant with the Turkish and EU standards for security buildings. Design should also provide all necessary outdoor equipment to secure the area.

The design of the building shall prevent humidity condensation.

The following designed surface shall be considered as a minimum:

GROUND FLOOR		
NO	**ROOM**	**APPROXIMATE AREA**
Z-01	Security Room	14 m2
Z-02	WC	2 m2
TOTAL NET AREA		**16 m2**

9.9 Visibility

For all buildings, EU Turkey visibility logo of noticeable size and durable material should be placed at the visible at the entry of buildings. Led lights should be installed to make logo visible at night. The size, material and position of logos should be approved by DGII and the Contracting Authority.

10 STRUCTURAL DESIGN

The building structure shall be made of reinforced concrete or steel.

Necessary structural designs in IMT shall be realized in accordance with applicable Turkish and EU specifications and standards below.

10.1 Specifications and standards

The analysis and verification of the structures shall be in accordance with the following specifications:

- EN 1990:2002 Eurocode: Basis of structural design
- EN 1991-1-1:2002 Eurocode 1: Actions on structures
- EN 1992-2:2004, Eurocode 2: Design of concrete structures
- EN 1993-1-1:2005, Eurocode 3: Design of steel structures
- EN 1994-1-1:2004, Eurocode 4: Design of composite steel and concrete structures
- EN 1997-1 Eurocode 7: Geotechnical design
- Seismic design data will be derived from AFAD

10.2 Units

The SI unit system will be used in the project.

Distance, displacement	m, mm
Mass	kg
Force	N, kN, MN
Moment	kNm
Stress	kPa, MPa
Unit weight	kN/m^3

Figure 3: Unit system used for structural design

10.3 Material

Unit weights of materials used in structures are listed below. In case of usage of any material other than the ones listed below, the unit weight will be indicated in the related section of the calculation report stating its reference as either a standard, norm or regulation.

Material	Unit Weight (kN/m³)
Structural Steel	78,5
Plain Concrete	22,0
Reinforced Concrete	25,0
Concrete in Prestressed Elements	25,0
Asphaltic Concrete + Isolation Layer	23,0
Compacted Fill	20

10.4 Material partial factors

Partial factors for materials, γc, γM and γs, are to be taken in accordance with EN 1992-2:2005.

Table 1: Material Factors for Reinforced Concrete

Classification	γ_c for concrete	γ_s for reinforcing steel
ULS (Persistent & Transient)	1.5	1.15
SLS (Persistent & Transient)	1.0	1.0
Seismic	1.2	1.0

Table 2: Material Factors for Structural Steel

Classification	γ_{M1} for cross sectional resistance	γ_{M1} for buckling resistance	γ_{M2} for joints and cross sections in tension to fracture
ULS (Persistent & Transient)	1.0	1.0	1.25

10.5 Concrete strength

The characteristic values for concrete are presented below.

Table 3: Material properties for concrete

Strength classes for concrete														
f_{ck} (MPa)	12	16	20	25	30	35	40	45	50	55	60	70	80	90
$f_{ck,cube}$ (MPa)	15	20	25	30	37	45	50	55	60	67	75	85	95	105
f_{cm} (MPa)	20	24	28	33	38	43	48	53	58	63	68	78	88	98
f_{ctm} (MPa)	1,6	1,9	2,2	2,6	2,9	3,2	3,5	3,8	4,1	4,2	4,4	4,6	4,8	5,0
$f_{ctk,\ 0,05}$ (MPa)	1,1	1,3	1,5	1,8	2,0	2,2	2,5	2,7	2,9	3,0	3,1	3,2	3,4	3,5
$f_{ctk,0,95}$ (MPa)	2,0	2,5	2,9	3,3	3,8	4,2	4,6	4,9	5,3	5,5	5,7	6,0	6,3	6,6
E_{cm} (GPa)	27	29	30	31	33	34	35	36	37	38	39	41	42	44
ε_{c1} (‰)	1,8	1,9	2,0	2,1	2,2	2,25	2,3	2,4	2,45	2,5	2,6	2,7	2,8	2,8
ε_{cu1} (‰)	3,5									3,2	3,0	2,8	2,8	2,8
ε_{c2} (‰)	2,0									2,2	2,3	2,4	2, 5	2,6
ε_{cu2} (‰)	3,5									3,1	2,9	2,7	2,6	2,6
n	2,0									1,75	1,6	1,45	1,4	1,4
ε_{c3} (‰)	1,75									1,8	1,9	2,0	2,2	2,3
ε_{cu3} (‰)	3,5									3,1	2,9	2,7	2,6	2,6

10.6 Concrete cover

The concrete cover is the distance between the surface of the outermost reinforcement closest to the concrete surface and the nearest concrete surface. Minimum concrete cover to provided is as follows:

- Columns, Walls: 5.0 cm

- Slabs: 4.0 cm

- Foundations and Piles: 7.5 cm

10.7 Steel reinforcement

Reinforcing steel shall be used Grade S420 according to EN 1992-1-1:2004. The reinforcement steel shall have the following characteristics:

- Modulus of elasticity: Es = 200,000 MPa

- Yield strength: fyk = 420 MPa

- Tensile / yield strength ratio: k = (ft/fy)k ≥ 1.15 and < 1.35

- Elongation at maximum force: εuk ≥ 7.5%

10.8 Bolts

All bolts shall be minimum class 10.9 with a fub= 1000MPa.

The tension strength of a bolt is determined based on the formula from Table 3.4 from EN1993-1-8.

$$F_{t,Rd} = \frac{k_2 \cdot f_{ub} \cdot A_s}{\gamma_{M2}}$$

The shear strength of a bolt is determined based on the formula from Table 3.4 of EN1993-1-8.

$$F_{v,Rd} = \frac{\alpha_v \cdot f_{ub} \cdot A_s}{\gamma_{M2}}$$

A bolt connection with combined shear and tension forces must fulfil the following criteria:

$$\frac{F_{v,Ed}}{F_{v,Rd}} + \frac{F_{t,Ed}}{1.4F_{t,Rd}} \leq 1.0$$

10.9 Welding

According to EN1993-1-8, all full penetration butt welds to be made with suitable consumable, which will produce all-weld tensile specimens having both minimum yield strength and a minimum tensile strength not less than those specified for the parent material. The same applies to partial penetration.

For fillet welds, the correlation factor βw is 0.9 for S355 according to table 4.1 of EN1993-1-8.

The design shear strength of a fillet weld is determined according to formula 4.4 EN1993-1-8:

$$f_{vw.d} = \frac{f_u/\sqrt{3}}{\beta_w \gamma_{M2}} = \frac{470/\sqrt{3}}{0.9 \cdot 1.25} = 241MPa$$

The strength of a fillet weld subjected to both shear and tension is determined according to the directional method in EN1993-1-8, formula 4.1:

$$\sqrt{\sigma_{perp}^2 + 3 \cdot \left(\tau_{perp}^2 + \tau_{parallel}^2\right)} \leq \frac{f_u}{\beta_w \cdot \gamma_{M2}} = \frac{470}{0.9 \cdot 1.25} = 418MPa$$

10.10 Design loads and combinations

EN 1990 Application gives rules and methods for establishing combinations of actions for serviceability and ultimate limit state verifications (except fatigue verifications) with the recommended design values of permanent, variable and accidental actions and factors to be used in the design.

Effects of actions that cannot occur simultaneously due to physical or functional reasons need to be considered together in combinations of actions.

Service limit state

EN1991-1-1 recommended values of service limit state factors for project will be used for SLS combinations.

Ultimate limit state

The design values of actions for ultimate limit states in the persistent and transient design situations are to be in accordance with the tables given below. In cases where the limit state is very sensitive to variations in the magnitude of permanent actions, the upper and lower characteristic values of these actions are used. Static equilibrium is verified according to the factors defined for EQU; design of structural members not involving geotechnical actions is made with the factors defined for STR; design

of structural members involving geotechnical actions and resistance of the ground is made following one of the three approaches given below:

Approach 1: applying in separate calculations design values of Set B and Set C to the geotechnical actions as well as the actions on/from the structure

Approach 2: applying design values of actions from Set B to the geotechnical actions as well as the actions on/from the structure

Approach 3: applying design values of actions from Set C to the geotechnical actions and simultaneously applying design values of actions from Set B to the actions on/from the structure.

Extreme limit state

EN1990 Annex A2, recommended values of ultimate limit states in the accidental and seismic design situation factors for project will be used for extreme ULS combinations.

10.11 Load combinations

Defined load combinations are presented below.

		DEAD & G	BALLAST	LL	BR	ENV(TR)	NS	CF	WIND	ENV-TEMP	EV	EQ-T	EQ-L	EH(KO)	SURCHARGE	TOPRAK(KA)	EH(EQ)-L	DEADEQ-T	DEADEQ-L
SERVICE	SER Characteristic	1	1	1	1	1	1	1	0,75	0,6	1	-	-	1	1	-	-	-	-
	SER Frequent	1	1	0,8	0,8	0,8	0,8	0,8	0,5	0,6	1	-	-	1	0,8	-	-	-	-
	SER Quasi-Permanent	1	1	-	-	-	-	-	-	0,5	1	-	-	1	-	-	-	-	-
SERV ENV	*SER Characteristic*	*SER Frequent*	*SER Quasi-Permanent*																
		DEAD & G	BALLAST	LL	BR	TR	NS	CF	WIND	ENV-TEMP	EV	EQ-T	EQ-L	EH(KO)	SURCHARGE	TOPRAK(KA)	EH(EQ)-L	DEADEQ-T	DEADEQ-L
STRENGTH	STR/GEO SETB MAX	1,35	1,35	1,45	1,45	1,45	1,45	1,45	1,125	0,9	1,35	-	-	1,5	1,5	-	-	-	-
	STR/GEO SETB MIN	1	1	-	-	-	-	-	1,5	0,9	1	-	-	1,5	-	-	-	-	-
	STR/GEO SETB 1	1	1	1,45	1,45	1,45	1,45	1,45	1,125	0,9	1	-	-	1,5	1,5	-	-	-	-
	STR/GEO SETB MAX a	1,35	1,35	-	-	-	-	-	1,5	0,9	1,35	-	-	1,5	-	-	-	-	-
	STR/GEO SETB MIN a	1	1	-	-	-	-	-	1,5	0,9	1	-	-	1,5	-	-	-	-	-
	STR/GEO SETB MAX b	1,15	1,15	1,45	1,45	1,45	1,45	1,45	1,125	0,9	1,15	-	-	1,5	1,5	-	-	-	-
	STR/GEO SETB MIN b	1	1	-	-	-	-	-	1,5	0,9	1	-	-	1,5	-	-	-	-	-
	STR/GEO SETB b1	1,15	1,15	-	-	-	-	-	1,5	0,9	1,15	-	-	1,5	-	-	-	-	-
	STR/GEO SETC MAX	1	1	1,25	1,25	1,25	1,25	1,25	0,975	0,78	1	-	-	1,3	1,3	-	-	-	-
	STR/GEO SETC MIN	1	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
	STR/GEO SETC 1	1	1	1,25	1,25	1,25	1,25	1,25	-	-	1	-	-	1,3	1,3	-	-	-	-
	STR/GEO SETC 2	1	1	-	-	-	-	-	1,3	0,78	1	-	-	1,3	1,3	-	-	-	-
		DEAD & G	BALLAST	LL	BR	TR	NS	CF	WIND	ENV-TEMP	EV	EQ-T	EQ-L	EH(KO)	SURCHARGE	TOPRAK(KA)	EH(EQ)-L	DEADEQ-T	DEADEQ-L
EARTHQUAKE	EQX	1	1	0,3	0,3	0,3	0,3	0,3	-	0,5	1	1	0,3	-	0,3	1	1	1	0,3
	EQY	1	1	0,3	0,3	0,3	0,3	0,3	-	0,5	1	0,3	1	-	0,3	1	1	0,3	1
DESIGN ENV	*STR/GEO SETB MAX*	*STR/GEO SETB MIN*		*STR/GEO SETB 1*		*STR/GEO SETB MAX a*		*STR/GEO SETB MIN a*		*STR/GEO SETB MAX b*		*STR/GEO SETB MIN b*		*STR/GEO SETB b1*		*STR/GEO SETC MAX*		*STR/GEO SETC MIN*	
	STR/GEO SETC 1	*STR/GEO SETC 2*		*EQX*		*EQY*													

Combinations are taken as per EN-1990-Annex-A2 Table A2.3, A2.4(B), A2.4(C) and A2.5

10.12 Structure computer model

All structures shall be modelled in finite elements analysis software which is globally accepted and checked by 3rd party consultants.

11 LANDSCAPE DESIGN

Conceptual design drawings referred to subject and scope of the landscape design are:

WKS-102-IMT-CD-DWG-LSP-001
WKS-102-IMT-CD-DWG-LSP-002
WKS-102-IMT-CD-DWG-LSP-003
WKS-102-IMT-CD-DWG-LSP-004
WKS-102-IMT-CD-DWG-LSP-005

Evergreen or deciduous plants shall be species of choice as they consume as relatively little quantities of water.

The landscaping design shall at least present the same esthetic and landscaping effects as those proposed in the Conceptual design as reference solution. The following plants species (or similar) are proposed:

- Acer Negundo (Boxelder Maple)
- Acer palmatum "Atropurureum" (Japanese Maple)
- Albizzia julibrissin (Silk Tree)
- Betula pendula (Birch Tree)
- Catalpa bignonoides (Southern Catalpa)
- Fraxinus excelsior (Fraxinus excelsior)
- Ginkgo biloba (Maidenhair Tree)
- Ligustrum japonica (Japanese Privet)
- Liquidambar styraciflua (Sweet Gum)
- Liriodendron tulipifera (Tulip Tree)
- Magnolia grandiflora (Evergreen Magnolia)
- Platanus orientalis (Oriental Plane)
- Tilia tomentosa (Silver Linden)
- Abies bornmülleriana (Nordmann Fir)
- Cedrus atlantica "Glauca" (Atlas Cedar)
- Cupressus arizonica "Glauca" (Arizona Cypress)
- Seed mixtures for meadow lawn.

The selection process shall be related to the selection of plants that are not psychopathological and entomological infected, which are real, vital and healthy, with developed roots (in proportion with the crown), etc.

Transportation shall be smooth and effective, because of the trees that are outside the soil exposed to different influences that are usual negative, and because the soil (pits) is prepared.

When soil is set and roughly aligned, there shall be a surface way of treatment - harrowing, and parts which are not plowed or set. During the cultivation process blown Manure shall be add, and then soil harrowing or chopping in small pieces (mechanically or manually).

Fertilization treatment of the soil should be done in autumn, because leafs are frosty during the winter and then during the spring to do the planting. If this is not possible, it is desirable that treatment shall be done at least 7-10 days before the planting.

11.1 Bicycle and electrical vehicle usage

Bicycle and electrical vehicle parking at certain points within IMT. Planning for usage of bicycle or electrical vehicle shall be foreseen.

Comfortable circulation of disabled users. ramps, tangible floor applications for the visually impaired and use of natural materials suitable for Tekirdağ climate zone shall be foreseen.

11.2 Fences and gates

The basic chain link fence made of galvanized (standard NEN-EN-ISO 1461) steel posts, placed vertically into the ground, shall be used for fencing of IMT and its belonging infrastructure.

Chain link fence could be made from stainless steel wire or PVC coated iron wire (rhombic wire mesh, chain link fencing mesh).

All fences and gates shall conform to the Design for construction and be CE-marked. Installation of gates shall be conforming to EN 12635.

11.3 Waste management and recycling

Establishment of a waste management facility within the campus, and placing the glass, paper, plastic waste containers, at collection points.

12 CARBON FOOTPRINT

According to the Conceptual design, a calculation of IMT total carbon footprint is provided.

Calculating the total carbon footprint and reduce it via planting trees and adopting renewable energy systems to reduce the CO_2 emission.

CO2 (electricity) =$electricity\ usage\ per\ year$ (kWh)/1000×0,84

= 6.681.897 kWh/1000×0.84

= 5612.8 metric tons

CO2 (truck) =$number\ of$ truck in IMT × $total\ trips\ for$ shuttle service vehicles $service\ each\ day$ ×$approximate\ travel\ distance\ of\ vehicle\ each\ day\ inside$ IMT

$only$ (KM) × 260/100 × 0.01

=100 × 2 × 2 × 260/100 × 0.01

= 10.4 metric tons

CO_2 (cars) = number of cars entering IMT × 2 × approximate travel distance of

vehicle each day inside IMT only (km) ×240/100 × 0.02

= 1014 ×2 × 2 × 260/100 × 0.02

= 210.9 metric tons

CO2 (motorcycle) = number of motorcycles entering in IMT × 2 × approximate travel

distance of vehicle each day inside IMT only (km) ×240/100 × 0.01

=50×2 ×2 ×260/100 × 0.01

= 5,2 metric tons CO2 (motorcycle)

CO_2 (total) = 5612.8 + 10.4 + 210.9 + 5.2 = 5839.3 metric tons

Estimated Carbon footprint in 1 year = 5839.3 metric tons

Trees remove carbon dioxide from the atmosphere through photosynthesis and store the carbon in their leaves, branches, stems, bark and roots. Approximately half the dry weight of a tree's biomass is carbon. One ton of C = 3.67 tons of 'carbon dioxide equivalent' (CO_2-e). Around 6 trees will fix 1 ton of CO_2.

In its lifetime, a maple tree with a girth of 10-30 cm can absorb 3.70 lakh tons of carbon dioxide from the atmosphere.

5839.3 metric ton /3,67 = 1591 trees needed to clean the carbon dioxide that IMT will omit in 1 year.

For all buildings and for entire IMT, the Contractor is expected to provide a carbon footprint calculation to define optimal planted area and tree species to be chosen.

For the access area and edge of IMT, plantation involves a straight path or road with a line of trees or large shrubs running along each side is foreseen. It helps in minimizing dust loads, gaseous pollutants, and noise pollution from traffic. Evergreen and deciduous trees are effective in minimizing air pollution by filtering, intercepting, and effectively absorbing pollutants for environmental improvement. The other trees will be chosen to not affect the view angle of the drivers for road safety.

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