



**TEİAŞ**

**TURKISH  
ELECTRICITY  
TRANSMISSION  
CORPORATION**

**TECHNICAL SPECIFICATION FOR POWER TRANSFORMER (400 kV/MV, 154  
kV/MV)**

The original version of this technical specification has been prepared in Turkish and in case of any inconsistency between English and Turkish, the Turkish language shall prevail.

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## TECHNICAL SPECIFICATION FOR POWER TRANSFORMER (400 kV/MV, 154 kV/MV)

### 1. GENERAL

#### 1.1. Subject and Scope

These specifications cover the conditions for the supply of 400 kV/MV, 154 kV/MV three phase oil immersed power transformers to be used at conventional substations.

Unless otherwise specified, the works to be performed in accordance with the Contract shall comply with the conditions of these specifications and shall include the following works:

- Design and manufacture of transformers together with all accessories and auxiliary equipment,
- Testing transformers and relevant components and provision of test reports,
- Supply of backup parts,
- Provision of special tools and instruments necessary for assembly and maintenance,
- Submission of drawings, electrical diagrams and the documents related with the assembly, operation and maintenance of the transformers for approval.
- Transportation of transformers to the location indicated in the delivery program, unloading them on rail or platform and pulling them up to the point of assembly.
- Assembly of transformers,
- Field tests of transformers to be performed before being taken into service,
- Commissioning.

Unless otherwise specified, the following works shall be provided by the Directorate:

- The reinforced concrete foundation equipped with the rail system and other necessary construction works for the installation of transformers,
- Grounding system,
- Appropriate storage for the components during the assembly works at the worksite.

#### 1.2. Standards and Documents

Unless otherwise specified, the design, production and tests of transformers shall be performed taking into consideration the latest editions of the following standards and /or documents.

Standard Number		Standard Name (Turkish/English)
TSE	International Equivalent	
TS EN ISO 9001	EN ISO 9001	Kalite Yönetim Sistemleri - Şartlar
		Quality management systems - Requirements
TS EN 60076-1	IEC 60076-1	Güç transformatörleri – Bölüm 1: Genel

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Standard Number		Standard Name (Turkish/English)
TSE	International Equivalent	
		Power transformers - Part 1: General
TS EN 60076-2	IEC 60076-2	Güç transformatörleri – Bölüm 2: Sıvıya daldırılan transformatörler için sıcaklık artışı Power transformers - Part 2: Temperature rise for liquid-immersed transformers
TS EN 60076-3	IEC 60076-3	Güç transformatörleri - Bölüm 3: INSULATION LEVELS, dielektrik deneyler and havadaki harici yalıtma aralıkları Power transformers -- Part 3: Insulation levels, dielectric tests and external clearances in air
TS EN 60076-4	IEC 60076-4	Güç transformatörleri - Bölüm 4: Yıldırım and anahtarlama darbe deneylerine kılavuz - Güç transformatörleri and reaktörler Power transformers -- Part 4: Guide to the lightning impulse and switching impulse testing - Power transformers and reactors
TS EN 60076-5	IEC 60076-5	Güç transformatörleri - bölüm 5: Kısa devre dayanım yeteneği Power transformers-Part 5: Ability to withstand short circuit
	IEC 60076-7	Power transformers - Part 7: Loading guide for oil-immersed power transformers
TS IEC 60076-8	IEC 60076-8	Güç transformatörleri - Kullanma kılavuzu Power transformers - Part 8: Application guide
TS EN 60076-10	IEC 60076-10	Güç transformatörleri - Bölüm 10: Ses seviyelerinin belirlenmesi Power transformers - Part 10: Determination of sound levels
TS EN 60076-18	IEC 60076-18	Güç transformatörleri Bölüm 18 - Frekans tepkisinin ölçümü Power transformers -- Part 18: Measurement of frequency response
TS 8756 EN 60721-1	IEC 60721-1	Çevre şartlarının sınıflandırılması- Bölüm 1: Çevre parametreleri and bunlara ait şiddet dereceleri Classification of environmental conditions Part 1: Environmental parameters and their severities
TS EN 60214-1	IEC 60214-1	Kademe değiştiriciler - Bölüm 1: Performans kuralları and deney yöntemleri Tap-changers - Part 1: Performance requirements and test methods (IEC 60214-1:2014)
TS IEC 60214-2	IEC 60214-2	Kademe değiştiriciler - Bölüm 2: Uygulama kılavuzu

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Standard Number		Standard Name (Turkish/English)
TSE	International Equivalent	
		Tap-changers - Part 2: Application guide
TS 2051 EN 60270	IEC 60270	Kablolar-Yüksek gerilim deney teknikleri-Kısmi boşalma ölçmeleri
		High voltage test techniques-Partial discharge measurements
TS EN 60296	IEC 60296	Mineral yalıtım oilları - Kullanılmamış - Elektroteknik uygulamalar için - Anahtarlama düzeni and transformatörlerde kullanılan
		Fluids for electrotechnical applications - Unused mineral insulating oils for transformers and switchgear
	IEC TR 62271-301	High-voltage switchgear and controlgear - Part 301: Dimensional standardisation of high-voltage terminals
TS 3033 EN 60529	IEC 60529	Mahfazalarla sağlanan koruma dereceleri (IP kodu) (elektrik donanımlarında)
		Degrees of protection provided by enclosures (IP code) (For electrical equipments)
TS EN 50216- 1/2/3/4/5/6	IEC 50216- 1/2/3/4/5/6	Güç transformatörleri and reaktör ara bağlantı parçaları
		Power transformer and reactor fittings
TS IEC 60502- 1+A1	IEC 60502-1 +AMD1	Kablolar - Beyan gerilimleri 1 kv'dan (um = 1,2 kv) 30 kv'a (um = 36 kv) kadar olan yalıtımı ekstrüzyonla çekilmiş güç kabloları and bunların yardımcı donanımları - Bölüm 1: Beyan gerilimleri 1 kv (um = 1,2 kv) and 3 kv (um = 3,6 kv) olan kablolar
		Power cables with extruded insulation and their accessories for rated voltages from 1 kV (U<(Index)m> = 1, 2 kV) up to 30 kV (U<(Index)m> = 36 kV) - Part 1: Cables for rated voltages of 1 kV (U<(Index)m> = 1, 2 kV) and 3 kV (U<(Index)m> = 3, 6 kV)
TS EN 60567	IEC 60567	Oillar elektrikli cihazlar için- Çözünmüş and serbest gaz analizleri için oil and gaz numunesi alma kılavuzu
		Oil-filled electrical equipment - Sampling of gases and analysis of free and dissolved gases - Guidance
TS EN 61181	IEC 61181	Mineral oil doldurulmuş elektrikselsel donanım- Çözünmüş gaz analizinin (DGA) elektrikselsel donanım üzerindeki fabrika deneylerine uygulanması
		Mineral oil-filled electrical equipment - Application of dissolved gas analysis (DGA) to

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Standard Number		Standard Name (Turkish/English)
TSE	International Equivalent	
		factory tests on electrical equipment
TS EN 60599	IEC 60599	Mineral oil ile doldurulmuş kullanımdaki elektrikli cihazlar - Çözünmüş and serbest gazların tayin sonuçlarının cihazın durumunun değerlendirilmesinde kullanılması kılavuzu Mineral oil-filled electrical equipment in service - Guidance on the interpretation of dissolved and free gases analysis
TS EN 61672-1	IEC 61672-1	Elektroakustik - Ses seviye ölçerleri - Bölüm 1: Özellikler Electroacoustics - Sound level meters -- Part 1: Specifications
TS EN 61869-1	IEC 61869-1	Ölçü transformatörleri - Bölüm 1: Genel kurallar Instrument Transformers - Part 1: General Requirements
TS EN 61869-2	IEC 61869-2	Ölçü transformatörleri - Bölüm 2: Akım transformatörleri için ek kurallar Instrument transformers - Part 2: Additional requirements for current transformers
TS 3989 EN 60156	IEC 60156	Yalıtım sıvıları-Güç frekansında delinme gerilimi tayini Insulating liquids-Determination of the breakdown voltage at power frequency- Test method
TS EN 60137	IEC 60137	Yalıtkan geçiş izolatörleri - 1000 v'un üzerindeki alternatif gerilimler için Insulated bushings for alternating voltages above 1000 V
TS EN 60947-1	IEC 60947-1	Alçak gerilim anahtarlama düzeni and kontrol düzeni - Bölüm 1: Genel kurallar Low-voltage switchgear and controlgear - Part 1: General rules
TS EN ISO 1461	ISO 1461	Demir and çelikten imal edilmiş materialer üzerine sıcak daldırmayla yapılan galvaniz kaplamalar - Özellikler and deney metotları Hot dip galvanized coatings on fabricated iron and steel articles - specification and test methods
TS EN 60641-1	IEC 60641-1	Elektriksel amaçlı presli karton and presli kağıt özellikleri-Bölüm 1: Tarifler and genel kurallar Specification for pressboard and presspaper for electrical purposes-Part 1: Definitions and general requirements
TS EN 60641-2	IEC 60641-2	Elektriksel amaçlar için presli kağıt and presli karton'da bulunması gereken şartlar-Bölüm 2:

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Standard Number		Standard Name (Turkish/English)
TSE	International Equivalent	
		Deney metotları
		Pressboard and presspaper for electrical purposes - Part 2: Methods of test
TS EN 60641-3-1	IEC 60641-3-1	Elektriksel amaçlar için prespan and presli mukavvada bulunması gereken şartlar-Bölüm 3:Münferit materialler için şartlar-Föy 1:Prespan, tipler b.0.1., b.2.1, b.3.1, b.3.3, b.4.1, b.4.3, b.5.1, b.6.1, and b.7.1 için kurallar
		Pressboard and presspaper for electrical purposes - Part 3: Specifications for individual materials - Sheet 1: Requirements for pressboard, types B.0.1, B.0.3, B.2.1, B.2.3, B.3.1, B.3.3, B.4.1, B.4.3, B.5.1, B.5.3 and B.6.1
TS EN 60641-3-2	IEC 60641-3-2	Elektriksel amaçlar için prespan and presli mukavvada bulunması gereken şartlar-Bölüm 3:Münferit materialler için şartlar-Föy 2:Presli mukavva, tipler p.2.1, p.4.1, p.4.2, p.4.3, p.6.1 and p.7.1
		Specification for pressboard and presspaper for electrical purposes-Part 3:Specifications for individual materials-Sheet 2:Requirements for presspaper, types P.2.1, P.4.1, P.4.2, P.4.3, P.6.1 and P.7.1
TS EN 60450	IEC 60450	Yeni and eski selülozik elektriksel yalıtkan materiallerin ortalama viskometrik polimerizasyon derecesinin ölçülmesi
		Measurement of the average viscometric degree of polymerization of new and aged cellulosic electrically insulating materials
TS EN 60763-1	IEC 60763-1	Tabakalı prespen için şartlar-Bölüm 1:Tarifler, sınıflandırma and genel kurallar
		Laminated pressboard for electrical purposes - Part 1: Definitions, classification and general requirements
TS EN 60763-2	IEC 60763-2	Tabakalı presli karton için şartlar-Bölüm 2:Deney metotları
		Specification for laminated pressboard - Part 2: Methods of test
TS EN 60763-3-1	IEC 60763-3-1	Tabakalı prespan için şartlar-Bölüm 3.münferit material için şartlar föy 1:Önceden presle tabakalanmış prespan için şartlar-Tipler lb 3.1.1, 3.1.2, 3.3.1 and 3.3.2
		Laminated pressboard for electrical purposes - Part 3: Specifications for individual materials - Sheet 1: Requirements for laminated

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Standard Number		Standard Name (Turkish/English)
TSE	International Equivalent	
		precompressed pressboard, Types LB 3.1A.1 and LB3.1A.2
	IEC 60554-1	Specification for cellulosic papers for electrical purposes. Part 1: Definitions and general requirements
TS EN 61061-1	IEC 61061-1	Elektriksel amaçlar için empenye edilmiş preslenmiş levha ahşap -Bölüm 1: Tarifler, gösteriliş and genel kurallar Non-impregnated densified laminated wood for electrical purposes - Part 1: Definitions, designation and general requirements
TS EN 61061-2+A1	IEC 61061-2+A1	Elektrik amaçlı empenye edilmemiş preslenmiş levha ahşap-Bölüm 2: Deney metodları Specification for non-impregnated, densified laminated wood for electrical purposes - Part 2: Methods of test
TS EN 60893-3-5	IEC 60893-3-5	Elektrik yalıtım materialleri - Termoset reçine esaslı endüstriyel rijit lâmine levhalar - Bölüm 3-5: Münferit materialer için özellikler - Polyester reçine esaslı rijit lâmine levhalar için gerekler Insulating materials - Industrial rigid laminated sheets based on thermosetting resins for electrical purposes - Part 3-5: Specifications for individual materials - Requirements for rigid laminated sheets based on polyester resins
	IEEE C57.93	IEEE Guide for Installation and Maintenance of Liquid-Immersed Power Transformers
TEİAŞ New Insulating Oil Purchase Specifications (given in the attachment of the specifications)		
TEİAŞ Oil Specifications for New Transformer Immersed with New Insulating Oil (given in the attachment of the Specifications)		

Electrical accessories, components and other auxiliary equipment shall be compliant with the relevant TSE or IEC standards even if not indicated in the above standards. In relation with the materials, for which those conditions do not exist, the bidder shall propose applicable standards, provided that the approval of the Directorate is obtained.

If equivalent or other superior standards are applied, their copies in Turkish and/or English shall be submitted together with the bid.

In case of differences between TSE and IEC standards, written permission of the Directorate shall be obtained about the standard to be applied.

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All chemical, physical and dielectric characteristics of the materials used in the production of transformers shall comply with the characteristics prescribed in the relevant ASTM (American Society for Testing and Materials) or DIN (Deutsches Institut für Normung) or norms of European Union Countries.

If the above standards and/or documents are modified at the stages after the stage of opening the bids received for transformers, the modification or edition that was in force on the date of bid shall apply.

### 1.3. Operational Conditions

Unless otherwise specified in the list of Warranted Characteristics, the transformers constituting the subject of the order shall be suitable for outdoor use under the following operational conditions.

The following conditions are normal operational conditions and the values in the Technical Specifications and their annexes are given in accordance with those conditions. If the Directorate has requests other than those conditions, those requests shall be indicated by the Directorate before the tender. The Manufacturer shall perform its works in compliance with the relevant standards taking into consideration the requests notified by the Directorate prior to the tender. The changes that may occur in the Technical Specifications, and if any, in the design, shall be submitted to the approval of the Directorate.

-	Altitude above sea level	Up to 1000 m
-	Environmental temperature	
	. Daily maximum	+45 °C
	. Daily minimum	-25 °C
	. 24 –hour average	Less than +35 °C
-	Annual average	Less than +25 °C
-	Maximum wind pressure	
	. On round surface	700 pascal
	. On flat surface	1200 pascal
-	Maximum solar radiation	1000 W/m <sup>2</sup>
-	Ice load	10 mm, Class 10
-	Susceptibility to industrial pollution	Yes (heavy pollution)
-	Maximum relative humidity (24 –hour average)	95 %
-	Lightning impulse probability	Yes
-	Earthquake (*)	
	. Horizontal acceleration	0,5 g (at ground level)
	. Vertical acceleration	0,25 g

(\*) The transformer shall be designed so as to withstand horizontal and vertical earthquake acceleration values and so that none of its units (bushing, etc.) will be damaged, the designs, drawings and materials necessary for the installation of the Transformer at the place of operation and the earthquake strength calculations of the

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Transformer shall be submitted by the Contractor. Any kind of bolts, fasteners, etc. necessary for the assembly and fixing of the Transformer that is produced in this way, shall be provided by the Contractor.

### 1.4. Auxiliary Power Supplies

The following auxiliary power supplies shall be provided at each location, where the Transformers will be installed:

-	Three phase AC system (with neutral)	380 volt + 10%, - 15%, 50 Hz (**)
-	Single phase AC system (phase – neutral)	220 volt + 10%, - 15%, 50 Hz (**)
-	DC system	110 or 220 volt, + 10%, - 15%

The transformers, for which 220 V DC will be used, shall be separately indicated after signing the contract.

## 2. TECHNICAL CHARACTERISTICS

### 2.1. Rated Values and Performance

The Transformers, which are included in the scope of these specifications shall be for outdoor use, shall be oil immersed (mineral oil) type and shall have the following characteristics:

-	Winding number	2			
-	Phase number	3			
-	Rated frequency (**)	50 Hz			
-	Cooling method	ONAN/ONAF			
-	Rated power	31.25 MVA	62.5 MVA	100 MVA	125 MVA
-	Requested rated power values in accordance with the cooling method				
	. ONAN	≥25MVA	≥50MVA	≥80MVA	≥90MVA
	. ONAF	31.25MVA	62.5MVA	100MVA	125 MVA
-	Temperature rises				
	. Top oil	≤ 55 °C			
	. Winding	≤ 60 °C			
	. Core surface	≤ 75°C			
	. Hot-spot point of the winding	≤73 °C			
-	Rated voltages				
	. High voltage (HV) winding	154kV	154kV	154kV	400kV
	. Low voltage (MV) winding	As in the list of warranted characteristics			
-	Tapped Winding	HV winding, on neutral side			
-	Tap changer type	On load			
-	Voltage regulation range	As in the list of warranted characteristics			
-	Tap number	As in the list of warranted characteristics			

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-	Category of voltage variation	CFVV (Constant Flux Voltage Variation)			
-	Tap powers	100% rated power at all taps			
-	Temporary overloading	In accordance with IEC 60076-7			
-	Maximum system voltages				
-	High voltage	170 kV	170 kV	170 kV	420 kV
-	Low voltage	As in the list of warranted characteristics			
-	Connection group	As in the list of warranted characteristics			
-	Insulation of windings	HV tapped, MV uniform			
-	System grounding method	HV direct grounding, MV direct or over resistance			
-	Impedance voltage	As in the list of warranted characteristics			
-	Insulation levels	As in the list of warranted characteristics			
-	Audible noise level	As in the list of warranted characteristics			

The values and characteristics requested in relation with Transformers are given in the List of Warranted Characteristics for information purposes. The Directorate shall prepare the List of Warranted Characteristics taking into consideration the place of use and operational conditions.

(\*\*) Frequency variation range: Unless otherwise specified in the Electrical Grid Code, the Transformers shall be designed so as to be operable continuously in 49-50.5 Hz frequency range, and taking into consideration that frequency can increase up to 52.5 Hz or decrease down to 47.5 Hz in extraordinary conditions, they shall be operable for 10 minutes in 52.5 Hz-51.5 Hz frequency range, 1 hour in 50.5 Hz-51.5 Hz frequency range, 1 hour in 48.5 Hz-49 Hz frequency range, 20 minutes in 48 Hz-48.5 Hz frequency range, 10 minutes in 47.5 Hz-48 Hz frequency range being connected to the transmission grid.

### 2.2. Overloading

The overloading conditions of the transformer shall be compliant with TS EN 60076-7 standard. The overloading performance of the transformer shall be ensured by switching off the backup radiator as is the case for temperature rise test.

The loading curve/ table related with the overloading conditions shall be submitted to the Directorate.

### 2.3. Tolerances

If the values measured for each Transformer during the Factory Acceptance Tests are within the value ranges indicated in the "WARRANTED" column of the List of Warranted Characteristics with the following tolerances, the Transformers will be accepted, however, the penalties indicated in Article 2.4 shall be applied for the losses.

Tolerances to be applied for rejection:

-	No-load losses at the main tap	+15%
-	Load losses at the main tap and at	+10%

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	rated current	
-	No-load transformer ratio deviation at all taps	±0.5%
-	Impedance voltages at the main tap and at rated current	As in the List of Warranted Characteristics
-	Impedance voltages at the extreme taps	As in the List of Warranted Characteristics
-	No load current at the main tap, at rated voltage and 10% above the rated voltage	+30%
-	Internal partial discharge	NO
-	Audible noise level	NO
-	Temperature rise	NO

### 2.4. Incompliance with Warranties

If the tests on the Transformers show that the equipment is not compliant with the warranted values (“WARRANTED” column) (provided that the losses are within the tolerances indicated above), the Directorate applies the following penalties separately for each transformer. No additional payment shall be given for the characteristics that are better than the warranted values.

#### a) No-load Losses:

A penalty of 7.000-USD shall be applied for each kW of no-load losses exceeding the warranted value at 110% or 100% of rated voltage (at the point, where deviation is maximum at 100% or 110% of the rated voltage).

#### b) Load Losses:

A penalty of 2.500 –USD shall be applied for each kW exceeding the warranted load loss value. For the calculation of this penalty, warranted characteristics shall be referred to from the warranted values (main tap, or highest or lowest tap) and it shall be calculated for the setting tap position giving the biggest deviation.

c) A penalty of 3.000 USD shall be applied for each kW exceeding the warranted power value of fan losses in the cooling system.

### 2.5. Assessment of Losses (At the stage of bid assessment)

The transformers, whose loss values are higher than the loss values requested by TEİAŞ in the list of warranted characteristics (“REQUESTED” column) shall be rejected.

Furthermore, the transformers, whose audible noise levels, partial internal discharge, temperature rise values are higher than those requested in the list of warranted characteristics (“REQUESTED” column) by TEİAŞ shall be rejected.

## 2.6. Deviations

The matters indicated in the Technical Specifications and the values given in the list of warranted characteristics have to be complied with strictly. In case of incompliance, the bidder shall clearly indicate the deviations in the list given in Annex-3. The List of Deviations that is completed by the bidder shall be assessed by the Directorate in terms of compliance with the essence of the Technical Specifications and with the relevant standards.

At the stage of bid assessment, the Directorate reserves the right to reject or accept the bids that contain technical deviations.

Furthermore, if nothing is indicated in the List of Deviations, it shall be assessed that the transformer and all equipment completely comply with the technical specifications.

## 2.7. Structural Characteristics

The materials to be used in the production of the Transformer shall be brand new, shall be of first class quality defined in the standards, shall be fit for purpose and complete.

### 2.7.1. Magnetic Circuit (Core)

The transformers shall be three- legged core type.

The core shall be made of high quality, cold-rolled silica sheet steel having smooth surfaces, whose crystals are oriented and which has high magnetic permeability. The attachments shall be cut at 45° and step-lap technology shall be applied. Each plate shall have insulation that will not deteriorate under pressure and under the effect of hot oil.

The steel sheets constituting the core and their insulation materials shall be designed so as not to allow the occurrence of harmful changes in the physical or electrical characteristics of the transformer for its entire life.

The layers constituting the core shall not be attached to each other with bolts at the legs and yokes, hot-spot formation shall be avoided. The core structure shall be so as to require the disassembly of minimum number of layers in the disassembly and replacement of windings.

Core plates and windings shall be appropriately supported to ensure protection against bending and to prevent movement during transportation and under short circuit conditions that may be encountered. Special side supports shall be placed in each corner to prevent the movement of the core during transportation. Additionally, the core bottom shall be connected to the tank bottom. The insulation between the core and the yoke iron shall be produced so as to withstand 2500 V rms, 1 minute, 50 Hz.

For core grounding, the internal terminal shall be connected to an external grounding terminal on the tank using a braided copper conductor with appropriate section and necessary insulation, from a single terminal. The internal terminal related with the core compression iron (yoke) grounding must be connected to another external grounding terminal using a separate conductor as indicated. The external grounding terminals shall be grounded being externally connected to the tank using conductors of appropriate section. The external grounding terminals must be easily accessible without discharging the tank oil and the relevant external connections must be detachable for the insulation tests of the core and the yoke in accordance with the tank and each other.

### 2.7.2. Windings

For HV windings, epoxy resin impregnated transposed conductors consisting of electrolytic copper conductor or lac-insulated electrolytic copper conductors shall be used. Those conductors shall be wound in multi-layers using **thermally upgraded** cellulosic paper. For MV windings, epoxy resin impregnated transposed conductors consisting of lac-insulated electrolytic copper conductors shall be used. If necessary, those conductors shall be wound in multi-layers using **thermally upgraded** cellulosic paper too.

The insulation of HV winding shall have tapped insulation for directly grounded neutral. The MV winding shall have uniform insulation.

The windings shall be produced so as not to allow insulation wear during operation and in case of temperature changes.

The windings and connections shall be produced and fixed so as to withstand the temperature rise, overloading conditions, forces in axial and radial directions occurring in case of short circuit and dielectric tests indicated in the technical data as explained in the construction standard of the transformer.

All current carrying joints between connection conductors and between those conductors and cable lugs shall be silver welded or compression type, multi-bolt connectors shall be used. All conductor ends shall be well-supported.

Winding canals shall be appropriate for the natural circulation of oil and by this way, pumping systems shall not be needed for oil circulation in ONAN/ONAF cooling.

### 2.7.3. Tank

Unless otherwise specified, the tank shall be welded and the cover shall be of bolt-connection type. The tank and the cover shall be made of high-quality steel plates.

The tanks and covers shall be designed so as not to leave any external pockets, where water can accommodate, and so as not to leave any internal pockets, in which oil can remain in case of tank drainage or where air can be trapped while the tank is being filled or where the gas escaping out can be trapped and prevent the operation

of Bucholz relay. The ventilation pipes shall connect all points, where air/ gas can be accumulated, to the Bucholz relay.

The tank shall be designed as a durable structure and care shall be paid to ensure that the production is completed with high-quality workmanship.

The tank must be durable against forces during transportation, vacuum forces stresses during oil drainage operation and hydrostatic and dynamic forces that occur in operation, especially during a short circuit.

The resonance frequencies of the tank must be sufficiently far from 50 Hz and 100 Hz.

All bolts used in the production of the tank shall be made of stainless steel. The boiler, cover and storage bolts shall be painted after being assembled.

Special precautions shall be taken by using non-magnetic steel wherever necessary in order to minimize the impacts of the fluxes that occur due to leakage flux and high current carrying conductors.

Tank and its accessories shall be designed and produced so as to allow avoiding from any harmful impact that may be produced by vibrations.

The welds shall be performed in compliance with the standards that define the welding works and by applying double welding, where sealing is requested. In order to make sure that there is no oil leakage, all relevant welds shall be subjected to oil leakage test.

The metal continuity between the parts constituting the tank and various pipes etc. must be performed so as to ensure that all of them are at the same potential.

If the lower ends of all bushings cannot be easily accessed, there shall be openings (manholes) on the cover allowing access to the lower ends of bushings. In case reintrant type bushings are used, no manholes are necessary. The inspection covers shall have lifting arms.

In order to be able to easily intervene to the tap selector section of the on-load tap changer, a manhole of appropriate size shall be provided.

The tank shall be equipped with lifting hooks, connections for pulling and with jack bases having sufficient strength for lifting the transformer in fully assembled and oil filled condition. The jack bases shall allow the application of hydraulic jacks even if the wheels are disassembled and the transformer is placed on the ground. Lifting hooks shall be provided on active sections to allow their extraction from the tank.

The bottom of the Transformer shall be suitable for sliding. A flat bottom or a bottom with plate that is formed with corrugated reinforcements designed for sliding it in parallel with the tank axes shall be provided. The necessary connections shall be

provided on the bottom or adjacent to the bottom for pulling the transformer in the directions indicated above.

The tank bottom shall have a strong and non-bending structure to carry the entire weight of the transformer on four pieces of single-flanged swiveling wheel groups, the wheel groups shall be rotatable horizontally in two directions perpendicular to each other. The wheels shall be suitable for moving the transformer with a rail gauge of 1440 mm on the short edge and 1440 and 2942 mm on the long edge. The wheels and wheel brakes, which prevent the undesired movements of the transformer, shall be provided.

The tank design and the dimensions of the main parts shall be suitable for railway transportation to be performed being lapped on side supports. For this purpose, two sets of support shall be provided to be assembled on the tank using bolts. The explanations in this context are given in Article 2.7.13.

All seals shall be placed in slots opened in the form of grooves or in grooves constituted with two steel bars that are welded around the tank for this purpose. The manufacturer shall apply an effective sealing system and shall ensure that no oil leakage occurs during operation. The diagram of the sealing system proposed with the bid shall be submitted together with references evidencing their long-period problem-free operation. The bolts used between the flanges shall be well-bolted against leakage of oil. Alternatively, externally – interlocking clamp can be used instead of the bolts.

The following accessories shall be provided on the tank:

- Oil drainage valve
- Lower and upper valves necessary for the draining and filtering of oil
- Oil sampling valves (top, middle, bottom)
- Vacuum pump valve (characteristics and position on the Transformer shall be determined after the order.)
- Two thermometer slots on the tank cover, one being for thermal image.
- Sealing valves on the tank side at the joint of each radiator with the tank
- Flanges for the connection of radiators to the tank
- Two tank grounding lugs made of steel with copper surface or directly made of stainless steel. The grounding lugs shall be welded on the tank bottom and shall be in the middle of two short edges. Clamp type terminals and bolts shall be provided for each lug grounding wire connection.
- A sufficient number of pressure relief valves having trip contacts on the tank cover. The relief pressure must be selected so as to prevent unnecessary reliefs especially in cases of short circuits in operation and during a successful short circuit type test. The pressure valves shall be placed on the tank.
- A ladder compliant with occupational safety shall be provided for climbing on the Transformer.
- A hole with embedded flange at zero elevation on the tank bottom for removing the sediments and oil sludge that accumulate as the result of aging (so as not to prevent sliding of the tank)

- A hardware plate made of rustproof material showing the open-closed positions of the valves shall be installed on the tank for operations such as oil filling, oil draining and vacuuming etc. the plates shall be fixed using screws made of rustproof material and the writings (signs) shall be indelible.
- The relief pressure of the relief valves shall be selected so as not to require unnecessary interventions especially during the short circuits in operation and during a successful short circuit test.
- Two anchorage points in the form of rectangular plates shall be welded on the tank walls of the transformer, approximately 250-350 mm lower than the cover level in compliance with the technical details given in Annex-6 in order to allow the installation of "Horizontal Life Line System" on the transformer by the Directorate to ensure occupational health and safety.

#### 2.7.4. Oil Conservator

Oil conservator shall be assembled on the tank wall using legs.

Each transformer shall be equipped with an oil conservator of sufficient capacity to accommodate the changes in the oil volume in the tank between the minimum ambient temperature and maximum ambient temperature and under the loading conditions in the field. A small amount of oil shall always exist in the oil conservator at a certain height and the volume of the conservator shall be sufficient to accommodate the oil expanding under maximum load and maximum temperature conditions.

The oil conservator shall have an appropriate division for on-load tap changer switch oil. The tank oil of the transformer shall be kept separately from the on-load tap changer switch oil.

The following equipment shall be provided in each oil division:

- Oil level indicator having the permitted maximum and minimum oil level alarm contacts.
- Breathing device with "silicagel" material, which dehumidifies the air and which is placed at an accessible height.
- Oil filling appliance
- Drainage valve
- Inspection manhole

The oil level indicator that will be assembled on the vertical surface of the oil conservator shall be readable when viewed from the ground level of the tank. The minimum and maximum levels at +20°C shall be marked on the dial. Other oil level marks shall be shown with the temperature values corresponding to those levels. Lifting hooks shall be provided on the oil conservator.

The oil conservator shall not contact directly with air to prevent the absorption of gases and humidity by the oil. The system called "Atmoseal" has to be applied. The dehydrating-Silicagel-breathing device shall additionally be installed between the oil

conservator and atmosphere in order to prevent the humidity accumulation in the air cell.

The bidders can submit different oil protection systems, for which a long –period operational experience is documented, to the Directorate for assessment.

The use of an oil conservator divided into two parts by using a flexible membrane between two flanges shall not be acceptable.

#### 2.7.5. Bushings and Terminals

The bushings shall be compliant with the relevant IEC standard and the electrical characteristics given in the List of Warranted Characteristics. The bushings with a rated value above 52 kV shall be of oil-immersed condenser type without corona and shall be hermetically sealed. The nominal creepage distance of the bushings shall be minimum 25 mm/kV. The insulators shall be brown and made of porcelain.

A test end shall be provided on the condenser bushings for measurement purposes. However, the necessary precautions shall be taken to prevent the adverse impact of the reaction of metals on the cover of that test end and its slot in time. The test cover shall be easily attachable and detachable during its operational life.

The design of bushings shall minimize the partial discharges and radio frequency interference.

Wherever applicable, the bushings at the same voltage level shall be interchangeable. An appropriate lifting system shall be provided.

The bushing type current transformers, the characteristics of which are given in the List of Warranted Characteristics, shall be provided on each HV bushing of 400/MV transformer. It shall be possible to disassemble the bushings without affecting the current transformers.

HV main terminals shall have 40 mm diameter, minimum 80 mm length and shall be copper or brass alloy depending on the place of application.

The condenser bushings shall be equipped with oil indicator, oil drainage and sampling tools that will allow the observation of oil level.

The fasteners between the bushings and the tank shall be designed so as to prevent damage to the porcelain due to the short circuits during operation and due to the stresses produced in the short circuit type test.

#### 2.7.6. On-load tap changer

The voltage regulation of HV windings shall be performed through the three-phase on-load tap changer, which is of resistance type, and which will be placed at the star point of the transformer. The on-load tap changer shall be compliant with IEC 60214-

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1 and IEC 60214-2 standards. The tap changing switch shall be of fast-operating type and shall contain independent energy storage facilities for both manual and motor driven operating mechanism. The rated current and tap voltage of the tap changer shall have a wide margin above the operational values.

Unless otherwise indicated, the on-load tap changer shall be of vacuum type. The necessary information on the proposed on-load tap changer shall be submitted together with the bid. If the on-load tap changer is requested of oil type by the Directorate, the transformer shall be equipped with a special, internal oil filtering system. The tap changer switches, operational experiences and performance quality of which are proven, shall be preferred by TEİAŞ.

The on-load tap changer must be capable of performing 100.000 switching operations without requiring any maintenance such as lubricating the motor drive mechanism and replacing the oil of tap changer switch (whichever occurs first), or must be operable for 10 years. The first maintenance for vacuum switches (if they will be used) must be performed after 300.000 switching operations. For oil type switches, it shall not be necessary to replace the tap changer switch contacts before 200.000 switching operations. For vacuum type switches, it shall not be necessary to replace the vacuum cells before 600.000 switching operations. The detailed technical characteristics of the vacuum tube shall be provided together with the bid.

The Diverter Switch and tap selector shall be assembled in the transformer tank. The diverter switch, which switches the current circuit on and off and the insulation oil, which is susceptible to direct pollution due to this operation, shall be placed in a special cell to be kept separate from the insulation oil in the transformer tank, and shall be connected to a separate division in the oil conservator. A protection relay, which will detect the sudden pressure change in the tap changer and the sudden oil flow variations between the tap changer and oil conservator, shall be installed.

A bolted cover that can be disassembled shall be provided for the diverter switch section in order to be able to access the diverter switch without opening the tank cover of the transformer or without need to lower the oil level in the tank. The Tap changer cover shall be equipped with a pressure valve that will prevent damages that may occur on the tap changer as the result of pressure. An observation window shall be provided on the control box cover of the tap changer in order to observe the operation position of the tap.

The diverter switch cell shall be equipped with an oil sampling tap, valves for oil drainage and an oil drainage system. The oil sampling valve shall be lowered down to an appropriate level using a pipe.

The tap changer mechanism shall be operated with a 3-phase motor-driven mechanism that is placed out of the Transformer tank. The motor operation shall be ensured in two ways, either only locally or only remotely.

The on-load tap changer shall be equipped with a blocking system (over-current blocking device) that prevents tap change under over-current.

All of the vertical and horizontal shafts of the diverter switch shall be in an appropriate enclosure.

There shall be a detachable crank for the manual control of tap changer. The motor operation shall be locked before actually moving the manual control shaft of the crank. The turning lever shall be at a height allowing easy control and the torque shall be compatible with the application of a force not exceeding 50 Nm. The direction of rotation shall be indicated near the point, where the turning lever is connected, and the number of lever turns for one (1) tap changing operation shall be given.

The operation mechanism of the tap changer (motor drive), its local controls and protections shall be in a box, the box shall be assembled on the tank at an appropriate height and shall have the following characteristics;

- All equipment and devices shall be assembled in the box so as to be easily accessible and box dimensions shall be sufficient.
- The box shall be of a strong airproof and dustproof type, shall be compliant with minimum IP 56 protection conditions under IEC 60529 and shall be appropriately protected against condensation.
- There shall be a transparent window of sufficient size on the control box allowing the observation of the position and numerator information of the analog indicator easily.
- Space shall be provided in the control box for the turning lever to be used for the manual control of the tap changer.
- The motor drive mechanism control box cover shall be designed so as not to contact with parts under voltage.
- It shall have a strong and moving door, which is installed with a locked mechanism.
- A pocket shall be provided inside the control box cover to put the single line diagram and tap switch catalog information.
- A sufficient amount of spare connector rails shall be provided in the control box for the assembly of the equipment that may be placed in the future.

The nameplate, warning and instruction plates shall be written in Turkish or their translation into Turkish shall be provided together with their English version. The technical drawings showing the physical dimensions of the control box, the layout of the equipment and devices inside the box and their dimensions shall be submitted to the Directorate for approval.

The motor-drive mechanism shall contain the following sections:

- Manual operation/ automatic operating control switch
- Local/ remote operating control switch
- Tap Rising/ Lowering control switch
- Detachable turning lever for manual operation
- Step by step control relay
- Mechanically driven tap position indicator that is observed through a control window and that can be seen from far distance

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- Tap changer operation indicator
- Thermal magnetic protection switch
- Thermostat – controlled heater
- AC internal lighting lamp with 1-meter extension cable, which is lit automatically when the control box cover is opened
- Socket with 10 A rated current
- Minimum six – step tap changer counter (numerator)
- Position end switches
- Mechanism that electrically transmits the tap position to a remote location
- Mechanism necessary for remotely observing the tap changer in operation position
- Operating contactors, auxiliary relays
- Auxiliary relays that are operated with push buttons/ switches and that ensure full operation of contacts and locking between the uprising/ lowering operations
- Terminal blocks for connection to the box, auxiliary contacts connected to the terminal blocks.
- Emergency stop button

The control panel shall contain the following parts:

- Automatic voltage regulator (**shall not be purchased unless otherwise specified by the Directorate**)
- As materials to be supplied for embedded assembly on the control panel at the substation; tap position indicator (for remote location), tap changer in operation indicator, tap uprising/lowering control buttons, Remote/ Local/ Automatic position indicators of the tap and tap stop button,

Tap changer indicator shall have a transducer with 20 mA output. The transducer output shall be 3x(4-20 mA). The cabling shall be made and prepared for commissioning so that the 1<sup>st</sup> outlet will be the outlet control panel, the 2<sup>nd</sup> outlet will be the SCADA panel and the 3<sup>rd</sup> outlet will be spare.

### 2.7.7. Cooling System

The cooling of Transformers shall be of ONAN/ONAF type and shall include radiators installed on the tank and fans for forced air circulation.

The radiators shall be of detachable type, shall be connected to the tank and/or battery system using O-ring seal flanges and shall be equipped with butterfly valves that will cut the oil inputs and outputs. In this way, it shall be possible to assemble and disassemble each group of radiators without switching off the transformer or without discharging the oil in the tank.

The design and production of radiators must ensure their vibration-free operation and that they are oil-proof notwithstanding the wind speed and atmospheric conditions. The radiators shall have a strong structure and shall be tightly connected to the tank.

The fan and motors shall be of high-efficiency and low noise level type.

Each radiator shall have a connection part for lifting, and oil and air drainage valves. The radiators shall be capable of withstanding the vacuum that the main tank can withstand.

The transformers shall be capable of operating in full compliance with the conditions indicated in the list of warranted characteristics when the fans are out of service (ONAN cooling) and at 80% of ONAF rated power.

The transformer shall have a backup radiator to ensure continuous operation at ONAN and ONAF full power indicated in the specifications without exceeding the indicated temperature rises in case of disassembly of any of the radiators.

Fan and motors shall be fully enclosed in compliance with indoor and outdoor operation, shall be protected against vibrations and outdoor weather impacts and accidental contact with fan propellers shall be prevented using a galvanized cage wire with openings not exceeding 25mm. The fan motors shall be divided into two groups at the motor supply point; each of the groups shall be protected with three phase miniature circuit breakers and shall be individually controlled with the contactor. Additionally, each motor shall have a contactor equipped with thermal relay.

Control and protection equipment shall be placed in appropriate metal boxes and shall accommodate the auxiliary equipment necessary for the operation and supply of cooling fans.

Each fan group shall be Locally manually/ remotely manually / automatically operable. For each fan group, "Locally Manual/ Remotely Manual/ Automatic" diverter switch shall be provided, furthermore, it shall contain the contactors necessary for remotely monitoring the switch position (central control panel).

Each fan group shall automatically switch on upon the signal received from the winding temperature thermometer and oil temperature thermometer and shall automatically stop when such signal decreases down the predetermined value. There shall not be any interlocking between the winding temperature and oil temperature circuits.

Control system shall have contacts to see the operating fan groups on the indicators. Alarm contacts shall be provided for the following abnormal conditions:

- Breakdown of one or more fans
- Cutoff of supply of the hot-start device or its malfunction.

The fan groups in operation lamp shall be green, fan groups failure lamp shall be red.

#### 2.7.8. Auxiliary Equipment (Accessories)

Each transformer to be delivered shall include the following accessories. Their prices shall be included in the transformer price:

- a) For top oil temperature, thermometer with divided dial, maximum indication cursor and electrically independent, separately adjustable alarm and trip contact
- b) Winding temperature indicator, equipped with 4 contacts with independent circuits, one of which is for high temperature alarm, one is for opening and two of

which are for cooler controls.

- c) Winding temperature shall be measured using thermal image technique. Thermal detection member and oil temperature detector shall be placed in a sealed pocket on the tank cover. Electrical transmitter shall be provided for the remote temperature recorder.
- d) Bucholz relay, which has two buoys, independent alarm and trip contacts and which is assembled on the pipe that combines the tank and the oil conservator, shall be equipped with relay, circuit test mechanism and gas sampling appliance that is placed at an accessible height. Bucholz relay shall not operate in case of short circuits in operation and during a successful short circuit type test.
- e) Oil level alarm relays for the tank and diverter switch
- f) A gas relay that has trip contacts that is assembled on the pipe that connects the tap switch cell to the cell belonging to the tap changer in the oil conservator (or an equivalent device)
- g) Butterfly valves that will cut off the up and down flow for the gas relays indicated above
- h) Valves for oil sampling (top, middle, bottom); bottom and top valves for the draining and filtering of oil shall be provided. Their characteristics and positions shall be explained in the bid. Furthermore, the diverter switch cell shall contain an oil sampling tap, valves for oil drainage operation and oil drainage system. The oil sampling valve shall be lowered to an appropriate level using a pipe.
- i) Two thermometer slots on the tank cover, one being for thermal imaging.
- j) Sufficient number of pressure relief valves on the tank cover having trip contacts. A pipe system shall be installed from the valve to the transformer bottom with appropriate diameter and dimensions in order to prevent the spilling of oil on and around the transformer in case of operation of pressure valve, taking into consideration the pressure and amount of oil. This matter shall be clearly shown in the approval drawing.
- k) A hole with embedded flange at zero elevation on the tank bottom to be able to remove the sediments and oil sludge that accumulate as the result of aging, whenever necessary (so as not to prevent the sliding of the tank)
- l) Remote winding temperature indicator with temperature indicator and electrical reset, which will be installed in embedded type in the Substation control panel.
- m) A device (conservator shutter mechanism) shall be placed between the oil conservator and Bucholz relay to cut off the oil flow in order to prevent the oil flow from the oil conservator to the tank in case of oil drainage from the tank due to any failure that occurs in the transformer. This device shall be automatically closed with the dynamic movement of oil when the oil flow increases and shall prevent the oil flow from the oil conservator to the tank, and hence the supply to the failure location. The mentioned device shall be assembled at the most appropriate point to ensure effective operation of the device.
- n) A signal relay shall be installed on the oil conservator to determine whether the rubber compensator in the oil conservator performs its function.
- o) In the Transformer (except radiator valves and oil sampling taps) direct flow Cr-Ni ball valve, the body and internal parts of which are made of stainless steel, shall be used.
- p) Transformer Monitoring System (TMS) (shall not be purchased unless otherwise specified by the Directorate)**

- q) Vacuum pump valve (will be agreed on its characteristics and position after placing the order)
- r) Sealing valves on the tank side at the joint of each radiator with the tank.

#### 2.7.9. Control Box and Cable Installation

All control boxes shall be placed at a height that can be accessed without a ladder considering the height of the foundation and base of the transformer. The temperature indicators, fan switches, auxiliary relays shall be placed at locations that can be accessed also during operation. The places, to which they are connected, shall be close to the relevant devices and shall be accessible also when the transformer is energized.

The control box of the transformer shall have a strong structure, shall be airproof and dustproof and shall be protected at minimum IP56 degree in accordance with IEC 60529 and shall be protected appropriately against condensation.

Appropriate heaters with thermostatic members and natural ventilation shall be provided in the control box of the Transformer. A lamp that is equipped with a transparent safety glass and controlled with a button connected to the movement of the door shall be provided.

The terminal blocks of the auxiliary power cable installation on all panels, the internal cabling of the equipment and the cable installations used for control, protection and alarm shall be of modular type and shall be made of self-extinguishing or flame retardant material. Terminal blocks shall be assembled on rails and shall be attached with springs. The rails shall be grounded.

The insulation level of cables on all panels shall not be less than 3 (tested at 2 kVrms in accordance with ground) the sheath quality shall be R2 and shall be of a type that is resistant against flame propagation and against the temperature that will occur close to the tank. The alarm and tripping circuits shall be independent.

The sections of the cables coming from the measurement and protection windings of bushing type current transformers on the Transformer to the current terminals in the transformer control box shall be minimum 6mm<sup>2</sup>. The terminal blocks shall be selected appropriately for cable section.

In all control boxes, the terminal block rows shall be separated from each other with a sufficient distance. On each rail row, there shall be minimum 10% spare terminal blocks for future use. A detachable marking band shall be provided on each terminal.

All electrical connections outside the Transformer shall be carried from terminal blocks using steel pipes or other protective sheaths. The cabling in the panels shall have PVC or similar oil-resistant insulation. The cables on the transformer shall be steel shielded multi-conductor, or alternatively, they shall be installed in flexible pipes or routes made of steel or aluminum.

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All cable routes and/or steel shielded multi-core conductors shall be tied using steel ties.

The conductors shall be terminated with tin coated lugs or clamp type terminals shall be used.

The ends of all cables that are adjacent to the terminal blocks shall be equipped with rings for the correct diagnosis.

A sufficient number of cable entrance holes equipped with sleeves and plastic taps resistant against external conditions shall be provided on the panel.

Color of the box shall suit with the color of the transformer.

The marks on the control box and the colors of the cables that are used shall be compliant with IEC 60445 standard and the following table.

- Brown, black, gray	a.c.	(alternating current)	phase	connections
- Blue (or light blue)	a.c.	(alternating current)	neutral	connections
- Yellow- Green	a.c.	(alternating current)	ground	connections
- Brown (L+), Gray (L-)	d.c.	(direct current)	circuits	

The circuit insulation shall be as follows:

- Power frequency withstand voltage  $\geq 2kV_{rms}$

Control voltage shall be 110 VDC.

A socket that is separately supplied from the lighting and heater circuit shall be provided in the control box. The socket circuit shall be protected with a 16A fuse.

### 2.7.10. Insulating Oil

This oil shall be brand new and unused, and unless otherwise specified, it shall comply with "TEİAŞ New Insulating Oil Purchase Specifications" given in Annex-4.

In any case, the bidder shall notify the type of the oil he will use to the Directorate for approval.

### 2.7.11. Lifting and Handling Utility

Appropriate utilities shall be provided for lifting the transformer enclosure, windings, oil conservator and the complete transformer.

At the bottom of the transformer, beams constituting a rectangle that allow the movement of the tank in directions parallel with its central axes shall be provided.

In order to move the transformer in parallel with the directions mentioned above, a pulling mechanism shall be provided on the transformer base or adjacent to it.

The transformer tank base shall have a chassis that does not deform and that can support the entire weight of the transformer on 4 wheels having a single flange. It

must be possible to position the wheel groups perpendicular to each other for bidirectional movement.

#### 2.7.12. Tank Grounding Assembly

On two surfaces of transformer tanks, grounding terminals made of copper clad steel or only stainless steel shall be provided. They must be welded at the point in the middle of two short edges on the transformer base.

#### 2.7.13. Transportation

The transformers shall be transported in compliance with IEEE C57.93 standards without assembling their bushings, oil conservator, cooling units, wheels and other accessories.

The transformers shall be designed for highway or railway (in compliance with wagon and load gauge of T.C.D.D.) transportation on a vehicle. Two sets of hooks shall be provided to be bolted on the tank.

Cooling units, oil conservator, bushings, wheels and other accessories shall be packed in chests taking the necessary precautions against corrosion, breaking, shocks and vibrations and shall be transported in compliance with domestic and international transportation rules.

The transformers shall be transported with additional gas supply (nitrogen cylinder) assembled against the leakages during transportation and storage. All holes (including the holes of the radiators) shall be closed with blind flanges.

The transformers shall not be transported being filled with oil.

The insulating oil of the transformer shall be shipped in barrels.

The transformer shall be transported together with its accessories and tool set.

Unless otherwise specified, the Contractor shall provide the quake and shock recording devices and those devices shall be assembled at various points of the transformer during transportation.

The units shall be dimensioned so that the width and height of the biggest part (including package) will not exceed the dimensions indicated in the List of Warranted Characteristics.

#### 2.7.14. Painting

The metal sections of the Transformers shall be made of corrosion-resistant material and surfaces shall be processed so as to minimize corrosion.

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All parts of the transformers, which are produced using metals that can rust shall be painted.

The internal surfaces of the Transformers, including their oil conservators, shall be protected with a paint that does not cause rust formation and which is tested for not melting in 100°C hot oil.

The following operations shall be performed for metal exterior surfaces:

a) Preparation of the exterior surface

Before painting all surfaces shall be subjected to pure white metal blasting – cleaning operation in compliance with “Steel Structure Painting Council”s specifications numbered SSPC-SP 5-63. The first undercoat shall be applied within maximum 24 hours following the blasting operation, before the blasted surfaces start rusting.

b) First coat painting (undercoating)

Catalyzed epoxy paints that contain rustproof coloring materials shall be used as undercoat for tanks, fans and radiators. It shall be possible to use also synthetic paints for the radiators.

c) Top coat painting

The top coat painting for the tank, fans and radiators shall be performed using paints belonging to one of the following categories.

- Alkyd and silicon based paints (30% Silicone-co-polymer)
- Polyurethane paints
- Vinyl paints of various mixtures

The paints for base coats between the undercoat and top coat, if any, can be determined by the Manufacturer. The paints of different coats shall have different colors sufficient to be clearly identified. The minimum thickness of each paint coat shall be 35 microns. The approval of the Directorate shall be obtained for the color of the top coat.

The Manufacturer shall notify the painting method it wants to apply to obtain approval, and shall especially indicate the nominal value of paint thickness of each coat. The painting works of the Transformer shall be completed before the performance of routine tests. The surfaces, for which top coat is completed, shall be protected against the damages that may occur during transportation and assembly. The manufacturer shall provide a sufficient amount of additional paint in order to remedy the damages that may occur in the paint.

Coating for parts to be subjected to galvanizing operation shall be performed using hot dip galvanizing method as recommended in TS EN ISO 1461.

### 2.7.15. Nameplates and Plates

Two nameplates shall be provided on each Transformer, which will be assembled on the long sides of the tank in completely opposite directions. Furthermore, there shall be plates containing the dimension drawings of each type of bushings used in the Transformer and information on such bushings, adjacent to the nameplates.

Motors, relays, bushings, on-load tap changer and all other devices including the cable and connection terminals shall be labeled so as to contain the information indicated in the relevant IEC standards.

The nameplates and plates of the outdoor materials shall be made of stainless steel or tested rustproof materials, the writings on them shall not deteriorate in time and they shall be fixed with stainless steel screws.

The nameplate, warning and instruction plates shall be written in Turkish or shall be repeated in Turkish together with the original language and shall be submitted to the Directorate for approval.

The nameplates shall contain all of the following information;

- Commercial trademark or name of the producer, country and city, where production is made
- Order number of the Directorate,
- Material code number,
- Serial number and type mark,
- Year of production,
- Rated voltage,
- Transformer ratio and taps,
- Short circuit current (kA)
- Short circuit current period (thermal) (s)
- Insulating level (kV)
- Type, rated current, serial no, insulation level of OLTC,
- Current transformers (current, turn ratio, class) (for 400 kV transformers),
- Insulation oil trademark and type
- Net weight (kg)
  - Core
  - Windings
  - Active section
  - Tank and accessories
  - Oil weight
  - Complete unit
- Gross transportation weight of the heaviest part,
- Other information indicated in IEC 60076-1, Article 8.2.

The recommended commissioning temperatures of the fan groups and pumps shall be written on the plates.

The diagram showing the layout of windings, connections, current transformers and

the physical relation of terminals of each of the transformers shall be included in the nameplate. The diagram for the cooling system shall be given. Each terminal shall be introduced with a plate.

#### 2.7.16. Dimensions

The outer dimensions of fully assembled transformer shall be submitted to the Directorate together with the bid for information purposes.

The relevant details shall be finalized after the order is placed.

### **3. TESTS**

#### 3.1. General

Unless otherwise specified in these specifications, the tests shall be performed in compliance with the standards listed in Article 1.2.

#### 3.2. Tests on Components at the Factory

Routine tests prescribed in the relevant standards shall be performed on all components before they are assembled on the Transformer.

All components (copper, magnetic sheets, insulating materials, on-load tap changer, bushings, current transformers, radiators, relays, etc.) must be subjected to routine tests at the factory of the contractor or component manufacturer in compliance with the relevant standards before being assembled on the Transformer. The Directorate reserves the right to send its representatives to those tests.

The detailed test reports evidencing that the routine tests performed for all components in compliance with the relevant standards were successful shall be provided by the Contractor to be assessed by the Directorate.

#### 3.3. Tests on Fully Assembled Transformer at Factory

High-accuracy devices shall be used and especially:

- The errors in transformer ratio checks shall not exceed  $\pm 0.2\%$
- The errors in oil and environmental temperature measurements shall not exceed  $\pm 0.2\%$
- In the measurement of losses and no-load current:
  - Current and voltage transformers shall be class 0.2 and it shall be known that the relevant errors are within  $\pm 0.2\%$  range.
  - The voltmeters and ammeters shall be class 0.2 or more accurate
  - Wattmeter for low power factor shall be class 0.5 or more accurate.

All measurement systems used in the tests must be certificated in compliance with ISO 9001 rules, must have appropriate accuracy, their periodic calibrations must be performed, their measurement systems must be verified and accuracy must be ensured in compliance with IEC 60076-8.

### 3.3.1. Type Tests

#### i) Short-Circuit Withstand Test

Unless otherwise specified, the short circuit type test shall be performed in accordance with the procedures given in IEC 60076-5. The short circuit dynamic withstand capacity shall be evidenced with the test and 9 short circuits shall be made as follows. The short circuit thermal withstand capacity shall be shown with calculations. The period of short circuit current shall be taken as 3 seconds in the calculation of thermal endurance.

The test diagram shall be one of the permitted ones in IEC standards. However, the test diagram shall be approved by the Directorate before the test. The tolerances of peak and rms values of the currents shall be compliant with IEC standard.

In this short circuit test:

The period of short circuit is 0,5 seconds with  $\pm 10\%$  tolerance.

For 25/31.25 MVA and 50/62.5 MVA power transformers, the value of  $k\sqrt{2}$  factor shall be taken as 2.55 in the calculation of peak value of the current in compliance with IEC 60076-5.

For 80/100 MVA and 90/125 MVA power transformers, the value of  $k\sqrt{2}$  factor shall be taken as 2.69 in the calculation of peak value of the current in compliance with IEC 60076-5.

Furthermore, in the calculation of peak and effective current of short circuit for 80/100 MVA and 90/125 MVA power transformer, the equivalent impedance of the supply shall be taken as ZERO.

The measurement of short circuit inductance shall be performed within  $\pm 0.1\%$  accuracy range. In this case, the star equivalent inductance value measured after the tests shall not deviate from the value measured in the original condition with more than 1%.

In case  $\pm 0.1\%$  accuracy cannot be ensured, the accuracy value of  $\pm 0.2\%$  shall be acceptable, provided that the star equivalent inductance value does not deviate from the value measured in the original condition with more than 0.9%.

9 short circuit tests shall be applied with short circuited MV terminals. (3 at the main tap, 3 at the highest tap, 3 at the lowest tap). The test procedure shall ensure that the indicated peak value of the test current passes through each phase.

- When the test is performed with 3 phases, by synchronizing the closing time of the short circuit breaker,
  - When the test is performed with single phase, by alternating the phase under test
- It shall be ensured that the indicated peak value of the test current passes through each phase 3 times.

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The following measurements and checks shall be performed during the test:

- a) Oscillographic records of the applied voltages and currents in order to check the values and the period,
- b) Measurement of short circuit inductance of the transformer before and after the test (measurements shall be performed with  $\pm 0,1\%$  accuracy)
- c) For informative purposes, SFRA (Sweep Frequency Response Analysis) Analysis at the beginning and end of short circuit test.  
The measurements shall be performed at the tap of the transformer that corresponds to the highest transformer ratio in accordance with IEC 60076-18 standard Table-1 and in the tap position, where the tuning windings are not switched on.

The following checks shall be performed after the completion of all short circuit tests:

- a) All routine tests, including the dielectric tests, shall be repeated at 100% of the prescribed test value.
- b) Visual inspection of the transformer that is extracted from the tank; at the same time, it shall be checked whether there is any deformation in the connections using the photographs taken before the tests.

The short circuit test that is performed under the conditions indicated above, shall be deemed to be successful in the following conditions.

- a) If the variation in the star equivalent inductance values before and after the tests is not more than 1% (one percent),
- b) If the routine tests are successful,
- c) If the visual inspection and untanked transformer photographs show that there is no failure or damage (that there is no deformation or movement in the windings, connections, support members, that there is no arc (flashover) beginning, etc.)

The axial compressions of the windings shall be checked for comparison with the compression applied before the short circuit type test.

During the test, pressure relief valve and Bucholz relay shall not be operating.

The tank and the bushings shall withstand over-pressure and vibrations without damage and oil leakage.

### ii) Temperature-Rise Test

It shall be performed in compliance with the method explained in IEC 60076-2, using short circuit test method and at all rated powers of the transformer (ONAN, ONAF), starting from the highest rated power (ONAF) of the transformer unless otherwise specified.

The temperature rise test shall be performed by taking the backup radiator out of operation, at maximum current tap and while the transformer is loaded with maximum total losses at that tap.

The top oil temperature shall be measured using detectors placed in minimum three pockets for 90/125 MVA power transformer and in minimum two pockets for other transformers, so as to correspond to the winding columns on the top cover of the tank in compliance with IEC 60076-2 standard. The average of the measured values shall be used.

The winding resistances shall be measured by using class 0.2 or more accurate measurement devices. The oil temperature shall be measured with  $\pm 0.2^{\circ}\text{C}$  or better accuracy.

The losses shall be measured during the test period and at a temperature that is as close to the reference temperature as possible.

The determination of winding hot-spot temperature rises shall be performed through direct measurement using fiber optic sensors basing on temperature rise type test results as indicated in IEC 60076-2. The maximum values that are measured with two methods shall be compliant with the warranted values. The number of sensors shall be compliant with IEC 60076-2, unless otherwise specified. The places of sensors shall be determined by the Contractor so as to be at the hottest point of the windings in accordance with the transformer design and shall be submitted to the DIRECTORATE for approval.

Unless otherwise specified, the Temperature Rise Test shall be performed on the first delivered transformer, Fiber Optic System shall be mounted only on the transformer, for which temperature rise test is performed and Hot-Spot Measurement shall be performed by using this system.

Dissolved Gas Analysis (DGA) shall be performed using a high-accuracy gas chromatography method in compliance with IEC61181 on the oil samples that are taken before and after the temperature rise test at maximum rated power (ONAF) of the transformer in compliance with IEC 60567.

The dissolved gas analysis (DGA) that is performed on the samples taken before and after the temperature rise test at maximum rated power (ONAF) of the transformer and its interpretation shall be performed as indicated in IEC 60076-2'de (Annex D: analysis of dissolved gases for the determination of regional excessive heating). The limit values are indicated in 60076-2 Table D.2. As the result of assessment of the results in accordance with this table;

- If the gas emission rate is smaller than the 1<sup>st</sup> limit value, the test results shall be accepted to be successful.

- If the gas emission rate is between the 1<sup>st</sup> limit values and the 2<sup>nd</sup> limit value, 2 years shall be added to the warranty period indicated in the contract for all transformers of the same characteristics.
- If the gas emission rate exceeds the 2<sup>nd</sup> limit value, the transformer shall be rejected.

iii) Measurement of Zero-Sequence Impedance(s) On Three-Phase Transformers

This measurement shall be performed in compliance with the procedure indicated in IEC 60076-1 article 11.6. The measurements shall be performed only at the main tap.

Zero-sequence magnetizing impedance shall also be measured by energizing the transformer in no-load position, with the test facilities by applying zero-sequence voltage of an appropriate value.

iv) Measurement of The Harmonics of The No-Load Current

The no-load current harmonics shall be measured and the magnitude of the harmonics shall be expressed as a percentage of the fundamental component.

v) Vacuum Test On Tank of Assembled Transformer

The test shall be performed preferably after the temperature rise test, when the tank does not contain oil, however with magnetic circuit and winding assembly performed and the auxiliary equipment shall be directly connected to the tank.

The test pressure in the tank (residual pressure) shall be 1 mm Hg or less.

The tank shall be kept in vacuum for a period of 6 hours.

After disconnecting the vacuum pump, the permitted maximum vacuum loss in the test shall not exceed 2 mmHg. The measurement device shall have the accuracy sufficient to show 1mmHg variation on its scale.

The permanent deformations that the tank will become subject to during this test shall be indicated in the test report.

vi) Pressure Test On Tank of Assembled Transformer

The test shall be performed at ambient temperature filling the tank with oil so that 2 atm stationary over-pressure for 400 kV/MV transformers and 1 atm stationary over-pressure for 154 kV/MV transformers will exist on the tank bottom. This pressure shall be provided by using a liquid column or gas pressure.

The test period shall not be less than 24 hours. At the end of the test, no oil leakage must occur in the tank, on the cover and in the oil conservator.

vii) Measurement of Audible Sound Level

Under the procedure indicated in IEC 60076-10, measurement shall be performed at all rated powers of the Transformer (ONAN, ONAF).

viii) Determination Of Transient Voltage Transfer Characteristics (IEC 60076-3)

ix) Assessment of Tank for Suitable Transport (IEC 60076-1)

It shall be assessed on the transformer, whose production is completed, in accordance with the approval documents.

x) Determination of Weight of the Transformer Prepared for Transportation (IEC 60076-1)

It shall be performed using calculation and/or weighing methods. If the calculation method will be used, the Contractor shall submit the weights and the calculations performed for the used materials to the Acceptance Commission.

xi) Measurement of Power Consumptions of the Fan Motors (IEC 60076-1)

### 3.3.2. Routine Tests

Routine tests shall be performed on each provided Transformer.

The tests shall be performed at any ambient temperature between 10°C and 40°C.

All external components and auxiliary equipment that may affect the performance of the transformer during the tests shall be assembled in their places as appropriate.

Routine tests are indicated hereunder.

a) Measurement of Winding Resistance

It shall be measured in accordance with the procedure indicated in IEC 60076-1, Article 11.2.

The measurement of HV winding DC resistances shall be performed at all tap positions. MV winding resistances shall also be measured. The test currents and winding temperature, at which DC resistance measurement is performed, shall be written in the test report.

b) Measurement of Voltage Ratio and Check of Phase Displacement

Voltage ratio shall be measured in all tap positions in compliance with the procedure indicated in IEC 60076-1, article 11.3.

c) Measurement of Capacitance and Dissipation Factor

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The measurement shall be performed between each winding and the tank and between the windings of the transformer. The top oil temperature of the transformer and humidity in % must be recorded and  $\tan\delta$  % values must be converted for 20 °C taking top oil temperature into consideration. The  $\tan\delta$  % converted for 20 °C must be smaller than 0,5.

$\tan\delta$  % measurements shall be performed for all condenser bushings of the transformer. C1, C2 and C1+C2 capacitances shall be measured on the bushings. For bushings,  $\tan\delta$  % (C1) shall be  $\leq 0,5$  and  $\tan\delta$  % (C2) shall be  $\leq 1$ .

The reports related with the tests performed for the bushings at the factory in compliance with the relevant standards shall be attached to the Factory Acceptance Test reports.

### d) Measurement of DC Insulation Resistance

The measurements shall be performed between the windings and between each winding and the tank (at 0, 15, 30, 45, 60 seconds and 10 minutes) using 5000 Volt DC insulation resistance test device. (the results shall be converted for 20 °C taking into consideration the top oil temperature.) Furthermore, the measurement of the insulation resistance between the core/ tank, clamp/ tank and core/ clamp (1 minute) shall be performed using 2500 Volt DC insulation test device. The dielectric absorption ratio for the transformers (60/30sec) and polarization index (10/1 min) shall be calculated

### e) Measurement of Short-Circuit Impedance and Load Loss

The measurement shall be performed in compliance with the procedure indicated in IEC-60076-1, Article 11.4. The measurements shall be performed at maximum, minimum and main tap positions.

### f) Measurement of No-Load Loss and Current

The measurement shall be performed in accordance with the procedures indicated in IEC 60076-1, Article 11.5.

### g) Dielectric Withstand Tests

Unless otherwise specified, Dielectric Withstand Tests shall be performed in accordance with IEC 60076-3.

Dielectric tests and their order of performance shall be as follows in accordance with IEC 60076-3 article 7.2.3:

- Lightning impulse tests (LI, LIC, LIN)
  - Full wave lightning impulse test (LI) (being combined with chopped wave lightning impulse test (LIC) in compliance with the test series defined in IEC 60076-3 article 13.3.3.1)

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- Chopped wave lightning impulse test (LIC) (IEC 60076-3 article 13.3.3.1)
- Lightning impulse test at neutral connection end (LIN) (IEC 60076-3 article 13.4)

### - Switching Impulse Test (SI)

It shall be applied only to the power transformer, whose HV rated voltage is 400 kV.

- Applied voltage test (AV) (IEC 60076-3 article 10)
- Line terminal A.C. withstand test (LTAC) (IEC 60076-3 article 12)
- Induced voltage test together with partial discharge measurement (IVPD) (IEC 60076-3 article 11.3)

This test shall be performed

- By using one hour PD measurement voltage at  $\sqrt{3} \times U_m$  (phase-phase) increased voltage and  $1.5 \times U_m$  (phase –phase) value for the power transformer with a HV rated voltage of 400 kV.
- By using one hour PD measurement voltage at  $2 \times U_r$  (phase-phase) increased voltage and  $1.5 \times U_m$  (phase –phase) value for the power transformer with a HV rated voltage of 154 kV.

### h) Tests On On-Load Tap Changers, Operation Test

The procedure indicated in IEC 60076-1, Article 11.7 shall be complied with.

#### i) Leak Testing with Pressure For Liquid-Immersed Transformers (Tightness Test)

The procedure indicated in IEC 60076-1 article 11.8 shall be complied with. However, the tests shall be performed at ambient temperature with 2 atms stationary pressure on the tank bottom for 400 kV/MV transformers and with 1 atm stationary pressure on the tank bottom for 154 kV/MV.

#### i) Check of The Ratios And Polarity Of Built-In Current Transformers

The reports on the tests of the current transformers in the bushings that were performed at the production stage and the polarity and conversion ratio values shall be submitted together with the acceptance test reports. In case of request by the test commission, the ratios and polarities shall be checked.

#### j) Quality Control of Paint Application

The paint check is performed by checking the film thickness and paint adherence. The paint thickness measurement shall be performed using a “Coating Inspection Device”. Especially the total thickness of paint coats and the separate thicknesses of the coats must be measured. 10 points shall be randomly selected on the painted

surfaces of the transformers (equipped with radiators or coolers): the average of the thicknesses of each coat shall not be less than the nominal value prescribed by the manufacturer for that coat.

The adherence characteristics of the paint film shall be verified using the cross cutting method in DIN EN ISO 2409 standard. The test shall be performed on 10 randomly selected points on the painted surfaces of the transformer. The variation degree shall not be higher than Gt 1.

As indicated in the test procedure, visual inspection and circuit check shall also be performed together with the insulation test.

k) Routine Tests On Welded Joints

The test reports of the routine tests performed by the manufacturer on welded joints shall be submitted.

l) Measurement of Magnetizing Current

Magnetizing current shall be measured (at highest, lowest and main taps) at high voltage winding at 10 kV AC voltage. On MV winding, magnetizing current shall be measured at 2 kV AC voltage.

m) SFRA (Sweep Frequency Response Analysis) Test

The measurements shall be performed in accordance with IEC 60076-18 standard Table -1 at the tap corresponding to the highest transformer ratio of the transformer and at the tap position, where the tuning windings are not switched on.

SFRA measurements to be performed at the manufacturer's factory shall be reported so as to provide basis for measurements to be made at the field. For this purpose, together with graphic printouts in A4 format, the digital copies (CD, USB, etc.) of the connection diagram and measurement results belonging to each measurement shall be included in the factory test reports that are prepared. The information on the used measurement devices and equipment shall be included in the report.

n) Oil Tests

It shall be documented with the test reports that the oil to be used in the Transformers is compliant with TEİAŞ New Insulating Oil Purchase Specifications and those reports shall be submitted to the Directorate for approval. In case such documentation cannot be made, complete tests shall be performed for the oil in compliance with the oil specifications given in ANNEX-4.

The following tests shall be applied on each oil sample to be taken from each transformer during acceptance and compliance with the Specifications on Oil of new Transformers that are immersed with New Insulating Oil of TEİAŞ given in ANNEX-5 shall be checked; the firm shall warrant that the used oil is of the same trademark and type as the proposed oil.

- Power Factor (Doble, 25 °C+100°C)
- Dielectric strength
- Acidity
- Internal surface tension
- Density
- Viscosity
- Color number
- Water amount

o) Checks on Gases Dissolved in Oil

Before and after the Dielectric Strength Tests, dissolved gas analysis (DGA) shall be performed in compliance with IEC61181 on the oil samples that are taken in compliance with IEC 60567 using high-accuracy gas chromatography method.

ö) Check of Fittings and All Protections of the Transformer

3.4. Field tests

a) Measurement of Winding Resistance

It shall be measured in accordance with the procedure indicated in IEC 60076-1, Article 11.2.

HV winding DC resistance measurement shall be performed at all tap positions, MV winding resistances shall also be measured. The test current and winding temperature used in the DC resistance measurement shall be written in the test report.

b) Measurement of Voltage Transformer Ratio and Check of Phase Displacement

The voltage transformer ratio shall be measured at all tap positions in compliance with the procedure indicated in IEC 60076-1, article 11.3.

c) Measurement of Capacity and Loss Factor

The measurement shall be performed between each winding and the tank and between the windings of the transformer. The top oil temperature of the transformer, ambient temperature and % humidity must be recorded and  $\tan\delta\%$  values must be converted to 20 °C taking into consideration the top oil temperature. The  $\tan\delta\%$  value that is converted to 20 °C must not be less than 0.5.

$\tan\delta$  % measurements shall also be performed for all condenser bushings of the transformer. C1, C2 and C1+C2 capacitances shall be measured at the bushings. At bushings,  $\tan \delta\%$  (C1) shall be  $\leq 0,5$  and  $\tan \delta\%$  (C2) shall be  $\leq 1$ .

d) Measurement of DC Insulation Resistance

The measurements shall be performed between the windings and each winding and the tank (at 0, 15, 30, 45, 60 seconds and 10 minutes) using 5000 Volt DC insulation resistance test device. (the results must be converted to 20°C taking into consideration the top oil temperature.) Furthermore, the measurement of the insulation resistance between core/ tank, clamp/ tank and core/ clamp (1 minute) shall be performed using 2500 Volt DC insulation test device. For the transformers, dielectric absorption ratio (60/30 sec) and polarization index (10/1 min) shall be calculated.

e) Measurement of Magnetizing Current

Magnetizing current shall be measured on the high voltage winding (at highest, lowest and main tap positions) at 10 kV AC voltage. On MV winding, magnetizing current shall be measured at 2 kV AC voltage.

f) SFRA (Sweep Frequency Response Analysis) Test

The measurements shall be performed in accordance with IEC 60076-18 standard Table -1 at the tap corresponding to the highest transformer ratio of the transformer and at the tap position, where the tuning windings are not switched on.

SFRA measurements to be performed at the field shall be performed so as to be the repetition of the measurements performed at the factory. In the prepared report, together with the printouts of the results belonging to all three phases that are overlapped on the same graphic, the printout of the factory and field results belonging to each phase overlapped on the same graphic shall be included. It is the responsibility of the Contractor to ensure the compatibility of the devices, equipment and software used in order to ensure that the field results repeat the factory results. The measurement results and the results of the tests performed in the field and at the factory shall be consistent.

g) Transformer Oil Tests

The oil barrels shall be sealed. After taking the transformer oil to the boat / tank (after performing the necessary cycling (drainage) operation in compliance with the procedure), sample oil shall be taken only from the 1<sup>st</sup> (first) boat / tank under the supervision of the representatives of the relevant Regional Directorate and the Contractor and a minute shall be prepared. The Contractor shall take minimum 1,5 liters of oil sample to perform the following tests and shall deliver it with a minute to the Chemistry Laboratory that is under the responsibility of TEİAŞ.

- Power Factor (Doble, 25°C+100°C)
- Acidity
- Internal Surface Tension
- Color Number
- Water Amount
- TDGA (Total Dissolved Gas Amount)

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No charge shall be taken from the Contractor for the tests indicated herein above.

The dielectric strength tests of the samples taken from each boat/ tank shall be had performed by the Contractor in the field under the supervision of the representatives of the relevant Regional Directorate (including the first boat/ tank). The puncture endurance test results shall be greater than 60 kV.

After the oil, the results of which are found appropriate in accordance with the above tests, is pumped into the transformer, and after keeping it resting for a period to be determined by the Contractor, minimum 2..5 liters of oil sample shall be taken by the Contractor for performing the following tests on such sample after preparing a minute under the supervision of the representatives of the relevant Regional Directorate and the Contractor and such oil sample shall be delivered to a Chemistry Laboratory under the responsibility of TEİAŞ with a minute.

The analysis to be performed on the oil sample taken from the oil immersed transformer are;

- Power Factor (Doble, 25°C+100°C)
- Dielectric strength
- Acidity
- Internal Surface Tension
- Color Number
- Water Amount
- TDGA (Total Dissolved Gas Amount)

TDGA amount shall be max.2%, water amount shall be max.10 ppm.

No charge shall be taken from the Contractor for the above tests.

h) The cabling between the cells, cabinets, boxes and terminal blocks shall be checked for the connection of the Substation to the central control panel.

i) The correct operation of on-load tap changer, all protections, alarms, indicators and control devices including the remote controls shall be checked.

i) Vacuum Sealing Test (IEC 60076-1 article 11.11)

#### **4. MATTERS RELATED WITH TESTS AND ACCEPTANCE CRITERIA**

The values and characteristics requested in the Technical Specifications and the List of Warranted Characteristics are the minimum values and characteristics requested by the Directorate. If the bidders propose superior values and characteristics, the Bidder shall not claim any rights, no extra premium shall be paid by the Directorate, however, if the bid prices are equal, the bidder of the superior values and characteristics shall be preferred.

#### 4.1. Type Tests

- l) The Bidders/ Contractors shall submit the certificate of the short circuit type test performed in compliance with the version of IEC 60076-5 standard issued on 07.02.2006 by an accredited laboratory on a three-phase transformer, which has the same characteristics with the transformer that is tendered, to the Directorate.

In case of failure in the submission of short circuit type test certificate for 154/33,6 kV, 25/31.25 MVA, 50/62.5 MVA, 154/33.6 kV, 80/100 MVA and 400/33,6 kV, 90/125 MVA power transformers, in case the submitted short circuit type test certificate does not belong to an transformer having the same characteristics with the tendered power transformer that is defined in the tender documents or in case it does not comply with the version of IEC 60076-5 standard issued on 07.02.2006; the Contractor shall have the short circuit type tests performed by an accredited laboratory without any expense being incurred by the Directorate and short circuit type test certificate shall be submitted to the Directorate. For 50/62,5 MVA, 154/11.1 kV power transformers, short circuit withstand type test report has to be submitted. However, in case it is not submitted, report shall be issued with the calculation method compliant with the Standard related with the short circuit resistance of those transformers and the warranty period shall be 5 years (60 months).

The short circuit type test certificate has to be submitted. However, if short circuit type test reports are submitted before the certificate, the report content must indicate that the short circuit type tests are successfully performed and that there is no matter preventing the issuance of short circuit type test certificate; and it shall be possible to place the shipment order for the transformers, for which the production and factory acceptance tests (type + routine tests) are completed, with all responsibility belonging to the Contractor. The payment of the shipped transformer/ transformers shall be made.

Short circuit type test certificate shall be submitted to the Directorate within 120 (one hundred and twenty) days as of the completion of the short circuit type test.

The electrical characteristics, windings, insulation distances, material characteristics, winding support and compressions and bushing and on-load tap changer connections of the proposed power transformer and the original (prototype) power transformer, on which the type test was performed, shall be identical.

When the manufacturers want to make small design changes on the original (prototype) power transformer, on which the short circuit type test was performed, including some changes in the magnetic core and changes in the oil amount, they shall notify the reasons of the changes that they want to make, the technical explanations evidencing that those changes do not decrease the endurance of power transformers against electro-dynamic forces to the Directorate together with all designs and construction drawings.

The design changes that are made without a notification to the directorate shall require the performance of short circuit type test free of charge.

The on-load tap changer and bushing changes that are subjected to type and routine tests prescribed in the relevant standards being independent from the power transformer shall not require the repetition of the short circuit type test.

The reports related with the type tests of tap changers and high voltage (170 kV and 420 kV) bushings included in the relevant standards (performed by an accredited laboratory or approved by an accredited agency) shall be submitted to the Directorate together with the relevant bid/approval documents.

In case values that are partially different from the Technical Specifications are applied in the short circuit type test performed by an International laboratory under the supervision of the Directorate's representatives, and if it is assessed that the requirements of the relevant standard are complied with and the Laboratory issued a Short Circuit Type Test Certificate and this certificate was accepted by the Directorate, the bidder, who performed the Short Circuit Type Test in compliance with the Technical Specifications shall be preferred in case of equal prices.

- II) The type tests indicated in the POWER TRANSFORMER (400 kV/MV, 154 kV/MV) TECHNICAL SPECIFICATIONS 3.3.1. Type Tests – sub-articles (ii), (iii), (iv), (v), (vi), (vii), (viii), (ix), (x) and (xi) shall be performed without any expenses being incurred by the Directorate even if the relevant type test reports were submitted.

#### 4.2. Criteria for the Acceptance of Power Transformers

##### 4.2.1. Criteria for the Acceptance of Factory Tests on the Main Components

All routine tests applied on the main components must give positive results in the range of the permitted tolerances. A negative result obtained from one of the tests shall not mean the rejection of all the materials in the order, however, the defected component shall not be accepted. Those test reports prepared by the Manufacturer shall be submitted to the acceptance commission before starting the factory acceptance tests. These reports shall be included in the attachment of the test and inspection protocol that is prepared after the performance of the acceptance tests.

##### 4.2.2. Criteria for the Acceptance of Type Tests

The above type tests shall be performed on the first transformer produced in the scope of the contract by an accredited laboratory or if approved by the Directorate, by the Manufacturer's laboratory, with the participation of the Directorate's representatives.

All type tests shall give positive results. In case of a negative result obtained from a type test, the transformer type related with such negative result shall be rejected. However, if the manufacturer performs a design change and undertakes to repeat the type tests required by such change within a reasonable period with all expenses being borne by the Contractor, the authority to decide shall belong only to the

Directorate and the repetition of tests may be accepted without giving any period extension.

Another power transformer/ other transformers can be produced by the Manufacturer before the completion of type tests on the first power transformer, provided that all responsibility will belong to the Contractor and that the Directorate confirms it. If the Contractor requests the performance of factory acceptance tests of the produced power Transformer / Transformers, the shipment and/or payment of any of the power transformers shall not be made until the type tests are successfully completed even if the power transformer/ transformers are under gratuitous bailee, and the date of successful completion of the type tests shall be taken into consideration as the date of delivery of the power transformers that are taken under gratuitous bailee and for which the factory acceptance tests are completed.

#### 4.2.3. Criteria for the Acceptance of Routine Tests

The routine tests indicated in Technical Specifications Article 3.3.2 shall be applied on all Transformers that are submitted for acceptance.

The date of commencement of tests shall be notified to the Directorate 15 (fifteen) days before for the tests to be performed in the country and 45 (forty-five) days before for the tests to be performed abroad.

Positive results shall be obtained from all routine tests. If a negative result is obtained from any of the routine tests, and if this result is found to be critical by the Directorate for the operation of the power transformer, the problematic part shall be replaced with a new one or the problem shall be remedied with all expenses being borne by the Contractor.

If the paint inspection results negatively, the Directorate shall have the right to request the re-painting of the power Transformer free of charge.

Routine tests shall be performed at the manufacturer's laboratory with the participation of the Directorate's representatives. The manufacturer's laboratory shall be accredited or the calibrations of the devices to be used in the tests shall be performed by an accredited organization and calibration certificates shall be submitted to the Inspection and Acceptance Commission before starting the tests.

All production checks and tests shall be performed under the supervision of the Directorate's representatives with all relevant charges being borne by the Contractor.

**ANNEX-1/A**  
**154/11.1 kV, 50/62.5 MVA POWER TRANSFORMER**  
**LIST OF WARRANTED CHARACTERISTICS**

Order No:

Drawing No:

Material Code No of the Directorate:

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
1.	Manufacturer and Place of Production			
2.	Manufacturer's type mark			
3.	Operational conditions (shall be determined by the Directorate)			
	- Altitude above sea level	(Meter)		
	- Environmental temperature			
	▪ Daily maximum	(°C)		
	▪ Daily minimum	(°C)		
	▪ 24-hour average	(°C)		
	▪ Annual average	(°C)		
	- Maximum wind pressure			
	▪ On round surface	(Pascal)		
	▪ On flat surface	(Pascal)		
	- Maximum solar radiation	(W/m <sup>2</sup> )		
	- Ice load	(mm)		
	- Susceptibility to industrial pollution	(Yes/no)		
	- Maximum relative humidity (24-hour average)	(%)		
	- Lightning impulse probability			
	- Earthquake			
	▪ Horizontal acceleration	(g)		
	▪ Vertical acceleration	(g)		
4.	Applied standards		Indicated in the Technical Specifications.	
5.	Transformer type		Power transformer	
6.	Phase number	(piece)	3	
7.	Winding number	(piece)	2	
8.	Connection group		YNyn0	
	<b>RATED VALUES</b>			
9.	Rated frequency (* ) T.S. Article 2.1 shall be	(Hz)	50 (*)	

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
	complied with.			
10.	Rated power	(MVA)	62.5	
11.	Cooling method		ONAN/ONAF	
12.	Power values in accordance with cooling method			
	- ONAN	(MVA)	50	
	- ONAF	(MVA)	62.5	
13.	Temperature rise (when any radiator is out of service)			
	- Top oil	(°C)	≤ 55	
	- Windings	(°C)	≤ 60	
	- Core surface	(°C)	≤ 75	
	- Hot Spot Point of Winding	(°C)	≤ 73	
14.	Temporary overloading		According to IEC 60076-7	
15.	Rated voltages			
	- HV winding	(kV)	154	
	- MV winding	(kV)	11.1	
16.	Highest system voltages			
	- HV	(kV)	170	
	- LV	(kV)	12	
17.	Tap Winding		HV, at neutral terminal	
18.	Tap changing type		On-load	
19.	Voltage regulation area		154 ± 10 x %1.25 kV	
20.	Tap position number	(piece)	21	
21.	Voltage setting;			
	- Category		CFVV (constant flux voltage variation)	
	- Method		Coarse fine tap selector or Reversing switch connection	
22.	Tap powers		Equal to 100% nominal power at all taps	
23.	Maximum tap current and relevant tap position	(A)		
24.	Impedance voltage %, 50 Hz, 75 °C (on 62.5 MVA basis) (*)			
	- At maximum voltage tap(21 <sup>st</sup> tap)			
	- At rated voltage tap(11 <sup>th</sup> tap)			

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
	- At minimum voltage tap (1 <sup>st</sup> tap)			
	(*) While tendering 154/11.1 kV - 50 (62.5) MVA transformer, the % Uk value of the transformer to be tendered shall be determined by the requesting unit taking into consideration the electrical characteristics of the substation, where such transformer will be used, and the impedance voltage of the existing transformers (% Uk).			
25.	% Resistance voltage (154/11.1 kV, on 62.5 MVA basis,75°C)			
26.	No load current at the main tap (on 62.5 MVA basis, at 50 Hz)			
	- HV Nominal voltage 90%	(%)		
	- HV Nominal voltage 100%	(%)		
	- HV Nominal voltage 110%	(%)		
	- HV Nominal voltage 115%	(%)		
	- HV Nominal voltage 120%	(%)		
27.	Continuous operation above nominal voltage			
	- At main tap		170 kV	
	- At other taps		+%10	
28.	No load current harmonics (% of basic component)			
	- 3 <sup>rd</sup> Harmonic	(%)		
	- 5 <sup>th</sup> Harmonic	(%)		
	- 7 <sup>th</sup> Harmonic	(%)		
	- 9 <sup>th</sup> Harmonic	(%)		
29.	Withstand period in case output terminals are short circuited while the input terminals are under nominal voltage			
	- Input HV	(sec)	3	
	- Input MV	(sec)	3	
30.	Zero-sequence impedance at the main tap(on 62.5 MVA basis)	(%)		
31.	Zero-Sequence Reactance that is magnetized between HV-Neutral(on 62.5 MVA basis)			
	- At highest tap			

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
	- At main tap			
	- At lowest tap			
32.	Maximum period that the transformer can be operated without exceeding the warranted temperature limits at no load and at 115% of the rated voltage (following long period full load operation at 30°C ambient temperature)		≥ 1 hour	
33.	Audible noise level at rated voltage at the main tap, LpA (ONAF)	(dB)	≤ 60	
34.	Insulation of windings and neutral grounding method			
	- HV winding		Windings tapped insulation, neutral directly grounded	
	- MV winding		Windings uniform insulation, neutral directly grounded or grounded over resistance	
	<b><u>INSULATION LEVELS</u></b>			
35.	Full wave lightning impulse (1.2/50 μsn)			
	- HV	(kV <sub>peak</sub> )	650	
	- MV	(kV <sub>peak</sub> )	75	
	- Neutral (HV)	(kV <sub>peak</sub> )	≥95	
36.	Applied voltage or line terminal A.C. withstand voltage(AV) (LTAC)			
	- HV	(kVrms)	275	
	- HV – N	(kVrms)	≥ 28	
	- MV, MV - N	(kVrms)	38	
37.	Switching impulse voltage			
	- HV	(kV peak)	540	
38.	Induced voltage test together with partial discharge measurement		Shall be compliant with IEC 60076-3.	
39.	Is the transformer practically independent from corona at 170 kV?		Yes	
	<b><u>LOSSES</u></b>			
40.	No load losses (at main tap)			

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
	- At 90% of the rated voltage	(kW)		
	- At rated voltage	(kW)	≤ 30	
	- At 110% of the rated voltage	(kW)	≤ 40	
41.	On-load losses (at 75°C) (on 62.5 MVA basis)			
	- At maximum voltage tap (at 21 <sup>st</sup> tap)	(kW)	≤ 245	
	- At rated voltage tap - (at 11 <sup>th</sup> tap)		≤ 250	
	- At minimum voltage tap (at 1 <sup>st</sup> tap)		≤ 265	
42.	Cooling system			
	- Number of fans (including backups)			
	- Number of backup fans			
	- Fan losses	(kW)		
	- Number of radiators (including backups)			
	- Number of backup radiators		≥ 1	
	<b><u>CHARACTERISTICS OF WINDINGS</u></b>			
43.	Material of windings		Copper	
44.	Winding average current density (on 62.5 MVA,154/11.1 kV basis)			
	- HV	(A/mm <sup>2</sup> )		
	- MV	(A/mm <sup>2</sup> )		
	- Tuning winding	(A/mm <sup>2</sup> )		
45.	Maximum current density			
	- HV	(A/mm <sup>2</sup> )		
	- MV	(A/mm <sup>2</sup> )		
	- Tuning winding	(A/mm <sup>2</sup> )		
46.	Section of winding conductors			
	- HV	(mm <sup>2</sup> )		
	- MV	(mm <sup>2</sup> )		
	- Tuning winding	(A/mm <sup>2</sup> )		
47.	Total weight of winding conductor			
	- HV	(kg)		
	- MV	(kg)		
	- Tuning winding	(kg)		
48.	Insulation of windings			
	- HV		Indicated in the Technical Specifications.	
	- MV		Indicated in the	

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
			Technical Specifications.	
	<b><u>CHARACTERISTICS OF MAGNETIC CIRCUIT</u></b>			
49.	Type		Core type	
50.	Number of legs		3	
51.	Material			
52.	Flux density on the legs (No load, at main tap, At rated voltage)	(Tesla)	≤ 1,63	
53.	No load Maximum flux density (at 154kV-%7,5/11.1kV transformer ratio, while the transformer is energized at 170 kV) (The type of manufacture, type and characteristic curve of the sheet to be used, its magnetizing and loss curves shall be submitted together with the bid))	(Tesla)	≤ 1,93	
54.	Core weight	(Ton)		
	<b><u>TANK</u></b>			
55.	Tank type		Indicated in the Technical Specifications.	
56.	Withstand capacity			
	- To vacuum		Full vacuum	
	- To overpressure		Indicated in the Technical Specifications.	
57.	Wall thickness	(mm)		
58.	Bottom thickness	(mm)		
59.	Cover thickness	(mm)		
60.	Paint thickness	(micron)	150	
61.	Top coat paint color		RAL 7033 or RAL 7039	
	<b><u>CHARACTERISTICS OF BUSHINGS</u></b>			
62.	Manufacturer and Place of Production			
	- HV			
	- MV			
	- Neutral (HV/MV)			
63.	Type			
	- HV		Condenser type	
	- MV			

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
	- Neutral (HV/MV)			
	- Insulators		Porcelain, brown	
64.	Rated voltages			
	- HV	(kV-rms)	170	
	- MV	(kV-rms)	12	
	- Neutral (HV/MV)	(kV-rms)	52/12	
65.	Rated current			
	- HV	(A)		
	- MV	(A)		
	- Neutral (HV/MV)	(A)		
66.	Dry power frequency withstand voltage (1 min.)			
	- HV	(kV-rms)	355	
	- MV	(kV-rms)	30	
	- Neutral (HV/MV)	(kV-rms)	105/30	
67.	Lightning impulse withstand voltage			
	- HV	(kV-peak)	750	
	- MV	(kV-peak)	75	
	- Neutral (HV/MV)	(kV-peak)	250/75	
68.	Minimum creepage distance (25 mm/ kV for HV bushings, 31 mm/ kV for MV bushings)			
	- HV	(mm)	4250	
	- MV	(mm)	372	
	- Neutral (HV/MV)	(mm)	1300/372	
69.	Minimum distance between parts that are under voltage (between phases)			
	- HV	(mm)	1600	
	- MV	(mm)	170	
70.	Minimum distance between phase and ground			
	- HV	(mm)	1330	
	- MV	(mm)	140	
	<b><u>CHARACTERISTICS OF ON-LOAD TAP CHANGER (OLTC)</u></b>			
71.	Manufacturer and Place of Production			
72.	Type Mark of the Manufacturer			
73.	OLTC type (*)			
	- Oil/ vacuum		Vacuum	
	(*) Unless otherwise specified by the Directorate, vacuum type OLTC shall be purchased			

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
74.	Used vacuum cylinder's;			
	- Manufacturer and place of production			
	- Manufacturer's type mark			
75.	Connection diagram			
76.	Rated current and relevant rated step voltage	(A - kV)		
77.	Max. rated current	(A)		
78.	Short circuit current capacity			
	- Thermal (3 sec.)	(kA)		
	- Dynamic (peak)	(kA)		
79.	Rated frequency	(Hz)	50	
80.	Tap setting range		154 ±10 x % 1,25 kV	
81.	Rated voltage	(kV-rms)	72.5	
82.	Max. rated step voltage	(V)		
83.	Tap position number		21	
84.	Transient resistance value	(ohm)	Shall be measured at manufacturing stage.	
85.	Insulation level (IEC 60214-1) (Lightning impulse/ power frequency)			
	- Against ground	(kV-peak /kV-rms)		
	- Between phases	(kV-peak /kVrms)		
	- Between the first and last contacts of the selector switch	(kV-peak /kV-rms)		
	- Between any two consecutive contacts of the selector switch	(kV-peak /kV-rms)		
	- Between the last contacts in open position of the diverter switch	(kV-peak /kV-rms)		
86.	Place of tap selector		In the tank	
87.	Place of diverter switch		A separate housing	
88.	Oil indicator alarm contact		Yes	
89.	Protection devices for safe operation		Yes	
90.	Motor operating mechanism (indicate the characteristics of the mechanism)		Yes	
91.	Number of operations before first maintenance			
	- Greasing		≥ 200.000	

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
	- Oil replacement (for oil immersed type)		≥ 100.000	
	- Replacement of contacts of the diverter switch (for oil immersed type)		≥ 200.000	
	- Replacement of cutoff cells of diverter switch for vacuum type		≥ 600.000	
	- Number of switching operations before first maintenance for vacuum type		≥ 300.000	
	<b><u>WEIGHT AND DIMENSIONS</u></b>			
92.	Net weights			
	- Core	(Ton)		
	- Windings	(Ton)		
	- Tank and accessories	(Ton)		
	- Cooling system	(Ton)		
	- Oil	(Ton)		
	- Total weight (with oil)	(Ton)	≤ 150	
93.	Gross ton weight of the greatest part necessary for transportation	(Ton)	≤ 60	
94.	Dimensions of the unit			
	- Width	(m)		
	- Length	(m)		
	- Height (with/without wheels)	(m)		
	- Top cover height (with/without wheels)	(m)		
95.	Transportation dimensions of the heaviest part			
	- Width	(m)	≤ 3.1	
	- Length	(m)		
	- Height	(m)	≤ 4	
96.	Rail gauge for wheel operation	(mm)	1440 (in width)	
97.	Rail gauge for wheel operation	(mm)	1440 and 2942 (in length)	

**ANNEX-1/B**  
**154/33.6 kV, 25/31.25 MVA POWER TRANSFORMER**  
**LIST OF WARRANTED CHARACTERISTICS**

Order No:

Drawing No:

Material Code No. of the Directorate:

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
1.	Manufacturer and Place of Production			
2.	Type Mark of the Manufacturer			
3.	Operational conditions (shall be determined by the Directorate)			
	- Altitude above sea level	(meter)		
	- Environmental temperature			
	▪ Daily maximum	(°C)		
	▪ Daily minimum	(°C)		
	▪ 24-hour average	(°C)		
	▪ Annual average	(°C)		
	- Maximum wind pressure			
	▪ On round surface	(Pascal)		
	▪ On flat surface	(Pascal)		
	- Maximum solar radiation	(W/m <sup>2</sup> )		
	- Ice load	(mm)		
	- Susceptibility to industrial pollution	(Yes/no)		
	- Maximum relative humidity (24-hour average)	(%)		
	- Lightning impulse probability			
	- Earthquake			
	▪ Horizontal acceleration	(g)		
	▪ Vertical acceleration	(g)		
4.	Applied standards		Indicated in the Technical Specifications.	
5.	Transformer type		Power transformer	
6.	Phase number	(piece)	3	
7.	Winding number	(piece)	2	
8.	Connection group		YNyn0	
	<b>RATED VALUES</b>			

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
9.	Rated frequency (* T.S. Article 2.1 shall be complied with.	(Hz)	50 (*)	
10.	Rated power	(MVA)	31.25	
11.	Cooling method		ONAN/ONAF	
12.	Power values in accordance with cooling method			
	- ONAN	(MVA)	25	
	- ONAF	(MVA)	31.25	
13.	Temperature rise (when any radiator is out of service)			
	- Top oil	(°C)	≤ 55	
	- Windings	(°C)	≤ 60	
	- Core surface	(°C)	≤ 75	
	- Hot spot point of windings (hot-spot point)	(°C)	≤ 73	
14.	Temporary overloading		According to IEC 60076-7	
15.	Rated voltages			
	- HV winding	(kV)	154	
	- MV winding	(kV)	33.6	
16.	Highest system voltages			
	- HV	(kV)	170	
	- MV	(kV)	36	
17.	Tap Windings		HV, at neutral terminal	
18.	Tap changing type		On-load	
19.	Voltage regulation area	(kV)	154 ± 12 x %1.25	
20.	Tap position number	(piece)	25	
21.	Voltage setting;			
	- Category		CFVV (constant flux voltage variation)	
	- Method		Coarse fine tap selector or Reversing switch connection	
22.	Tap powers		Equal to 100% nominal power at all taps	
23.	Maximum tap current and relevant tap position	(A)	137.8 (1.kademe)	

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
24.	Impedance voltage %, 50 Hz, 75 °C (on 62.5 MVA basis)			
	- At maximum voltage tap (25th tap)		%12.8 (tol.: ±%10)	
	- At rated voltage tap (13th tap)		%12 (tol.: ±%7,5)	
	- At minimum voltage tap (1.kademe)		%11.4 (tol.: %±10)	
25.	% Resistance voltage (154/33.6 kV, 31.25 MVA bazında,75°C)			
26.	No load current at the main tap (on 62.5 MVA basis, at 50 Hz)			
	- HV Nominal voltage 90%	(%)		
	- HV Nominal voltage 100%	(%)		
	- HV Nominal voltage 110%	(%)		
	- HV Nominal voltage 115%	(%)		
	- HV Nominal voltage 120%	(%)		
27.	Continuous operation above nominal voltage			
	- At main tap	(kV)	170	
	- At other taps		+%10	
28.	No load current harmonics (% of basic component)			
	- 3rd harmonic	(%)		
	- 5th harmonic	(%)		
	- 7th harmonic	(%)		
	- 9th harmonic	(%)		
29.	Withstand period in case output ends are short circuited while the input ends are under nominal voltage			
	- Input HV	(sec)	3	
	- Input MV	(sec)	3	
30.	Zero-sequence impedance at the main tap(on 62.5 MVA basis)	(%)		
31.	Zero-Sequence Reactance that is magnetized between HV- Neutral (on 62.5 MVA basis)			
	- At highest tap			
	- At main tap			
	- At lowest tap			

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
32.	Maximum period that the transformer can be operated without exceeding the warranted temperature limits at no load and at 115% of the rated voltage (following long period full load operation at 30°C environmental temperature)		≥ 1 hour	
33.	Audible noise level at rated voltage at the main tap, LpA (ONAF)	(dB)	≤ 60	
34.	Insulation of windings and neutral grounding method			
	- HV winding		Windings tapped insulation, neutral directly grounded	
	- MV winding		Windings uniform insulation, neutral directly grounded or grounded over resistance	
	<b><u>INSULATION LEVELS</u></b>			
35.	Full wave lightning impulse (1.2/50 μsec)			
	- HV	(kV <sub>peak</sub> )	650	
	- MV	(kV <sub>peak</sub> )	170	
	- Neutral (HV)	(kV <sub>peak</sub> )	≥95	
36.	Applied voltage or line terminal A.C. withstand voltage (AV) (LTAC)			
	- HV	(kV-rms)	275	
	- HV – N	(kV-rms)	≥ 38	
	- MV, MV - N	(kV-rms)	70	
37.	Switching impulse voltage	(kV peak)		
	- HV	(kV peak)	540	
38.	Induced voltage test together with partial discharge measurement		Shall be compliant with IEC 60076-3.	
39.	Is the transformer practically independent from corona at 170 kV?		Yes	

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
	<b><u>LOSSES</u></b>			
40.	No load losses (at main tap)			
	- At 90% of the rated voltage	(kW)		
	- At rated voltage	(kW)	≤ 16	
	- At 110% of the rated voltage	(kW)	≤ 20	
41.	On-load losses (at 75°C) (on 62.5 MVA basis)			
	- At maximum voltage tap (at 25th tap)	(kW)	≤ 115	
	- At rated voltage tap (at 13th tap)		≤ 120	
	- At minimum voltage tap (at 1st tap)		≤ 125	
42.	Cooling system			
	- Number of fans (including backups)			
	- Number of backup fans			
	- Fan losses	(kW)		
	- Number of radiators (including backups)			
	- Number of backup radiators		≥ 1	
	<b><u>CHARACTERISTICS OF WINDINGS</u></b>			
43.	Material of windings		Copper	
44.	Winding average current density (on 62.5 MVA, 154/33.6 kV basis)			
	- HV	(A/mm <sup>2</sup> )		
	- MV	(A/mm <sup>2</sup> )		
	- Tuning winding	(A/mm <sup>2</sup> )		
45.	Maximum current density			
	- HV	(A/mm <sup>2</sup> )		
	- MV	(A/mm <sup>2</sup> )		
	- Tuning winding	(A/mm <sup>2</sup> )		
46.	Section of winding conductors			
	- HV	(mm <sup>2</sup> )		
	- MV	(mm <sup>2</sup> )		
	- Tuning winding	(A/mm <sup>2</sup> )		
47.	Total winding conductor weight			
	- HV	(kg)		
	- MV	(kg)		
	- Tuning winding	(kg)		
48.	Insulation of windings			

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
	- HV		Indicated in the Technical Specifications.	
	- MV		Indicated in the Technical Specifications.	
	<b><u>CHARACTERISTICS OF MAGNETIC CIRCUIT</u></b>			
49.	Type		Core type	
50.	Number of legs		3	
51.	Material			
52.	Flux density on the legs (No load, at main tap, At rated voltage)	(Tesla)	$\leq 1,63$	
53.	No load Maximum flux density (at 154kV-%7,5/33.6 kV conversion ratio, while the transformer is energized at 170 kV) (The type of manufacture, type and characteristic curve of the sheet to be used, its magnetizing and loss curves shall be submitted together with the bid))	(Tesla)	$\leq 1,93$	
54.	Core weight	(Ton)		
	<b><u>TANK</u></b>			
55.	Tank type		Indicated in the Technical Specifications.	
56.	Withstand capacity			
	- To vacuum		Full vacuum	
	- To overpressure		Indicated in the Technical Specifications.	
57.	Wall thickness	(mm)		
58.	Bottom thickness	(mm)		
59.	Cover thickness	(mm)		
60.	Paint thickness	(micron)	150	
61.	Finish coat paint color		RAL 7033 or RAL 7039	
	<b><u>CHARACTERISTICS OF BUSHINGS</u></b>			
62.	Manufacturer and Place of Production			
	- HV			

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
	- MV			
	- Neutral (HV/MV)			
63.	Type			
	- HV		Condenser type	
	- MV			
	- Neutral (HV/MV)			
	- Insulators		Porcelain, brown	
64.	Rated voltages			
	- HV	(kV-rms)	170	
	- MV	(kV-rms)	36	
	- Neutral (HV/MV)	(kV-rms)	52/36	
65.	Rated current			
	- HV	(A)	≥400	
	- MV	(A)	≥1600	
	- Neutral (HV/MV)	(A)	≥400/1600	
66.	Dry power frequency withstand voltage (1 min.)			
	- HV	(kV-rms)	355	
	- MV	(kV-rms)	77	
	- Neutral (HV/MV)	(kV-rms)	105/77	
67.	Lightning impulse withstand voltage			
	- HV	(kV-peak)	750	
	- MV	(kV-peak)	170	
	- Neutral (HV/MV)	(kV-peak)	250/170	
68.	Minimum creepage distance (25 mm/ kV for HV bushings, 31 mm/ kV for MV bushings)			
	- HV	(mm)	4250	
	- MV	(mm)	1116	
	- Neutral (HV/MV)	(mm)	1300/1116	
69.	Minimum distance between parts that are under voltage (between phases)			
	- HV	(mm)	1600	
	- MV	(mm)	390	
70.	Minimum distance between phase and ground			
	- HV	(mm)	1330	
	- MV	(mm)	320	
	<b><u>CHARACTERISTICS OF ON- LOAD TAP CHANGER (OLTC)</u></b>			

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
71.	Manufacturer and Place of Production			
72.	Type Mark of the Manufacturer			
73.	OLTC type (*)			
	- Oil/ vacuum		Vacuum	
	(*) Unless otherwise specified by the Directorate, vacuum type OLTC shall be purchased			
74.	Used vacuum cylinder's;			
	- Manufacturer and place of production			
	- Manufacturer's type mark			
75.	Connection diagram			
76.	Rated current and relevant rated step voltage	(A - kV)		
77.	Max. rated current	(A)		
78.	Short circuit current capacity			
	- Thermal (3 sec.)	(kA)		
	- Dynamic (peak)	(kA)		
79.	Rated frequency	(Hz)	50	
80.	Tap setting range	(kV)	154 ±12 x % 1,25	
81.	Rated voltage	(kV-rms)	72.5	
82.	Max. rated step voltage	(V)		
83.	Tap position number		25	
84.	Transient resistance value	(ohm)	Shall be measured at the manufacturing stage.	
85.	Insulation level (IEC 60214-1) (Lightning impulse/ power frequency)			
	- Against ground	(kV-peak /kV-rms)		
	- Between phases	(kV-peak /kV-rms)		
	- Between the first and last contacts of the selector switch	(kV-peak /kV-rms)		
	- Between any two consecutive contacts of the selector switch	(kV-peak /kV-rms)		

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
	- Between the last contacts in open position of the diverter switch	(kV-peak /kV-rms)		
86.	Place of tap selector		In the tank	
87.	Place of diverter switch		A separate housing	
88.	Oil indicator alarm contact		Yes	
89.	Protection devices for safe operation		Yes	
90.	Motor operating mechanism (indicate the characteristics of the mechanism)		Yes	
91.	Number of operations before first maintenance			
	- Greasing		≥ 200.000	
	- Oil replacement (for oil immersed type)		≥ 100.000	
	- Replacement of contacts of the diverter switch (for oil immersed type)		≥ 200.000	
	- Replacement of cutoff cells of diverter switch for vacuum type		≥ 600.000	
	- Number of switching operations before first maintenance for vacuum type		≥ 300.000	
	<b>WEIGHT AND DIMENSIONS</b>			
92.	Net weights			
	- Core	(Ton)		
	- Windings	(Ton)		
	- Tank and accessories	(Ton)		
	- Cooling system	(Ton)		
	- Oil	(Ton)		
	- Total weight (with oil)	(Ton)	≤ 150	
93.	Gross ton weight of the greatest part necessary for transportation	(Ton)	≤ 60	
94.	Dimensions of the unit			
	- Width	(m)		
	- Length	(m)		
	- Height (with/without wheels)	(m)		
	- Top cover height (with/without wheels)	(m)		
95.	Transportation dimensions of the heaviest part			

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
	- Width	(m)	≤ 3.1	
	- Length	(m)		
	- Height	(m)	≤ 4	
96.	Rail gauge for wheel operation	(mm)	1440 (In width)	
97.	Rail gauge for wheel operation	(mm)	1440 and 2942 (in length)	

**ANNEX-1/C**  
**154/33.6 kV, 50/62.5 MVA POWER TRANSFORMER**  
**LIST OF WARRANTED CHARACTERISTICS**

Order No:

Drawing No:

Material Code No of the Directorate:

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
1.	Manufacturer and Place of Production			
2.	Type Mark of the Manufacturer			
3.	Operational conditions (shall be determined by the Directorate)			
	- Altitude above sea level	(meter)		
	- Environmental temperature			
	▪ Daily maximum	(°C)		
	▪ Daily minimum	(°C)		
	▪ 24-hour average	(°C)		
	▪ Annual average	(°C)		
	- Maximum wind pressure			
	▪ On round surface	(Pascal)		
	▪ On flat surface	(Pascal)		
	- Maximum solar radiation	(W/m <sup>2</sup> )		
	- Ice load	(mm)		
	- Susceptibility to industrial pollution	(Yes/no)		
	- Maximum relative humidity (24-hour average)	(%)		
	- Lightning impulse probability			
	- Earthquake			
	▪ Horizontal acceleration	(g)		
	▪ Vertical acceleration	(g)		
4.	Applied standards		Indicated in the Technical Specifications.	
5.	Transformer type		Power transformer	
6.	Phase number	(piece)	3	
7.	Winding number	(piece)	2	
8.	Connection group		YNyn0	
	<b>RATED VALUES</b>			

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
9.	Rated frequency (* T.S. Article 2.1 shall be complied with.	(Hz)	50 (*)	
10.	Rated power	(MVA)	62.5	
11.	Cooling method		ONAN/ONAF	
12.	Power values in accordance with cooling method			
	- ONAN	(MVA)	50	
	- ONAF	(MVA)	62.5	
13.	Temperature rise (when any radiator is out of service)			
	- Top oil	(°C)	≤ 55	
	- Windings	(°C)	≤ 60	
	- Core surface	(°C)	≤ 75	
	- Hot spot point of winding (hot-spot point)	(°C)	≤ 73	
14.	Temporary overloading		According to IEC 60076-7	
15.	Rated voltages			
	- HV winding	(kV)	154	
	- MV winding	(kV)	33.6	
16.	Highest system voltages			
	- HV	(kV)	170	
	- MV	(kV)	36	
17.	Tap Windings		HV, at neutral terminal	
18.	Tap changing type		On-load	
19.	Voltage regulation range		154 ± 12 x %1.25 kV	
20.	Tap position number	(piece)	25	
21.	Voltage setting;			
	- Category		CFVV (constant flux voltage variation)	
	- Method		Coarse fine tap selector or Reversing switch connection	
22.	Tap powers		Equal to 100% nominal power at all taps	
23.	Maximum tap current and relevant tap position	(A)	275.7 (1 <sup>st</sup> tap)	

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
24.	Impedance voltage %, 50 Hz, 75 °C (on 62.5 MVA basis)			
	- At maximum voltage tap (25th tap)		%12.8 (tol.: ±%10)	
	- At rated voltage tap (13th tap)		%12 (tol.: ±%7,5)	
	- At minimum voltage tap (1.kademe)		%11.4 (tol.: %±10)	
25.	% Resistance voltage (154/33.6 kV, on 62.5 MVA basis,75°C)			
26.	No load current at the main tap (on 62.5 MVA basis, at 50 Hz)			
	- HV Nominal voltage 90%	(%)		
	- HV Nominal voltage 100%	(%)		
	- HV Nominal voltage 110%	(%)		
	- HV Nominal voltage 115%	(%)		
	- HV Nominal voltage 120%	(%)		
27.	Continuous operation above nominal voltage			
	- At main tap	(kV)	170	
	- At other taps		+%10	
28.	No load current harmonics (% of basic component)			
	- 3rd harmonic	(%)		
	- 5th harmonic	(%)		
	- 7th harmonic	(%)		
	- 9th harmonic	(%)		
29.	Withstand period in case output ends are short circuited while the input ends are under nominal voltage			
	- Input HV	(sec)	3	
	- Input MV	(sec)	3	
30.	Zero-sequence impedance at the main tap(on 62.5 MVA basis)	(%)		
31.	Zero-Sequence Reactance that is magnetized between HV- Neutral (on 62.5 MVA basis)			
	- At highest tap			
	- At main tap			
	- At lowest tap			

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
32.	Maximum period that the transformer can be operated without exceeding the warranted temperature limits at no load and at 115% of the rated voltage (following long period full load operation at 30°C environmental temperature)		≥ 1 hour	
33.	Audible noise level at rated voltage at the main tap, LpA (ONAF)	(dB)	≤ 60	
34.	Insulation of windings and neutral grounding method			
	- HV winding		Windings tapped insulation, neutral directly grounded	
	- MV winding		Windings uniform insulation, neutral directly grounded or grounded over resistance	
	<b><u>INSULATION LEVELS</u></b>			
35.	Full wave lightning impulse (1.2/50 μsn)			
	- HV	(kV <sub>peak</sub> )	650	
	- MV	(kV <sub>peak</sub> )	170	
	- Neutral (HV)	(kV <sub>peak</sub> )	≥95	
36.	Applied voltage or line terminal A.C. withstand voltage (AV) (LTAC)			
	- HV	(kV-rms)	275	
	- HV – N	(kV-rms)	≥ 38	
	- MV, MV - N	(kV-rms)	70	
37.	Switching impulse voltage	(kV peak)		
	- HV	(kV peak)	540	
38.	Induced voltage test together with partial discharge measurement		Shall be compliant with IEC 60076-3.	
39.	Is the transformer practically independent from corona at 170 kV?		Yes	

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
	<b><u>LOSSES</u></b>			
40.	No load losses (at main tap)			
	- At 90% of the rated voltage	(kW)		
	- At rated voltage	(kW)	≤ 30	
	- At 110% of the rated voltage	(kW)	≤ 40	
41.	On-load losses (at 75°C) (on 62.5 MVA basis)			
	- At maximum voltage tap (at 25th tap)	(kW)	≤ 245	
	- At rated voltage tap (at 13th tap)		≤ 250	
	- At minimum voltage tap (at 1st tap)		≤ 265	
42.	Cooling system			
	- Number of fans (including backups)			
	- Number of backup fans			
	- Fan losses	(kW)		
	- Number of radiators (including backups)			
	- Number of backup radiators		≥ 1	
	<b><u>CHARACTERISTICS OF WINDINGS</u></b>			
43.	Material of windings		Copper	
44.	Winding average current density (on 62.5 MVA, 154/33.6 kV basis)			
	- HV	(A/mm <sup>2</sup> )		
	- MV	(A/mm <sup>2</sup> )		
	- Tuning winding	(A/mm <sup>2</sup> )		
45.	Maximum current density			
	- HV	(A/mm <sup>2</sup> )		
	- MV	(A/mm <sup>2</sup> )		
	- Tuning winding	(A/mm <sup>2</sup> )		
46.	Section of winding conductors			
	- HV	(mm <sup>2</sup> )		
	- MV	(mm <sup>2</sup> )		
	- Tuning winding	(A/mm <sup>2</sup> )		
47.	Total winding conductor weight			
	- HV	(kg)		
	- MV	(kg)		
	- Tuning winding	(kg)		
48.	Insulation of windings			

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
	- HV		Indicated in the Technical Specifications.	
	- MV		Indicated in the Technical Specifications.	
	<b><u>CHARACTERISTICS OF MAGNETIC CIRCUIT</u></b>			
49.	Type		Core type	
50.	Number of legs		3	
51.	Material			
52.	Flux density on the legs (No load, at main tap, At rated voltage)	(Tesla)	$\leq 1,63$	
53.	No load Maximum flux density (at 154kV-%7,5/33.6 kV conversion ratio, while the transformer is energized at 170 kV) Note: The type of manufacture, type and characteristic curve of the sheet to be used, its magnetizing and loss curves shall be submitted together with the bid).	(Tesla)	$\leq 1,93$	
54.	Core weight	(Ton)		
	<b><u>TANK</u></b>			
55.	Tank type		Indicated in the Technical Specifications.	
56.	Withstand capacity			
	- To vacuum		Full vacuum	
	- To overpressure		Indicated in the Technical Specifications.	
57.	Wall thickness	(mm)		
58.	Bottom thickness	(mm)		
59.	Cover thickness	(mm)		
60.	Paint thickness	(micron)	150	
61.	Finish coat paint color		RAL 7033 or RAL 7039	
	<b><u>CHARACTERISTICS OF BUSHINGS</u></b>			
62.	Manufacturer and Place of Production			

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
	- HV			
	- MV			
	- Neutral (HV/MV)			
63.	Type			
	- HV		Condenser type	
	- MV			
	- Neutral (HV/MV)			
	- Insulators		Porcelain, brown	
64.	Rated voltages			
	- HV	(kV-rms)	170	
	- MV	(kV-rms)	36	
	- Neutral (HV/MV)	(kV-rms)	52/36	
65.	Rated current			
	- HV	(A)	≥400	
	- MV	(A)	≥1600	
	- Neutral (HV/MV)	(A)	≥400/1600	
66.	Dry power frequency withstand voltage (1 min.)			
	- HV	(kV-rms)	355	
	- MV	(kV-rms)	77	
	- Neutral (HV/MV)	(kV-rms)	105/77	
67.	Lightning impulse withstand voltage			
	- HV	(kV-peak)	750	
	- MV	(kV-peak)	170	
	- Neutral (HV/MV)	(kV-peak)	250/170	
68.	Minimum creepage distance (25 mm/ kV for HV bushings, 31 mm/ kV for MV bushings)			
	- HV	(mm)	4250	
	- MV	(mm)	1116	
	- Neutral (HV/MV)	(mm)	1300/1116	
69.	Minimum distance between parts that are under voltage (between phases)			
	- HV	(mm)	1600	
	- MV	(mm)	390	
70.	Minimum distance between phase and ground			
	- HV	(mm)	1330	
	- MV	(mm)	320	
	<b><u>CHARACTERISTICS OF ON-LOAD TAP CHANGER (OLTC)</u></b>			

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
71.	Manufacturer and Place of Production			
72.	Type Mark of the Manufacturer			
73.	OLTC type (*)			
	- Oil/ vacuum		Vacuum	
	(*) Unless otherwise specified by the Directorate, vacuum type OLTC shall be purchased			
74.	Used vacuum cylinder's;			
	- Manufacturer and place of production			
	- Manufacturer's type mark			
75.	Connection diagram			
76.	Rated current and relevant rated step voltage	(A - kV)		
77.	Max. rated current	(A)		
78.	Short circuit current capacity			
	- Thermal (3 sec.)	(kA)		
	- Dynamic (peak)	(kA)		
79.	Rated frequency	(Hz)	50	
80.	Tap setting range		154 ±12 x % 1,25 kV	
81.	Rated voltage	(kV-rms)	72.5	
82.	Max. rated step voltage	(V)		
83.	Tap position number		25	
84.	Transient resistance value	(ohm)	Shall be measured at the manufacturing stage.	
85.	Insulation level (IEC 60214-1) (Lightning impulse/ power frequency)			
	- Against ground	(kV-peak /kV-rms)		
	- Between phases	(kV-peak /kV-rms)		
	- Between the first and last contacts of the selector switch	(kV-peak /kV-rms)		
	- Between any two consecutive contacts of the selector switch	(kV-peak /kV-rms)		

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
	- Between the last contacts in open position of the diverter switch	(kV-peak /kV-rms)		
86.	Place of tap selector		In the tank	
87.	Place of diverter switch		A separate housing	
88.	Oil indicator alarm contact		Yes	
89.	Protection devices for safe operation		Yes	
90.	Motor operating mechanism (indicate the characteristics of the mechanism)		Yes	
91.	Number of operations before first maintenance			
	- Greasing		≥ 200.000	
	- Oil replacement (for oil immersed type)		≥ 100.000	
	- Replacement of contacts of the diverter switch (for oil immersed type)		≥ 200.000	
	- Replacement of cutoff cells of diverter switch for vacuum type		≥ 600.000	
	- Number of switching operations before first maintenance for vacuum type		≥ 300.000	
	<b><u>WEIGHT AND DIMENSIONS</u></b>			
92.	Net weights			
	- Core	(Ton)		
	- Windings	(Ton)		
	- Tank and accessories	(Ton)		
	- Cooling system	(Ton)		
	- Oil	(Ton)		
	- Total weight (with oil)	(Ton)	≤ 150	
93.	Gross ton weight of the greatest part necessary for transportation	(Ton)	≤ 60	
94.	Dimensions of the unit			
	- Width	(m)		
	- Length	(m)		
	- Height (with/without wheels)	(m)		
	- Top cover height (with/without wheels)	(m)		
95.	Transportation dimensions of the heaviest part			

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
	- Width	(m)	≤ 3.1	
	- Length	(m)		
	- Height	(m)	≤ 4	
96.	Rail gauge for wheel operation	(mm)	1440 (In width)	
97.	Rail gauge for wheel operation	(mm)	1440 and 2942 (in length)	

**ANNEX-1/D**  
**154/33.6 kV, 80/100 MVA POWER TRANSFORMER**  
**LIST OF WARRANTED CHARACTERISTICS**

Order No:

Drawing No:

Material Code No. of the Directorate:

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
1.	Manufacturer and Place of Production			
2.	Type Mark of the Manufacturer			
3.	Operational conditions (shall be determined by the Directorate)			
	- Altitude above sea level	(meter)		
	- Environmental temperature			
	▪ Daily maximum	(°C)		
	▪ Daily minimum	(°C)		
	▪ 24-hour average	(°C)		
	▪ Annual average	(°C)		
	- Maximum wind pressure			
	▪ On round surface	(Pascal)		
	▪ On flat surface	(Pascal)		
	- Maximum solar radiation	(W/m <sup>2</sup> )		
	- Ice load	(mm)		
	- Susceptibility to industrial pollution	(Yes/no)		
	- Maximum relative humidity (24-hour average)	(%)		
	- Lightning impulse probability			
	- Earthquake			
	▪ Horizontal acceleration	(g)		
	▪ Vertical acceleration	(g)		
4.	Applied standards		Indicated in the Technical Specifications.	
5.	Transformer type		Power transformer	
6.	Phase number	(piece)	3	
7.	Winding number	(piece)	2	
8.	Connection group		YNyn0	
	<b>RATED VALUES</b>			
9.	Rated frequency (*) T.S. Article 2.1 shall be	(Hz)	50 (*)	

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
	complied with.			
10.	Rated power	(MVA)	100	
11.	Cooling method		ONAN/ONAF	
12.	Power values in accordance with cooling method			
	- ONAN	(MVA)	80	
	- ONAF	(MVA)	100	
13.	Temperature rise (when any radiator is out of service)			
	- Top oil	(°C)	≤ 55	
	- Windings	(°C)	≤ 60	
	- Core surface	(°C)	≤ 75	
	- Hot spot point of winding (hot-spot point)	(°C)	≤ 73	
14.	Temporary overloading		According to IEC 60076-7	
15.	Rated voltages			
	- HV winding	(kV)	154	
	- MV winding	(kV)	33.6	
16.	Highest system voltages			
	- HV	(kV)	170	
	- MV	(kV)	36	
17.	Tap Winding		HV, at neutral terminal	
18.	Tap changing type		On-load	
19.	Voltage regulation area		154 ± 12 x %1.25 kV	
20.	Tap position number	(piece)	25	
21.	Voltage setting;			
	- Category		CFVV (constant flux voltage variation)	
	- Method		Coarse fine tap selector or Reversing switch connection	
22.	Tap powers		Equal to 100% nominal power at all taps	
23.	Maximum tap current and relevant tap position	(A)	441.1 (1.kademe)	
24.	Impedance voltage %, 50 Hz, 75 °C (on 100 MVA basis)			

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
	- At maximum voltage tap (25th tap)		%12.8 (tol.: $\pm\%10$ )	
	- At rated voltage tap (13th tap)		%12 (tol.: $\pm\%7,5$ )	
	- At minimum voltage tap (1.kademe)		%11.4 (tol.: $\pm\%10$ )	
25.	% Resistance voltage (154/33.6 kV, on 100 MVA basis, 75°C)			
26.	No load current at the main tap (on 100 MVA basis, at 50 Hz)			
	- HV Nominal voltage 90%	(%)		
	- HV Nominal voltage 100%	(%)		
	- HV Nominal voltage 110%	(%)		
	- HV Nominal voltage 115%	(%)		
	- HV Nominal voltage 120%	(%)		
27.	Continuous operation above nominal voltage			
	- At main tap		170 kV	
	- At other taps		+%10	
28.	No load current harmonics (% of basic component)			
	- 3rd harmonic	(%)		
	- 5th harmonic	(%)		
	- 7th harmonic	(%)		
	- 9th harmonic	(%)		
29.	Withstand period in case output ends are short circuited while the input ends are under nominal voltage			
	- Input HV	(sec)	3	
	- Input MV	(sec)	3	
30.	Zero-sequence impedance at the main tap (on 100 MVA basis)	(%)		
31.	Zero-Sequence Reactance that is magnetized between HV- Neutral (on 100 MVA basis)			
	- At highest tap			
	- At main tap			
	- At lowest tap			
32.	Maximum period that the transformer can be operated without exceeding the warranted temperature limits at no load and at 115% of the		$\geq 1$ hour	

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
	rated voltage (following long period full load operation at 30°C environmental temperature)			
33.	Audible noise level at rated voltage at the main tap, LpA (ONAF)	(dB)	≤ 60	
34.	Insulation of windings and neutral grounding method			
	- HV winding		Windings tapped insulation, neutral directly grounded	
	- MV winding		Windings uniform insulation, neutral directly grounded or grounded over resistance	
	<b><u>INSULATION LEVELS</u></b>			
35.	Full wave lightning impulse (1.2/50 μsec)			
	- HV	(kV <sub>peak</sub> )	650	
	- MV	(kV <sub>peak</sub> )	170	
	- Neutral (HV)	(kV <sub>peak</sub> )	≥95	
36.	Applied voltage or line terminal A.C. withstand voltage (AV) (LTAC)			
	- HV	(kV-rms)	275	
	- HV – N	(kV-rms)	≥ 38	
	- MV, MV - N	(kV-rms)	70	
37.	Switching impulse voltage			
	- HV	(kV peak)	540	
38.	Induced voltage test together with partial discharge measurement		Shall be compliant with IEC 60076-3.	
39.	Is the transformer practically independent from corona at 170 kV?		Yes	
	<b><u>LOSSES</u></b>			
40.	No load losses			

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
	(at main tap)			
	- At 90% of the rated voltage	(kW)		
	- At rated voltage	(kW)	≤ 35	
	- At 110% of the rated voltage	(kW)	≤ 45	
41.	On-load losses (at 75°C) (on 100 MVA basis)			
	- At maximum voltage tap (at 25th tap)	(kW)	≤ 282	
	- At rated voltage tap (at 13th tap)		≤ 272	
	- At minimum voltage tap (at 1st tap)		≤ 272	
42.	Cooling system			
	- Number of fans (including backups)			
	- Number of backup fans			
	- Fan losses	(kW)		
	- Number of radiators (including backups)			
	- Number of backup radiators		≥ 1	
	<b><u>CHARACTERISTICS OF WINDINGS</u></b>			
43.	Material of windings		Copper	
44.	Winding average current density (100 MVA,154/33.6 kV basis )			
	- HV	(A/mm <sup>2</sup> )		
	- MV	(A/mm <sup>2</sup> )		
	- Tuning winding	(A/mm <sup>2</sup> )		
45.	Maximum current density			
	- HV	(A/mm <sup>2</sup> )		
	- MV	(A/mm <sup>2</sup> )		
	- Tuning winding	(A/mm <sup>2</sup> )		
46.	Section of winding conductors			
	- HV	(mm <sup>2</sup> )		
	- MV	(mm <sup>2</sup> )		
	- Tuning winding	(A/mm <sup>2</sup> )		
47.	Total winding conductor weight			
	- HV	(kg)		
	- MV	(kg)		
	- Tuning winding	(kg)		
48.	Insulation of windings			
	- HV		Indicated in the Technical Specifications.	
	- MV		Indicated in	

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
			the Technical Specifications.	
	<b><u>CHARACTERISTICS OF MAGNETIC CIRCUIT</u></b>			
49.	Type		Core type	
50.	Number of legs		3	
51.	Material			
52.	Flux density on the legs (No load, at main tap, At rated voltage)	(Tesla)	$\leq 1,63$	
53.	No load Maximum flux density (at 154kV-%7,5/33.6kV conversion ratio, while the transformer is energized at 170 kV) Note: The type of manufacture, type and characteristic curve of the sheet to be used, its magnetizing and loss curves shall be submitted together with the bid).	(Tesla)	$\leq 1,93$	
54.	Core weight	(Ton)		
	<b><u>TANK</u></b>			
55.	Tank type		Indicated in the Technical Specifications.	
56.	Withstand capacity			
	- To vacuum		Full vacuum	
	- To overpressure		Indicated in the Technical Specifications.	
57.	Wall thickness	(mm)		
58.	Bottom thickness	(mm)		
59.	Cover thickness	(mm)		
60.	Paint thickness	(micron)	150	
61.	Finish coat paint color		RAL 7033 or RAL 7039	
	<b><u>CHARACTERISTICS OF BUSHINGS</u></b>			
62.	Manufacturer and Place of Production			
	- HV			
	- MV			
	- Neutral (HV/MV)			
63.	Type			

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
	- HV		Condenser type	
	- MV			
	- Neutral (HV/MV)			
	- Insulators		Porcelain, brown	
64.	Rated voltages			
	- HV	(kV-rms)	170	
	- MV	(kV-rms)	36	
	- Neutral (HV/MV)	(kV-rms)	52/36	
65.	Rated current			
	- HV	(A)	≥ 600	
	- MV	(A)	≥ 2000	
	- Neutral (HV/MV)	(A)	≥ 600/2000	
66.	Dry power frequency withstand voltage (1 min.)			
	- HV	(kV-rms)	355	
	- MV	(kV-rms)	77	
	- Neutral (HV/MV)	(kV-rms)	105/77	
67.	Lightning impulse withstand voltage			
	- HV	(kV-peak)	750	
	- MV	(kV-peak)	170	
	- Neutral (HV/MV)	(kV-peak)	250/170	
68.	Minimum creepage distance (25 mm/ kV for HV bushings, 31 mm/ kV for MV bushings)			
	- HV	(mm)	4250	
	- MV	(mm)	1116	
	- Neutral (HV/MV)	(mm)	1300/1116	
69.	Minimum distance between parts that are under voltage (between phases)			
	- HV	(mm)	1600	
	- MV	(mm)	390	
70.	Minimum distance between phase and ground			
	- HV	(mm)	1330	
	- MV	(mm)	320	
	<b><u>CHARACTERISTICS OF ON-LOAD TAP CHANGER (OLTC)</u></b>			
71.	Manufacturer and Place of Production			
72.	Type Mark of the Manufacturer			
73.	OLTC type (*)			
	- Oil/ vacuum		Vacuum	
	(*) Unless otherwise specified			

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
	by the Directorate, vacuum type OLTC shall be purchased			
74.	Used vacuum cylinder's;			
	- Manufacturer name and place of production			
	- Manufacturer's type mark			
75.	Connection diagram			
76.	Rated current and relevant rated step voltage	(A - kV)		
77.	Max. rated current	(A)		
78.	Short circuit current capacity			
	- Thermal (3 sec.)	(kA)		
	- Dynamic (peak)	(kA)		
79.	Rated frequency	(Hz)	50	
80.	Tap setting range		154 ±12 x % 1,25 kV	
81.	Rated voltage	(kV-rms)	72.5	
82.	Max. rated step voltage	(V)		
83.	Tap position number		25	
84.	Transient resistance value	(ohm)	Shall be measured at the manufacturing stage.	
85.	Insulation level (IEC 60214-1) (Lightning impulse/ power frequency)			
	- Against ground	(kV-peak /kV-rms)		
	- Between phases	(kV-peak /kV-rms)		
	- Between the first and last contacts of the selector switch	(kV-peak /kV-rms)		
	- Between any two consecutive contacts of the selector switch	(kV-peak /kV-rms)		
	- Between the last contacts in open position of the diverter switch	(kV-peak /kV-rms)		
86.	Place of tap selector		In the tank	
87.	Place of diverter switch		A separate housing	
88.	Oil indicator alarm contact		Yes	
89.	Protection devices for safe operation		Yes	
90.	Motor operating mechanism (indicate the characteristics of the mechanism)		Yes	

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
91.	Number of operations before first maintenance			
	- Greasing		$\geq 200.000$	
	- Oil replacement (for oil immersed type)		$\geq 100.000$	
	- Replacement of contacts of the diverter switch (for oil immersed type)		$\geq 200.000$	
	- Replacement of cutoff cels of diverter switch for vacuum type		$\geq 600.000$	
	- Number of switching operations before first maintenance for vacuum type		$\geq 300.000$	
	<b>WEIGHT AND DIMENSIONS</b>			
92.	Net weights			
	- Core	(Ton)		
	- Windings	(Ton)		
	- Tank and accessories	(Ton)		
	- Cooling system	(Ton)		
	- Oil	(Ton)		
	- Total weight (with oil)	(Ton)	$\leq 150$	
93.	Gross ton weight of the greatest part necessary for transportation	(Ton)	$\leq 90$	
94.	Dimensions of the unit			
	- Width	(m)		
	- Length	(m)		
	- Height (with/without wheels)	(m)		
	- Top cover height (with/without wheels)	(m)		
95.	Transportation dimensions of the heaviest part			
	- Width	(m)	$\leq 3.1$	
	- Length	(m)		
	- Height	(m)	$\leq 4$	
96.	Rail gauge for wheel operation	(mm)	1440 (In width)	
97.	Rail gauge for wheel operation	(mm)	1440 and 2942 (in length)	

**ANNEX-1/E**  
**400/33.6 kV, 90/125 MVA POWER TRANSFORMER**  
**LIST OF WARRANTED CHARACTERISTICS**

Order No:

Drawing No:

Material Code No of the Directorate:

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
1.	Manufacturer and Place of Production			
2.	Type Mark of the Manufacturer			
3.	Operational conditions (shall be determined by the Directorate)			
	- Altitude above sea level	(meter)		
	- Environmental temperature			
	▪ Daily maximum	(°C)		
	▪ Daily minimum	(°C)		
	▪ 24-hour average	(°C)		
	▪ Annual average	(°C)		
	- Maximum wind pressure			
	▪ On round surface	(Pascal)		
	▪ On flat surface	(Pascal)		
	- Maximum solar radiation	(W/m <sup>2</sup> )		
	- Ice load	(mm)		
	- Susceptibility to industrial pollution	(Yes/no)		
	- Maximum relative humidity (24-hour average)	(%)		
	- Lightning impulse probability			
	- Earthquake			
	▪ Horizontal acceleration	(g)		
	▪ Vertical acceleration	(g)		
4.	Applied standards		Indicated in the Technical Specifications.	
5.	Transformer type		Power transformer	
6.	Phase number	(piece)	3	
7.	Winding number	(piece)	2	
8.	Connection group		YNd11	
	<b>RATED VALUES</b>			
9.	Rated frequency (Hz) (* T.S. Article 2.1 shall be	(Hz)	50 (*)	

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
	complied with.			
10.	Rated power	(MVA)	125	
11.	Cooling method		ONAN/ONAF	
12.	Power values in accordance with cooling method			
	- ONAN	(MVA)	90	
	- ONAF	(MVA)	125	
13.	Temperature rise (when any radiator is out of service)			
	- Top oil	(°C)	≤ 55	
	- Windings	(°C)	≤ 60	
	- Core surface	(°C)	≤ 75	
	- Hot spot point of winding (hot-spot point)	(°C)	≤ 73	
14.	Temporary overloading		According to IEC 60076-7	
15.	Rated voltages			
	- HV winding	(kV)	400	
	- MV winding	(kV)	33.6	
16.	Highest system voltages			
	- HV	(kV)	420	
	- MV	(kV)	36	
17.	Tap Windings		HV, at neutral terminal	
18.	Tap changing type		On-load	
19.	Voltage regulation area		400 ± 12 x %1.25 kV	
20.	Tap position number	(piece)	25	
21.	Voltage setting;			
	- Category		CFVV (constant flux voltage variation)	
	- Method		Coarse fine tap selector or Reversing switch connection	
22.	Tap powers		Equal to 100% nominal power at all taps	
23.	Nominal current of MV winding in case of continuous operation (in ONAF case)			
	- 31.5	(A)	2291/√3	
	- 33.6	(A)	2148/√3	
	- 34.5	(A)	2092/√3	

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
24.	Maximum tap current and relevant tap position	(A)	212.3 (1 <sup>st</sup> tap)	
25.	Impedance voltage %, 50 Hz, 75 °C (on 125 MVA basis)			
	- At maximum voltage tap (25th tap)		%16 (tol.: +%5,- %10)	
	- At rated voltage tap (13th tap)		%15 (tol.: ±%5)	
	- At minimum voltage tap (1 <sup>st</sup> tap)		%14 (tol.: -%5,+ %10)	
26.	% Resistance voltage (400/33.6 kV, 125 MVA bazında,75°C)			
27.	No load current at the main tap (on 125 MVA basis, at 50 Hz)			
	- HV Nominal voltage 90%	(%)		
	- HV Nominal voltage 100%	(%)		
	- HV Nominal voltage 110%	(%)	≤ 0.6	
	- HV Nominal voltage 115%	(%)		
	- HV Nominal voltage 120%	(%)		
28.	Continuous operation above nominal voltage			
	- At main tap	(kV)	420	
	- At other taps		+%10	
29.	No load current harmonics (% of basic component)			
	- 3rd harmonic	(%)		
	- 5th harmonic	(%)		
	- 7th harmonic	(%)		
	- 9th harmonic	(%)		
30.	Air core reactance observed between HV terminal and neutral (on 125 MVA basis)			
	- At 400 kV+%15/33.6 kV ratio			
	- At 400 kV/33.6 kV ratio			
	- At 400 kV-%15/33.6 kV ratio			
31.	Withstand period in case output ends are short circuited while the input ends are under nominal voltage			
	- Input HV	(sec)	3	
	- Input MV	(sec)	3	
32.	Zero-sequence impedance at the main tap(on 125 MVA	(%)		

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
	basis)			
33.	Maximum period that the transformer can be operated without exceeding the warranted temperature limits at no load and at 115% of the rated voltage (following long period full load operation at 30°C environmental temperature)		≥ 1 hour	
34.	Magnetic impedance in case of zero sequence energizing at main tap (at nominal power and voltage)	(%)		
35.	When HV side of the transformer is energized at any tap, withstand capacity of MV ends against short circuit repeated with 1 sec period		Minimum 100 times	
36.	Permissible operation period of the transformer for zero sequence voltages in case of single phase- ground failure of MV side	(min)		
	- %5 nominal phase-ground voltage			
	- %10 nominal phase-ground voltage			
	- %20 nominal phase-ground voltage			
	- %40 nominal phase-ground voltage			
	- %60 nominal phase-ground voltage			
	- %80 nominal phase-ground voltage			
	- 100% nominal phase-ground voltage			
37.	Audible noise level at rated voltage at the main tap, LpA (ONAF)	(dB)	≤ 70	
38.	Insulation of windings and neutral grounding method			
	- HV winding		Windings tapped insulation, neutral directly grounded	
	- MV winding		Windings	

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
			uniform insulation	
	<b><u>INSULATION LEVELS</u></b>			
39.	Full wave lightning impulse (1.2/50 $\mu$ s)			
	- HV	(kV <sub>peak</sub> )	1425	
	- MV	(kV <sub>peak</sub> )	170	
	- Neutral (HV)	(kV <sub>peak</sub> )	$\geq 250$	
40.	Applied voltage or line terminal A.C. withstand voltage (AV) (LTAC)			
	- HV	(kV-rms)	630	
	- HV-N	(kV-rms)	$\geq 95$	
	- MV	(kV-rms)	70	
41.	250/2500 $\mu$ sec switching impulse test to be applied on HV terminals		1050	
42.	Induced voltage test together with partial discharge measurement		Shall be compliant with IEC 60076-3.	
43.	Is the transformer practically independent from corona at 420 kV?		Yes	
	<b><u>LOSSES</u></b>			
44.	No load losses (at main tap)			
	- At 90% of the rated voltage	(kW)		
	- At rated voltage	(kW)	$\leq 65$	
	- At 110% of rated voltage	(kW)	$\leq 85$	
	- At 115% of rated voltage	(kW)	$\leq 105$	
45.	On-load losses (at 75°C) (on 125 MVA basis)			
	- At maximum voltage tap (at 25th tap)	(kW)	$\leq 300$	
	- At rated voltage tap (at 13th tap)	(kW)	$\leq 315$	
	- At minimum voltage tap (at 1st tap)	(kW)	$\leq 325$	
46.	Cooling system			
	- Number of fans (including backups)			
	- Number of backup fans			
	- Fan losses	(kW)		
	- Number of radiators (including backups)			
	- Number of backup radiators		$\geq 1$	
47.	Losses on-load at 400 Kv-4x1.25%/33.6 kV ratio and	(kW)		

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
	when 2170A current passes through the MV winding at 75°C			
	<b><u>CHARACTERISTICS OF WINDINGS</u></b>			
48.	Material of windings		Copper	
49.	Winding average current density (on 125 MVA, 400/33.6 kV basis)			
	- HV	(A/mm <sup>2</sup> )		
	- MV	(A/mm <sup>2</sup> )		
	- Tuning winding	(A/mm <sup>2</sup> )		
50.	Maximum current density			
	- HV	(A/mm <sup>2</sup> )		
	- MV	(A/mm <sup>2</sup> )		
	- Tuning winding	(A/mm <sup>2</sup> )		
51.	Section of winding conductors			
	- HV	(mm <sup>2</sup> )		
	- MV	(mm <sup>2</sup> )		
	- Tuning winding	(A/mm <sup>2</sup> )		
52.	Total winding conductor weight			
	- HV	(kg)		
	- MV	(kg)		
	- Tuning winding	(kg)		
53.	Insulation of windings			
	- HV		Indicated in the Technical Specifications.	
	- MV		Indicated in the Technical Specifications.	
	<b><u>CHARACTERISTICS OF MAGNETIC CIRCUIT</u></b>			
54.	Type		Core type	
55.	Number of legs		3	
56.	Material			
57.	Flux density on the legs (No load, at main tap, At rated voltage)	(Tesla)	≤ 1,63	
58.	No load Maximum flux density (at 400 kV-%7,5/33.6 kV conversion ratio when the transformer is energized at 420 kV) (The type of manufacture, type and characteristic curve of the sheet to be used, its magnetizing and loss curves shall be submitted together	(Tesla)	≤ 1,93	

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
	with the bid))			
59.	Core weight	(Ton)		
	<b><u>TANK</u></b>			
60.	Tank type		Indicated in the Technical Specifications.	
61.	Withstand capacity			
	- To vacuum		Full vacuum	
	- To overpressure		Indicated in the Technical Specifications.	
62.	Wall thickness	(mm)		
63.	Bottom thickness	(mm)		
64.	Cover thickness	(mm)		
65.	Paint thickness	(micron)	150	
66.	Finish coat paint color		RAL 7033 or RAL 7039	
	<b><u>CHARACTERISTICS OF BUSHINGS</u></b>			
67.	Manufacturer and Place of Production			
	- HV			
	- MV			
	- Neutral (HV)			
68.	Type			
	- HV		Condenser type	
	- MV			
	- Neutral (HV)			
	- Insulators		Porcelain, brown	
69.	Rated voltages			
	- HV	(kV-rms)	420	
	- MV	(kV-rms)	52	
	- Neutral (HV)	(kV-rms)	52	
70.	Rated current			
	- HV	(A)	≥ 400	
	- MV	(A)	≥ 2500	
	- Neutral (HV)	(A)	≥ 400	
71.	Dry power frequency withstand voltage (1 min.)			
	- HV	(kV-rms)	695	
	- MV	(kV-rms)	105	
	- Neutral (HV)	(kV-rms)	105	
72.	Full wave (1.2/50 μs) lightning impulse withstand voltage			
	- HV	(kV-peak)	1425	

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
	- MV	(kV-peak)	250	
	- Neutral (HV)	(kV-peak)	250	
73.	Switching impulse voltage			
	- HV	(kV-peak)	1050	
74.	Minimum creepage distance (25 mm/ kV for HV bushings, 31 mm/ kV for MV bushings)			
	- HV	(mm)	10500	
	- MV	(mm)	1116	
	- Neutral (HV)	(mm)	1300	
75.	Minimum distance between parts that are under voltage (between phases)			
	- HV	(mm)	3840	
	- MV	(mm)	390	
76.	Minimum distance between phase and ground			
	- HV	(mm)	3200	
	- MV	(mm)	320	
77.	Bushing type current transformers (for each HV phase) (*)		- 3 core 250/5-5-5A 60 VA-10P10 - 1 core 250/1A 30 VA-Sn:0.5 safety factor:5	
	(*) It shall be possible for the Directorate to change the values of current transformers used on HV bushings depending on Directorate's choice.		-	
	<b><u>CHARACTERISTICS OF ON-LOAD TAP CHANGER (OLTC)</u></b>			
78.	Manufacturer and Place of Production			
79.	Type Mark of the Manufacturer			
80.	OLTC type (*)			
	- Oil/ vacuum		Vacuum	
	(*) Unless otherwise specified by the Directorate, vacuum type OLTC shall be purchased			
81.	Used vacuum cylinder's;			

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
	- Manufacturer name and place of production			
	- Manufacturer's type mark			
82.	Connection diagram			
83.	Rated current and relevant rated step voltage	(A - kV)		
84.	Max. rated current	(A)		
85.	Short circuit current capacity			
	- Thermal (3 sec.)	(kA)		
	- Dynamic (peak)	(kA)		
86.	Rated frequency	(Hz)	50	
87.	Tap setting range		400 ±12 x % 1,25 kV	
88.	Rated voltage	(kV-rms)	72.5	
89.	Max. rated step voltage	(V)		
90.	Tap position number		25	
91.	Transient resistance value	(ohm)	Shall be measured at the manufacturing stage.	
92.	Insulation level (IEC 60214-1) (Lightning impulse/ power frequency)			
	- Against ground	(kV-peak /kV-rms)		
	- Between phases	(kV-peak /kV-rms)		
	- Between the first and last contacts of the selector switch	(kV-peak /kV-rms)		
	- Between any two consecutive contacts of the selector switch	(kV-peak /kV-rms)		
	- Between the last contacts in open position of the diverter switch	(kV-peak /kV-rms)		
93.	Place of tap selector		In the tank	
94.	Place of diverter switch		A separate housing	
95.	Oil indicator alarm contact		Yes	
96.	Protection devices for safe operation		Yes	
97.	Motor operating mechanism (indicate the characteristics of the mechanism)		Yes	
98.	Number of operations before first maintenance			
	- Greasing		≥ 200.000	
	- Oil replacement (for oil		≥ 100.000	

## TEİAŞ

NO	DEFINITION	UNIT	REQUESTED	WARRANTED
	immersed type)			
	- Replacement of contacts of the diverter switch (for oil immersed type)		$\geq 200.000$	
	- Replacement of cutoff cells of diverter switch for vacuum type		$\geq 600.000$	
	- Number of switching operations before first maintenance for vacuum type		$\geq 300.000$	
	<b><u>WEIGHT AND DIMENSIONS</u></b>			
99.	Net weights			
	- Core	(Ton)		
	- Windings	(Ton)		
	- Tank and accessories	(Ton)		
	- Cooling system	(Ton)		
	- Oil	(Ton)		
	- Total weight (with oil)	(Ton)		
100.	Gross ton weight of the greatest part necessary for transportation	(Ton)	$\leq 160$	
101.	Dimensions of the unit			
	- Width	(m)		
	- Length	(m)		
	- Height (with/without wheels)	(m)		
	- Top cover height (with/without wheels)	(m)		
102.	Transportation dimensions of the heaviest part			
	- Width	(m)	$\leq 3.4$	
	- Length	(m)		
	- Height	(m)	$\leq 4.25$	
103.	Rail gauge for wheel operation	(mm)	1440 (In width)	
104.	Rail gauge for wheel operation	(mm)	1440 and 2942 (in length)	

**ANNEX-2  
POWER TRANSFORMER (400 kV /MV,154 kV/MV)  
LIST OF DEVIATIONS**

**Order No.** : .....

**Drawing No.:** .....

**Material code No of the Directorate :** .....

**A- DEVIATIONS FROM TECHNICAL SPECIFICAITONS**

(The articles containing deviations and what those deviations are shall be clearly indicated by the bidder.)

- .....
- .....
- .....
- .....
- .....
- .....
- .....
- .....

**B- DEVIATIONS IN THE LIST OF WARRANTED CHARACTERISTICS**

(The articles containing deviations and what those deviations are shall be clearly indicated by the bidder.)

- .....
- .....
- .....
- .....

TEİAŞ

**ANNEX-3**  
**TEİAŞ NEW INSULATING OIL PURCHASE SPECIFICATIONS**

TEİAŞ New Insulating Oil Purchase Specifications shall be attached to the technical specifications in the form of a separate file.

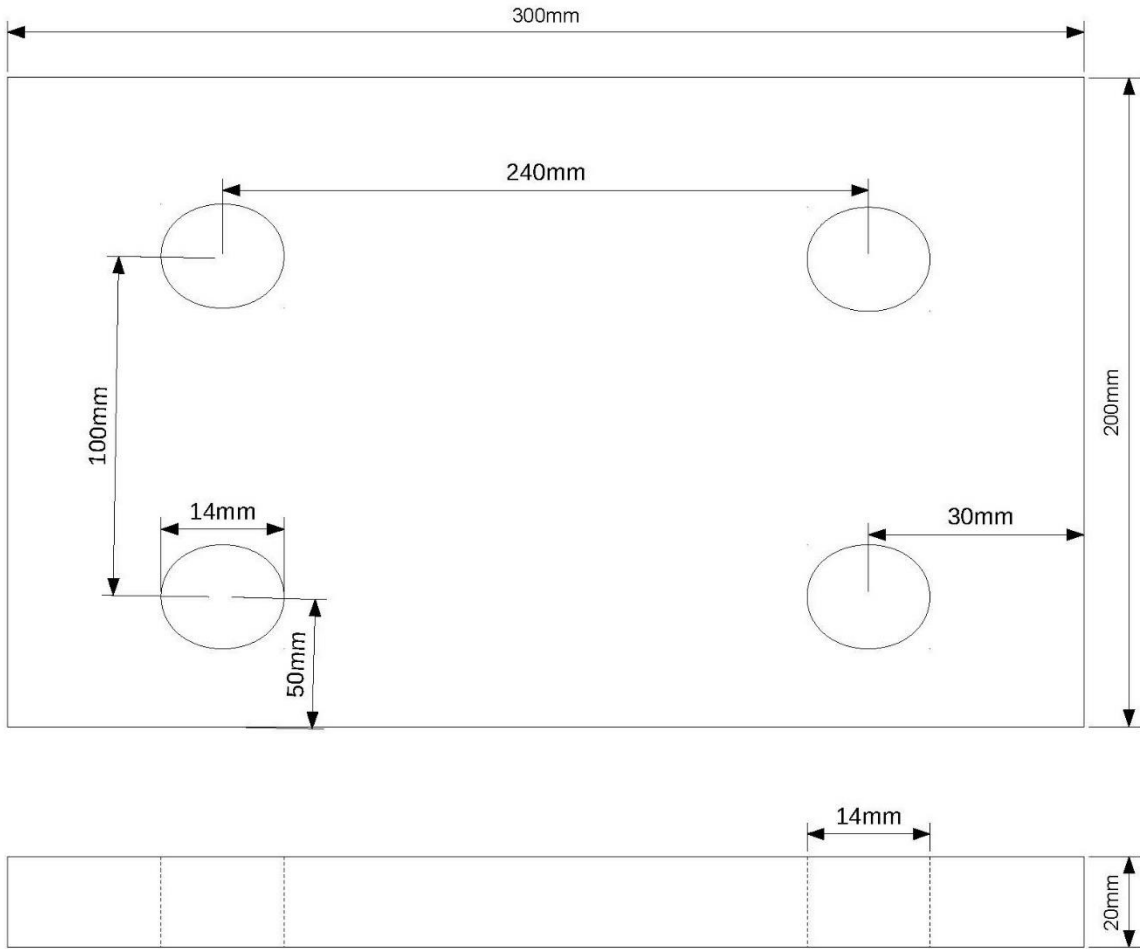
TEİAŞ

**ANNEX-4**  
**TEİAŞ OIL SPECIFICATIONS FOR NEW TRANSFORMERS IMMERSSED WITH**  
**NEW INSULATING OIL**

TEİAŞ Oil Specifications for New Transformers Immersed with New Insulating Oil shall be attached to the technical specifications in the form of a separate file.

TEİAŞ

**ANNEX-5  
ANCHORAGE PLATE DETAILED DRAWING**



Malzeme: **St37**