



ELES, d.o.o.

Dokumentacija za razpis

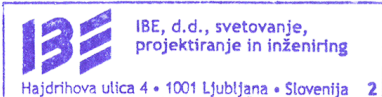
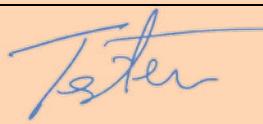
ŠT.:	NAČRT:	ŠT. NAČRTA:
3	NAČRT S PODROČJA ELEKTROTEHNIKE	
3/5	Dobava transformatorjev T211 in T212	R4PO01-6E/11

RTP 400/220/110 kV Podlog / Rekonstrukcija transformacije 220/110 kV

VZDRŽEVALNA DELA V JAVNO KORIST

ŠT. PROJEKTA:	ŠT. MAPE:	IZVOD:	KRAJ IN DATUM:
R4PO01-A025/645	R4PO01-6E/M11	1	Ljubljana, maj 2026

NASLOVNA STRAN NAČRTA

INVESTITOR		
INVESTITOR 1		
ime in priimek ali naziv družbe	ELES, d.o.o.	
naslov ali poslovni naslov družbe	Hajdrihova ulica 2, 1000 LJUBLJANA	
PODATKI O GRADNJI		
naziv gradnje	RTP 400/220/110 kV Podlog / Rekonstrukcija transformacije 220/110 kV	
kratak opis gradnje	Zamenjava transformatorjev 220/110 kV T211 in T212, zamenjava VN opreme in ostale opreme v 4 TR poljih ter pripadajoče ureditve	
VRSTE GRADNJE	<input type="checkbox"/>	NOVOGRADNJA - NOVOZGRAJEN OBJEKT
	<input type="checkbox"/>	NOVOGRADNJA - PRIZIDAVA
	<input type="checkbox"/>	REKONSTRUKCIJA
	<input type="checkbox"/>	SPREMEMBA NAMEMBNOSTI
	<input type="checkbox"/>	ODSTRANITEV CELOTNEGA OBJEKTA
	<input type="checkbox"/>	LEGALIZACIJA
	<input type="checkbox"/>	MANJŠA REKONSTRUKCIJA
	<input type="checkbox"/>	VZDRŽEVANJE OBJEKTA
	<input checked="" type="checkbox"/>	VZDRŽEVALNA DELA V JAVNO KORIST
PODATKI O PROJEKTNi DOKUMENTACIJI		
vrsta dokumentacije	Dokumentacija za razpis (DZR)	
številka projekta	R4PO01-A025/645	
PODATKI O NAČRTU		
strokovno področje načrta	3	NAČRT S PODROČJA ELEKTROTEHNIKE
naziv načrta	3/5	Dobava transformatorjev T211 in T212
številka načrta	R4PO01-6E/11	
datum izdelave	maj 2026	
datum spremembe	/	
PODATKI O PROJEKTANTU NAČRTA		
projektant načrta (naziv družbe)	IBE, d.d., svetovanje, projektiranje in inženiring	
naslov	Hajdrihova ulica 4, 1001 Ljubljana	
odgovorna oseba projektanta načrta	dr. Franc Sinur	
podpis odgovorne osebe projektanta načrta		
PODATKI O IZDELOVALCU NAČRTA		
ime in priimek pooblaščenega arhitekta, poobl. inženirja	mag. Marko Testen, univ. dipl. inž. el.	
identifikacijska številka	IZS E-1293	
podpis pooblaščenega arhitekta, pooblaščenega inženirja		

PODATKI O VODJI PROJEKTIRANJA

VODJA PROJEKTIRANJA

mag. Marko Testen, univ. dipl. inž. el.

identifikacijska številka

IZS E-1293

podpis vodje projektiranja



DODATNI PODATKI O DOKUMENTACIJI

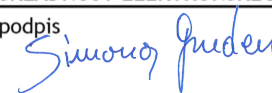
DRUGI SODELAVCI

izdelava dokumentacije

Aljaž Brenčič, mag. inž. el.

SKLADNOST ELEKTRONSKEGA IN FIZIČNEGA IZVODA

podpis



datum

29.05.2026

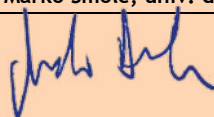
KONTROLA PROJEKTA

V skladu s Pravilnikom o kontroli projektov je bila imenovana komisija za kontrolo projekta. Kontrola projekta v skladu s sistemom vodenja kakovosti IBE d.d. je bila opravljena.

predsednik komisije za kontrolo projekta

mag. Marko Smole, univ. dipl. inž. el.

podpis predsednika komisije



OZNAČEVANJE DOKUMENTACIJE PO INTERNEM STANDARDU IBE D.D.

IBE številka projekta

R4PO01-A025/645

IBE številka načrta

R4PO01-6E/11

IBE številka mape

R4PO01-6E/M11

KAZALO VSEBINE NAČRTA

INVESTITOR				
INVESTITOR 1				
ime in priimek ali naziv družbe		ELES, d.o.o.		
naslov ali poslovni naslov družbe		Hajdrihova ulica 2, 1000 LJUBLJANA		
PODATKI O GRADNJI				
naziv gradnje		RTP 400/220/110 kV Podlog / Rekonstrukcija tranformacije 220/110 kV		
PODATKI O PROJEKTNIM DOKUMENTACIJAM				
vrsta dokumentacije		Dokumentacija za razpis (DZR)		
številka projekta		R4PO01-A025/645		
strokovno področje načrta		3	NAČRT S PODROČJA ELEKTROTEHNIKE	
naziv načrta		3/5	Dobava transformatorjev T211 in T212	
številka načrta		R4PO01-6E/11		
pogl.	št.	dokument	id. oznaka	strani
številka mape		R4PO01-6E/M11		
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TEHNIČNO POROČILO

INVESTITOR

INVESTITOR 1

ime in priimek ali naziv družbe

ELES, d.o.o.

naslov ali poslovni naslov družbe

Hajdrihova ulica 2, 1000 LJUBLJANA

PODATKI O GRADNJI

naziv gradnje

RTP 400/220/110 kV Podlog / Rekonstrukcija transformacije
220/110 kV

PODATKI O PROJEKTNIM DOKUMENTACIJAM

vrsta dokumentacije

Dokumentacija za razpis (DZR)

številka projekta

R4PO01-A025/645

strokovno področje načrta

3

NAČRT S PODROČJA ELEKTROTEHNIKE



naziv načrta

3/5

Dobava transformatorjev T211 in T212

številka načrta

R4PO01-6E/11

Revision:		Revision note:				Revision date:	
Signature:							
Investor:							
Facility:		S/S 400/220/110 kV Podlog					
Designer:		 IBE, svetovanje, projektiranje in inženiring Ljubljana, Slovenija					
Part of facility/system:		Power transformer 220/110 kV, 150 MVA					
Type of design:		3 ELECTRICAL INSTALLATION AND ELECTRICAL EQUIPMENT					
Title of document:		Technical specification for 220/110 kV power transformers					
Name and surname		Id. No.:					
Approved by:		mag. Marko Testen, univ. dipl. inž. el.		E-1293			
Confirmed by:		mag. Marko Testen, univ. dipl. inž. el.		E-1293			
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Type:		DZR					
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1 SCOPE AND LIMITS OF SUPPLY

1.1 SCOPE OF SUPPLY

Scope of this Tender documentation is supply of power transformers 150 MVA, 220/110 kV to replace the existing transformers:

- T211 and T212 at substation Podlog (S/S Podlog),
- T211 at substation Kleče (S/S Kleče),
- T212 at substation Divača (S/S Divača).

The Tenderer must supply all devices, equipment, and perform all auxiliary works necessary to ensure the permanent, reliable, and safe operation of the high-voltage equipment covered by this Tender, even if not explicitly specified herein.

The scope of this Tender is:

1. Supply and installation of a power transformers, comprising:
 - a) supply of 150 MVA power transformers in accordance with the technical requirements and data in this Tender,
 - b) performance of acceptance tests in accordance with the Tender requirements,
 - c) packaging and transport of the transformers to the installation site including all transport arrangements and insurance,
 - d) placing and fastening of the transformers on the foundation,
 - e) installation of transformers assembly (bushings, cooling systems, conservator, oil filling, etc.),
 - f) supervision and participation in wiring coordination, installation and functional testing of the protection and control systems,
 - g) removal of packaging material and other material used during transport and installation,
 - h) training of the Customer's personnel,
 - i) parameterization of the transformers on-line monitoring system and implementation of all necessary communication connections, including integration with the existing ELES central system for on-line control,
 - j) supply of 20 pieces of 3D-printed power transformer models at a 1:40 scale.
2. Dismantling of the existing power transformers, including:
 - a) preparation of an environmental protection report,
 - b) preparation of a construction waste management study for the transformer in accordance with applicable legislation,

- c) rental of all necessary transport equipment, including operating personal,
- d) arrangement of all required transport permits for moving the transformers from S/S Podlog, S/S Kleče and S/S Divača to the decommissioning site (including permits, fees, transport studies, and all related transport costs),
- e) disconnection of the transformers grounding connections,
- f) removal of transformers oil,
- g) dismantling of the cooling system and bushings (high-voltage, medium-voltage and low-voltage),
- h) dismantling of the conservator and associated pipe connections,
- i) preparation of the transformers unit for transport (including protection of dismantled equipment against potential leakage of residual insulating oil),
- j) transfer of the transformers from the foundation to the transport vehicle,
- k) organisation and execution of transport to the decommissioning site, including all transport arrangements and insurance,
- l) removal of all equipment to landfill site for dismantling or destruction,
- m) record sheets issuing,
- n) Final dismantling of remaining parts of the transformer unit at a suitable location compliant with ISO 14001 and related standards.

The scope of supply does not include any civil construction works. The Tenderer must provide all necessary documentation required for the continuation and successful completion of the project in a timely manner.

The deadline for the supply of equipment shall be as stipulated in the contract signed between the Tenderer and the Customer.

Definition of terms used in this tender:

- The term Tenderer, as used in this Tender, refers to the entity participating in the Tender process up to the conclusion of the contract for the supply of equipment and execution of works under this Tender. Upon contract award, the Tenderer also assumes the role of the Supplier for the supply of equipment and the Contractor for the execution of works as defined in the concluded contract.
- The term Customer refers to Eles d.o.o., its authorized representatives, or any organization or individual authorized by Eles to act on its behalf.

1.2 SPARE PARTS

The Tenderer shall provide service activities and spare parts for the transformer throughout its entire operational lifetime, which shall be no less than 40 years.

The supply of spare parts includes:

- 1 piece of 220 kV bushing - HV-N (Hitachi Energy type: GSA 245-OA/1600 LF),
- 1 piece of 220 kV bushing - HV-N (Hitachi Energy type: GSA170-OA/1600 LF),
- 1 piece of 110 kV bushing (Hitachi Energy, type: GSA-OA 123/1600 LF).

1.3 ERECTION TOOLS

All tools necessary for the transformer erection works, in accordance with the detailed description and instructions, shall be provided by the Tenderer or by the electrical installation contractor.

1.4 LIMITS OF SUPPLY

The following interface points between the transformer, civil structure, and other equipment define the limits of supply:

1. Interface with civil structure:
 - a) transformer unloaded and fixed to the foundation.
2. Interface with primary electrical equipment:
 - b) HV terminals (3),
 - c) HV neutral terminal (1),
 - d) LV terminals (3),
 - e) LV neutral terminal (1).
3. Interface with secondary electrical devices (in transformer cubicles):
 - a) terminals for connections to 400/231 V AC substation auxiliary power supply system,
 - b) terminals for connections to the substation control, protection and monitoring systems.
4. Earthing:
 - c) terminals for transformer earthing.

1.5 SCOPE OF ERECTION AND SUPERVISION

All erection works on the transformer and on the equipment within the scope of supply shall be carried out by the Tenderer, in accordance with the defined limits of supply. The Tenderer shall propose an erection company, subject to the Customer's approval.

The Tenderer must ensure transport supervision and unloading at the installation site.

Additionally, the Tenderer shall prepare an erection and supervision works program, along with a cost estimate for these activities, which must be included in the offered price.

All works must be performed in compliance with the applicable environmental and occupational health and safety standards. In particular, the Tenderer must observe the requirements and guidelines of ISO 14001 and OHSAS 45001, under which the Customer is certified.

2 BASIC REQUIREMENTS

2.1 BASIC DATA

Technical data for power transformer 220/110 kV, 150 MVA, shall be as follows:

No.	Description	Data
1.	Nominal output at nominal and constant values of voltage, frequency, and current acc. to IEC (to be used as reference for guaranteed data and for definition of nominal characteristics)	150 MVA
2.	Continuous output rating at voltage range $U_r \pm 15\%$, at frequency range $50 \text{ Hz} \pm 2.5 \text{ Hz}$, with temperature rise values as defined in tender	150 MVA
3.	Tertiary winding output rating	/
4.	Rated voltages, no-load:	
	- high voltage (HV)	220 kV
	- low voltage (LV)	115 kV
	- tertiary winding voltage	10,5 kV
5.	On-load tap changer:	
	- winding location	HV winding neutral
	- range	$\pm 15\%$
	- steps	$\pm 12 \times 1,25\%$
6.	Impedance voltage HV/LV at 75°C	
	- at the rated voltage ($\pm 0\%$)	$13 \pm 7,5\%$
7.	Rated frequency	50 Hz
8.	Winding connection:	
	- HV	star
	- LV	star
	- tertiary winding	delta
9.	Vector group	YNyn0+d5
10	Neutral point status in normal operating condition:	
	- HV neutral point rigidly grounded	
	- LV neutral point isolated	
11.	Type of cooling acc. to IEC	ONAN/ONAF – 60/100 %
12.	Allowed transformer noise level when tested in accordance with IEC 60076-10 (sound pressure method) at rated voltage (U_r)	66 dB (ONAN) 70 dB (ONAF)

2.2 OPERATING CONDITIONS

The operating conditions are determined by system requirements, which define the transformer loading. The Slovenian power system is connected to ENTSO-E at a voltage level of 220 kV.

Before transformer designing, the value of the maximum expected three-phase short-circuit current (I''_{k3}) on the 220 kV and 110 kV busbars must be taken into account for the planned installation location.

The highest three-phase short-circuit current values at the busbars are:

- | | |
|----------------------------|-------------------------------|
| 1. 220 kV busbars (Podlog) | $I''_{k3} = 23,3 \text{ kA},$ |
| 2. 110 kV busbars (Podlog) | $I''_{k3} = 37,5 \text{ kA},$ |
| 3. 220 kV busbars (Kleče) | $I''_{k3} = 14,3 \text{ kA},$ |
| 4. 110 kV busbars (Kleče) | $I''_{k3} = 40,9 \text{ kA},$ |
| 5. 220 kV busbars (Divača) | $I''_{k3} = 14,1 \text{ kA},$ |
| 6. 110 kV busbars (Divača) | $I''_{k3} = 43,8 \text{ kA},$ |
| 7. short circuit duration | $t_{sc} = 1 \text{ s}.$ |

Normal operating conditions are met when the transformer is operating at:

- | | |
|--------------------|---------------------|
| 1. rated voltage | $\leq 111 \%,$ |
| 2. rated frequency | $\pm 2 \%,$ |
| 3. $\cos \varphi$ | from 0,8 up to 1,0. |

Abnormal operating conditions assume:

- | | |
|--------------------|---------------------|
| 1. rated voltage | $> 111 \%,$ |
| 2. rated frequency | $\pm 5 \%,$ |
| 3. $\cos \varphi$ | from 0,8 up to 1,0. |

The 220 kV voltage level network is effectively earthed at the neutral point (earth fault factor is $k \leq 1.3$), also the 110 kV voltage network is effectively earthed at the neutral point ($k \leq 1.3$).

The transformer design must also comply with all other site-specific requirements as defined in the relevant parts of this Tender documentation.

2.2.1 Standard voltages

The following standardized voltages are applied on site:

Standard high voltages for the transmission system:

nominal voltage	400 kV	220 kV	110 kV
maximum operating voltage	420 kV	245 kV	123 kV
grounding of neutral point	effective	effective	effective

Standard low voltages for secondary systems:

Three phase AC voltage	400/231 V, ± 5 %, four-wire, grounded (TN-C-S)
Single phase AC voltage	230 V, ± 5 %, three-wire, grounded (TN-C-S)
DC control and protection voltage	220 V, -15 %, +10 %, not grounded with insulation supervision

Voltages listed above are maximum value of the nominal operating voltages acc. to IEC 60038. AC system frequency is 50 Hz.

Required nominal currents for the equipment and devices are stated in special technical specifications.

2.3 SPECIFIC GUARANTEES

2.3.1 *Continuous output rating*

The continuous output power rating of the transformer, as specified in the schedules of technical data, shall be guaranteed within the limits of winding temperature rises and hot spots defined by the applicable international standards IEC 60076.

If the transformer fails to meet these requirements, the Tenderer shall be bound to modify the transformer or any related equipment causing the deficiency within six months to meet the Customer's requirements.

2.3.2 *Losses*

The no-load loss, short-circuit loss, and auxiliary circuit losses (including cooler fans and motor drive for the on-load tap changer) of the transformer, as specified in the technical data tables, shall be guaranteed with a tolerance of +0%. A tolerance of +0 dB is permitted for the transformer noise warranty.

If the losses during the Factory Acceptance Tests (FAT) exceed the guaranteed values, the Customer reserves the right to claim a reduction in the purchase price in accordance with the General Tender Specification.

3 GENERAL REQUIREMENTS

3.1 ON SITE CONDITIONS

Tenderer has to consider the following on-site conditions:

1. altitude is below 1000 m,
2. equipment shall be designed for the following on site temperature ranges:
 - a) outdoor equipment: from -25 °C to + 40 °C
3. equipment shall be designed to be earthquake-resistant. Reference parameters: peak ground acceleration on type A ground $a_{gR} = 0,25$ g, medium soil type with fundamental period, $T_b = 0.15$ s for horizontal seismic effects; vertical effects in accordance with the parameters in NAD, following SIST EN 1998-1; importance class IV according to SIST EN 1998-1,
4. pollution degree b according to IEC TS 60815-1,
5. ice conditions Class 10 according to IEC,
6. equipment shall be dimensioned for the wind loading 42 m/s (1,1 kN/m²),
7. equipment noise level shall not exceed 70 dB during ONAF operation, measured by the sound pressure method according to IEC, at rated voltage (U_r),
8. equipment shall comply with electromagnetic compatibility requirements applicable to high-voltage air-insulated electrical power substations.

3.2 CONSTRUCTION, MATERIALS AND WORKMANSHIP

Materials used in the manufacturing of the specified equipment shall be of the type, composition, and physical properties best suited to their intended purposes, in accordance with the tender parameters, requirements, and best engineering practices.

All materials used shall be new, of first quality, suitable for their intended use, free from defects or imperfections, and compliant with the applicable standards.

All surfaces shall be finished precisely and smoothly. Painted surfaces shall have rounded corners with a minimum radius of 2 mm. Drilled holes and openings shall be designed so as not to weaken the primary structure or material; the same applies to other shaped components.

Welding shall be performed only by qualified personnel holding approved certificates.

In general, the allowable design stresses for materials and steel structures shall not exceed the values specified in standards DIN 18800 and, for welded parts, DIN 4100.

Material selection and production procedures for the supplied equipment shall be carefully chosen to suit the equipment's purpose, considering all site and operational conditions. Higher-quality materials shall be used wherever ordinary materials may be insufficient.

Incoming materials, production stages, and final product inspections shall be conducted in accordance with the producer's documented QA/QC procedures.

Material specifications, including grade or class, shall be clearly indicated on the relevant detailed drawings submitted for review.

Should any deviations from the documentation and/or instructions occur during manufacturing, the Tenderer must immediately notify the Customer.

3.3 TECHNICAL REGULATIVE AND STANDARDS

Unless otherwise specified, the design, materials, manufacture, and testing of all works under this Contract shall comply with the approved standard(s).

The following standards, in their most recent editions, are considered approved and generally accepted for the purposes of this Contract:

1. SIST - Slovenian national standards (Industrial standards valid in the Republic of Slovenia),
2. EN - European standards (including those published by CEN and CENELEC),
3. ISO - International Organization for Standardization standards,
4. IEC - International Electrotechnical Commission standards,
5. DIN - German industrial standards,
6. VDE - German technical-scientific association standards.

If no SIST, EN, ISO, IEC, DIN, or VDE standards exist for a specific case, the Tenderer may propose a relevant national standard for the Customer's approval. Any proposed standards will be accepted only with the Customer's written approval and as specified in the Contract, provided they are written or translated into the Contract language (English) and indicate equivalence to the approved standards listed in this Contract.

The latest editions of the approved standards (SIST, EN, ISO, IEC, DIN, VDE) shall be binding for the manufacture, erection, and testing of the transformers. The Tenderer shall prepare a list of applicable standards and clauses, which must be submitted to and agreed upon with the Customer in writing prior to Contract signing.

Here below, only some of important IEC Standards are listed for reference:

- | | |
|--------------------|--|
| 1. SIST EN 1998-1 | Eurocode 8: Design of structures for earthquake resistance
- Part 1: General rules, seismic actions and rules for buildings |
| 2. IEC 60076 | Power transformers |
| 3. SIST EN 60076-1 | General |
| 4. SIST EN 60076-2 | Temperature rise for liquid-immersed transformers |
| 5. SIST EN 60076-3 | Insulation level & dielectric tests external clearances in air |

6. SIST EN 60076-4	Guide to the lightning impulse and switching impulse testing - Power transformers and reactors
7. SIST EN 60076-5	Ability to withstand short circuit
8. SIST EN 60076-7	Loading guide for oil-immersed power transformers
9. SIST EN 60076-10	Determination of sound levels
10. SIST EN 60137	Insulated bushings for alternating voltages above 1000 V
11. SIST EN 60156	Insulating liquids - Determination of the breakdown voltage at power frequency - Test method
12. SIST EN IEC 60214 (-1, -2)	Tap-changers
13. SIST EN 60228	Conductors of insulated cables
14. SIST EN IEC 60296	Unused mineral insulating oils for transformers and switchgear
15. SIST EN IEC 60422	Mineral insulating oils in electrical equipment – Supervision and maintenance guidance
16. SIST EN 60450	Measurement of the average viscometric degree of polymerization of new and aged cellulosic electrically insulating materials
17. SIST EN 60529	Degrees of protection provided by enclosures (IP Code)
18. SIST EN IEC 60567	Sampling of gases and analysis of free and dissolved gases - Guidance
19. SIST EN IEC 60599	Mineral oil-impregnated electrical equipment in service - Guide to the interpretation of dissolved and free gases analysis
20. SIST IEC/TR 60616	Terminal and tapping markings for power transformers
21. SIST EN 60617	Graphical symbols for diagrams
22. SIST EN 60815-1	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions - Part 1: Definitions, information and general principles
23. SIST EN IEC 61125	Unused hydrocarbon based insulating liquids - Test methods for evaluating the oxidation stability
24. SIST EN 61181	Mineral oil-filled electrical equipment - Application of dissolved gas analysis (DGA) to factory tests on electrical equipment
25. SIST EN 61198	Mineral insulating oils – Methods for the determination of 2-furfural and related compounds

26. SIST EN IEC 61462	Composite hollow insulators - Pressurized and unpressurized insulators for use in electrical equipment with rated voltage greater than 1 000 V - Definitions, test methods, acceptance criteria and design recommendations
27. SIST EN 61850	Communication networks and systems for power utility automation
28. IEC TS 62073	Guidance on the measurement of hydrophobicity of insulator surfaces
29. SIST EN 62217	Polymeric HV insulators for indoor and outdoor use - General definitions, test methods and acceptance criteria
30. SIST EN 62271-1	High-voltage switchgear and controlgear - Part 1: Common specifications for alternating current switchgear and controlgear
31. SIST EN 795	Personal fall protection equipment – Anchor devices
32. SIST EN IEC 61869-1	Instrument transformers - Part 1: General requirements
33. SIST EN IEC 61869-2	Instrument transformers - Part 2: Additional requirements for current transformers
34. SIST EN IEC 61936-1	Power installations exceeding 1 kV a.c. - Part 1: Common rules
35. SIST EN 50629	Energy performance of large power transformers ($U_m > 36$ kV or $S_r \geq 40$ MVA)« or Commission Regulation (EU) No. 548/2014 of 21 May 2014 on implementing Directive 2009/125/ES
36. SIST EN ISO 2409	Paints and varnishes - Cross-cut test
37. SIST EN ISO 4624	Paints and varnishes - Pull-off test for adhesion
38. SIST EN ISO 8501-1	Preparation of steel substrates before application of paints and related products - Visual assessment of surface cleanliness - Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings
39. SIST EN ISO 12944-2	Barve in laki - Protikorozijska zaščita jeklenih konstrukcij z zaščitnimi premaznimi sistemi - 2. del: Klasifikacija okoljskih pogojev (ISO 12944-2)
40. SIST EN ISO 12944-5	Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 5: Protective paint systems (ISO 12944-5:2019)

41. DIN 3230-3	Technical delivery conditions for valves; Compilation of test methods
42. DIN 4100	Welded structural steelwork – calculation and structural details
43. DIN 18800	Steel structures

If discrepancies are found between the data provided in the Table of Technical Characteristics of the transformer and the requirements of the aforementioned (or other applicable) standards, such ambiguities must be resolved through a written agreement. The Tenderer must take into account that certain requirements specified in the schedules of technical data exceed those outlined in the standards; in such cases, the Customer's requirements shall prevail.

The metric system is used in the standardized international measurement system SI (Système International d'Unités).

3.4 PACKAGING

The Tenderer shall prepare, pack, and load all materials and equipment in a manner that ensures protection from damage during shipment and shall be fully responsible for any damage resulting from improper packing. Each package shall be clearly marked with essential information (contents, weight, and handling instructions) on two opposite sides. All items exceeding 50 kg gross weight must be prepared for machine handling. All electrical components and delicate mechanical parts that may be damaged by moisture shall be packed in hermetically sealed containers.

Spare parts shall be packed separately as specified and delivered in appropriate packaging suitable for storage for a minimum period of 10 years.

3.5 TRANSPORTATION

The equipment construction shall be suitable for transport by rail or road to S/S Podlog (the method of transport shall be determined by the Tenderer). For each type of equipment, the maximum weight and dimensions of the transport package shall be specified.

All heavy equipment items shall be equipped with lifting hooks or lifting jacks to facilitate transport and installation.

The Tenderer shall verify all transport possibilities and limitations prior to submitting the offer and shall bear full responsibility for the selection of the transport route.

The Tenderer shall independently organize the transportation, including loading and unloading. The Tenderer must investigate all possibilities for transporting heavy and oversized equipment to the site and within the site to the final installation location. Detailed transport information must be provided to the Customer no later than three months after the signing of the Contract. The Tenderer shall provide separate price offers for transport and transport insurance.

During transport of the transformer to the final site, the transformer shall be equipped with two (2) mechanical shock recorders, mounted diagonally on the transformer tank. Upon delivery, the devices shall be opened and the data analyzed during commissioning, in the presence of both the Tenderer and the Customer. The Tenderer shall submit a report on transport-induced mechanical stresses to the Customer.

3.5.1 *Transportation by Roads*

S/S Podlog is accessible via highway E57, using the exit for Ločica ob Savinji or Žalec, followed by national roads.

All transport activities must comply with applicable regulations concerning the planning and construction of roads and bridges, as well as road safety regulations.

Prior to each exceptional (oversized) transport, the Tenderer shall obtain the necessary transport permit from the relevant Road Administration Authority and submit it to the Customer. If the total weight of the exceptional transport exceeds the legal limits, or if the permitted load capacity of bridges or roads may be exceeded, a structural stability assessment for each affected bridge and/or road section shall be carried out.

3.5.2 *Transportation by Railway*

The nearest railway station to the S/S Podlog site is in Celje, approximately 15 km from the substation.

The nearest railway station to the S/S Kleče site is in Ljubljana, approximately 7 km from the substation.

The nearest railway station to the S/S Divača site is in Divača, approximately 2 km from the substation.

The railway network connects Ljubljana to the Port of Koper, Austria (via Jesenice or Šentilj), Croatia (via Zidani Most and Zagreb), Hungary (via Hodoš), and Italy (via Trieste).

3.5.3 *Ports*

The nearest ports to the S/S Podlog, S/S Divača and S/S Kleče sites are:

1. Koper, Slovenia - approx. 170 km by the main roads,
2. Trieste, Italy - approx. 160 km by the main roads (partly via Italy),
3. Monfalcone, Italy - approx. 180 km by the main roads (partly via Italy).

3.6 WARRANTY PERIOD

The general Defects Liability Period (warranty period) for the tendered equipment shall be defined in the Contract.

The warranty period for anti-corrosion protection shall be 10 years.

In the event of a failure or other irregularity of the equipment during the warranty period, the Tenderer shall send a representative to the site no later than two (2) days after receiving the written notification. If the Tenderer fails to respond within the required timeframe, the Customer has the right to request replacement equipment at the Tenderer's expense.

Failures or deficiencies of the supplied equipment shall be determined by a joint commission composed of representatives from both the Tenderer and the Customer. All faults or deficiencies identified by the commission must be repaired by the Tenderer **within two (2) weeks** from the date of the commission meeting or within the timeframe agreed upon in the commission's conclusions.

If any failures are detected during erection or within the warranty period that compromise the required reliability, the Tenderer shall repair or replace the defective equipment at their own cost.

In the event of a failure of the active part of the transformer during the start-up or operational phase within the warranty period, the Tenderer is obliged to replace, at a minimum, the entire active part. The repair period is limited to a maximum of **one (1) year** from the date of the failure.

The transformer repair shall be supervised by the Customer, with support from external expert institutions. Before any repair is undertaken, a rehabilitation plan, prepared by the Customer, must be reviewed and approved by both the Customer and the Tenderer.

All repairs performed during the warranty period must comply with the same technical requirements (as defined in the technical tender documentation) and contractual provisions (including warranty coverage and contractual penalties) as those applicable to the manufacture of a new transformer.

The Contract shall also define the warranty conditions for replaced equipment or components. An exception applies to software errors, which must be rectified at the Tenderer's expense even after the warranty period has expired.

In the case of a warranty intervention that requires the equipment to be out of operation for more than **five (5) days**, the warranty period shall be extended by the duration of the downtime required for fault elimination. The warranty period for replacement parts used to rectify the fault is specified in the general tender conditions.

The Tenderer is responsible for all costs associated with dismantling, reinstallation, testing, transport, insurance, and any other expenses related to the replacement of the equipment. The Customer shall not be entitled to claim compensation for indirect damages.

In the event of a dispute regarding the validity of a claim, and if no agreement can be reached between the Tenderer and the Customer, the **District Court in Ljubljana** shall have jurisdiction. Its decision shall be final and binding on both parties.

3.7 TRAINING

The Tenderer shall provide an appropriate amount of expert training for the Customer's personnel. The expert training shall be organized as follows:

1. training during erection and start-up of operation, conducted under the leadership of the Tenderer's expert personnel,
2. operation and maintenance courses held both at the Tenderer's facilities and at the Customer's site.

The training is intended for operation and maintenance personnel in the following scope:

- 10 people on-site for 1 day for the transformer at each S/S, and
- 5 people on-site for 1 day for the monitoring system at each S/S.

The remaining time shall be allocated for additional information, explanations, and support during the warranty period.

Training shall be based on the equipment applications for the S/S Podlog, S/S Divača and S/S Kleče.

The training plan shall specify the number of sessions, personnel involved, location, and expenses in the offer. Training costs shall be covered by the Tenderer and included in the Tender price.

4 GENERAL CONSTRUCTION REQUIREMENTS

Transformer equipment shall be constructed according to the latest approved standards and good engineering practices, with a minimum mechanical protection level of IP55. The following guidelines shall be fully respected:

1. all low-voltage equipment must be installed in appropriate cabinets or enclosures, or otherwise protected from weather, environmental conditions, and accidental contact,
2. all equipment connections and connections within cabinets must be easily accessible. All elements intended for operational interaction (instruments, control and changeover switches, indicator lights, buttons, displays, etc.) must be installed at an appropriate height on the front walls of the cabinet or on the cabinet doors. These elements must be logically and clearly arranged at a height between 80 and 180 cm above the floor,
3. all devices, connections, and cable inlets must be designed to prevent the outbreak or spread of fire, as well as any damage caused by fire,
4. All equipment must be protected against animals causing short circuits.
5. cable connection guidelines:
 - a) cable glands must be installed on the underside of equipment or cabinets,
 - b) all equipment must be designed for cable connections from the bottom and installed to allow easy access to connection terminals and cable entries.
 - c) all cables must be shielded and grounded in accordance with good EMC engineering practice,
 - d) the shields of all cables included in the delivery shall be grounded via EMC cable glands. EMC glands must ensure contact between the gland and the cable shield along the entire circumference (full 360-degree connection). EMC glands must also have adequate contact with the cabinet housing or indirectly with the grounding busbar (see point f),
 - e) cables not included in the delivery generally do not have a fine-wire shield with at least 80% sheath coverage; therefore, the cabinets must provide grounding of their shields to the grounding busbar, as stated in point f,
 - f) each cabinet or box must have, on the side where cables are grounded, a grounding busbar or busbars enabling proper connection and grounding of cable shields (EMC guidelines at least in accordance with SIST EN 61936-1, IEC TR 61000-5-2, and IEC TR 61000-5-6).
6. devices must be modular, consisting of units that allow easy transportation and assembly. Components must be quickly replaceable without special tools,
7. installed equipment must withstand all electrical, mechanical, and thermal loads that may occur during normal operation and in the event of any short circuit or ground faults at the installation site,
8. each device must be equipped with factory and type markings, as well as identification

plates indicating intended use in the Slovenian language. All markings must be clearly visible,

9. parts of devices that will be permanently or occasionally at high electrical potential must be protected against accidental contact and visibly marked in accordance with relevant regulations,
10. all transformer equipment components, such as coolers, valves, oil flow indicators, control devices, and similar, must be of standardized design and easily replaceable without modification.

4.1 CABINETS AND ENCLOSURES

All cabinets and enclosures must be designed for continuous operation under the climatic conditions prevailing at the installation site and must provide adequate EMC and EMS protection for the installed devices. The Tenderer shall fully and reasonably comply with the following guidelines for cabinets and junction boxes:

1. cabinets and enclosures must be made of stainless steel sheet with a minimum thickness of 1.5 mm, providing rigid support for the installed equipment, and painted to match the tank color (RAL 7038),
2. they must be supplied complete, including all frames and doors, with hinges and locks,
3. for outdoor installations, cabinets must have:
 - a) a sloping roof to protect against rain,
 - b) adequately protected ventilation openings to prevent ingress of moisture and rain,
 - c) a built-in anti-condensation heater designed to maintain an internal temperature approximately 5°C above ambient temperature to prevent condensation. The heater must be single-phase AC with automatic control via an adjustable thermostat.
4. Cabinets must provide adequate natural ventilation with dust-protected ventilation openings, ensuring that the internal temperature remains below 55°C under all operating conditions, assuming a maximum ambient temperature of 40°C and fully operational equipment inside,
5. the protection class of the cabinets shall be at least IP55 according to SIST EN 60529,
6. cabinets must be equipped with an interior lamp that is switched on and off by a microswitch on the door,
7. all cabinets and equipment must include terminal blocks of appropriate quality, manufactured by reputable companies with relevant references, and permanently numbered. Terminal quality must be comparable to products from Weidmüller or Phoenix.
8. all wire connections must be clearly marked with the corresponding element or terminal numbers.
9. all switching and protection devices (circuit breakers, switches, MCBs, fuses, etc.) must

be of high quality from reputable manufacturers such as Moeller, Siemens, Schneider, or ABB. These elements must be installed logically within the cabinet,

10. vibration dampers must be installed wherever necessary to ensure the proper operation of the equipment.
11. easy access to terminals, connections, and equipment for servicing must be ensured. Manual control and monitoring elements must be located at a height between 80 cm and 180 cm above the floor,
12. cabinets must be equipped with an earthing bar for incoming cable grounding, in accordance with EMC regulations and good engineering practice. A copper (Cu) earthing bar, minimum 30x5 mm, must be installed along the entire length of the cabinet, panel, or board. Each earthing bar must be directly connected to the transformer tank using a NYY-J Cu 70 mm² conductor. All metal cable shields of cables supplied and entering the cabinet must be grounded via EMC cable glands,
13. cabinets must be manufactured with a suitable metal plate for fixing EMC cable glands in the respective sections, properly grounded according to EMC guidelines and SIST EN 61936-1,
14. all metal parts must be galvanically connected to form a single conductive assembly to ensure operational safety and electromagnetic compatibility (EMC). Metal doors and other loose metal elements that are not rigidly connected must be grounded to the housing via a copper (Cu) braided flexible conductor with a minimum cross-section of 16 mm²,
15. safety distances between conductors and between conductors and grounded parts must comply with applicable technical regulations and standards,
16. live parts of equipment must be protected against accidental contact and clearly marked with appropriate warning labels,
17. each cabinet or box must have at least 20% spare internal space for possible future installation of additional equipment,
18. cabinets must have a documentation holder installed on the inside of the door to accommodate cabinet documentation,
19. cabinets and enclosures must be fully manufactured and factory-tested, including all components, identification plates, internal wiring, cable connections, and markings.

4.1.1 Low voltage switchgear and protection elements

All elements of the auxiliary systems must be properly sized to ensure continuous operation of the entire cooling system at the nominal load of the transformer (including protection circuit breakers, cables, wiring, and others).

MCBs must be single-phase or three-phase, correctly rated for the current, equipped with a sealed tripping mechanism, and, if necessary, fitted with auxiliary contacts.

Contactors must be air-operated with arc protection class AC-3 according to IEC standards. They must remain engaged until the corresponding selective overcurrent protection device operates

and be capable of withstanding the possible fault current. The thermal overcurrent release must be adjustable, meet the requirements of the drive, and be temperature-compensated up to 70 °C.

Fuses must be appropriately selectively selected, they must limit and interrupt the short-circuit current in a specific branches. For currents up to 63 A, they must be designed to allow replacement without the need for special tools.

Switches must allow manual control from the front. They must have a control handle and self-cleaning contacts in a strong, arc-resistant housing and a mechanism for rapid switching on and off. They must be capable of switching rated currents. If necessary, they should have built-in HRC fuses.

4.1.2 *Wiring in control and drive cabinets*

All wiring in control and drive cabinets must be made using copper insulated conductors with fine-wire strands and a minimum conductor cross-section of 1.5 mm². The insulation of wiring and cables must be fire-resistant or UV-resistant PVC, or another material with similar properties. It must withstand all operational, electrical, and environmental loads at the installation site without consequences. All control, signal, and power cables must have a metal shield to prevent electromagnetic interference.

Terminals of appropriate size must be installed on all wired connections according to the conductor thickness. All external connections must be made on one or more separate terminal strips. These terminal strips must be clearly numbered from left to right and top to bottom.

The terminals must be mounted on terminal strips that are independent, non-flammable, and consist of two separate mounting plates, suitable for connecting both solid and stranded conductors. Each terminal strip shall include additional spare terminals. Insulating barriers shall be installed between each circuit and between different types of secondary circuits. Their design shall provide adequate protection while allowing easy access to the terminals.

Terminals shall be properly surface-treated to prevent oxidation and the harmful effects of electrolysis. All terminals shall be permanently and clearly marked, with markings firmly attached so they do not fall off if wiring is disconnected.

4.2 INSTRUMENTATION, CONTROL AND PROTECTION EQUIPMENT

The measuring ranges of the delivered sensors and other components must be adapted to the typical ranges of the expected measured values.

All sensors with integrated connection cables must be equipped with cables of sufficient length to avoid the need for additional joints between the sensor and the corresponding terminal in the associated cabinet, box, or panel. Sensors with connection cables must have manufactured and tested connectors.

The following general requirements must be observed:

1. all equipment must be suitable for the environmental conditions at the installation site (e.g., appropriate IP protection rating),

2. all equipment must be suitable for continuous operation under site specific conditions,
3. all parts of the transmitters and their mounting components must be made of corrosion-resistant materials,
4. all supplied equipment must ensure reliable connection and grounding of the connection cables,
5. all control and monitoring circuits must be designed for 220 V DC operation,
6. current capacity and contact resistance must ensure a reliable connection to the control system (220 V DC),
7. circuits of protection devices must be galvanically isolated from the control and monitoring circuits,
8. all protection devices must have two potential-free (normally open) contacts for the protection system,
9. all analogue transmitters must be designed for a 4–20 mA output current with an isolated DC output. Two-wire active connections are preferred; if not feasible, a separate transmitter power supply is required.

Instrumentation, control, and protection equipment must be supplied and connected within appropriate control and monitoring cabinets as specified in other sections of this documentation.

4.2.1 Winding thermal image (WTI)

The WTI must allow monitoring of the thermal image of the windings for both local and remote supervision. It must include an appropriate number of adjustable contacts for cooling control, remote alarms, and shutdown functions.

The WTI must include:

1. a temperature sensor with a measurement range from 0 °C to 160 °C,
2. a current transformer installed in phase V of the HV winding for monitoring winding temperature (must not be of class P). It must be suitable for external calibration using forced current in the transformer's secondary circuit.

The WTI device must be installed in a suitable enclosure to ensure adequate protection against environmental conditions. It must be equipped with the following electrically independent potential-free contacts:

1. two (2x) or more potentially independent contacts used in a transformer cooling control system,
2. one (1x) potential-free alarm contact used for:
 - a) control system,
3. two (2x) potentially independent contacts used for:

- a) protection system - external tripping to protection terminal A,
- b) protection system - external tripping to protection terminal B.

The device must also include the following analog output:

1. one (1x) isolated 4–20 mA current output. The output must be of the active type (i.e., the 4–20 mA loop is powered by the sensor). If this is not feasible, an appropriate power supply for the current loop must be included in the delivery.

4.2.2 Pressure relief valve

Spring-loaded pressure relief valves shall provide rapid relief of any overpressure that may develop in the transformer tank. They must be set to operate at a static pressure lower than the hydraulic test pressure. The valve shall extend at least 25 mm into the tank to prevent gas accumulation at the opening.

A pressure relief valves shall be installed in all oil-filled compartments and must be appropriately sized. The oil discharge must be directed away from the top cover of the transformer and any working areas. A suitable pipe extension shall be provided to guide the oil discharge downward into the oil sump beneath the transformer.

The device shall be equipped with the following mutually independent potential-free contacts:

1. two (2x) potentially independent contacts that shall be used for:
 - a) protection system - external tripping to protection terminal A,
 - b) protection system - external tripping to protection terminal B.

4.2.3 Buchholz relay

A double float type Buchholz relay shall be provided. The relay must be equipped with a test tap to check its operation and a test button for activation. It must be installed in such a way that any gases that may arise in the transformer are collected in it.

The relay must be equipped with the following independent potential-free contacts:

1. two (2x) potentially independent contacts for gas accumulation alarm, which shall be used for:
 - a) control system,
 - b) on-line monitoring system.
1. Two (2x) independent contacts for transformer tripping in the event of a sudden pressure rise, to be used for:
 - a) protection system - external tripping to protection terminal A,
 - b) protection system - external tripping to protection terminal B.

4.2.4 Tap changer protection relay

The protection relay must be designed to protect the tap changer switch and the transformer in the event of a fault within the oil compartment of the tap changer. The protection relay (e.g., MR RS2001) shall monitor the oil flow in accordance with IEC 60214-1.

The relay must be equipped with the following mutually independent potential-free contacts:

1. two (2x) mutually potential independent contacts for switching off the transformer, which will be used for:
 - a) protection system - external tripping to protection terminal A,
 - b) protection system - external tripping to protection terminal B.

4.2.5 Dial capillary type thermometer (OTI)

The dial capillary type thermometer for measuring oil temperature shall operate on the principle of changing the volume of the filling in the sensor, which is transmitted via the membrane capsule and mechanism to the instrument pointer for visual display, the maximum value indicator and to adjustable contacts. The temperature indication range shall be from 0 to 160 °C.

The OTI must be installed in a weatherproof enclosure with a minimum protection rating of IP65, suitable for outdoor conditions.

The OTI must be installed in a weatherproof box to ensure adequate protection from environmental conditions. The OTI shall be equipped with the following potentially independent potential-free contacts:

1. two (2x) or more potentially independent contacts used in a transformer cooling control system,
2. one (1x) potential-free alarm contact used for the control system,
3. two (2x) potentially independent contacts used for:
 - a) protection system - external tripping to protection terminal A,
 - b) protection system - external tripping to protection terminal B.

The device must be equipped with the following analog output:

1. one (1x) isolated current output 4-20 mA. The current output must be of the active type (the 4-20 mA current loop is powered by the sensor). If this is not possible, a power supply for the current loop shall be included in the delivery.

4.2.6 Resistance type temperature detectors (RTD)

Resistance type temperature detectors (RTD) must meet the following requirements:

1. standard Pt100 resistance type temperature detectors (RTD) with 100 Ω at 0°C, in accordance with EN 60751,
2. RTD elements shall be electrically isolated from ground (ungrounded),

3. three-wire or four-wire connection.

If RTD detectors are used for a transformer monitoring system, they can be connected directly to the monitoring device installed on the transformer.

If RTD detectors are used for a control system, they must also have a measurement transducer "RTD to 4-20 mA". The current output of the transducer must be of the active type (the 4-20 mA current loop is powered by the sensor). If this is not available, a power supply for the current loop shall be included in the delivery.

4.2.7 Oil level indicator

The oil level indicator shall provide reliable indication of the oil level in the transformer. It shall be of the magnetic type with an adequate number of independent and adjustable contacts for detecting low or high oil levels.

The device shall be equipped with the following electrically independent potential-free contacts:

1. two (2x) potential free contacts (indication of low oil level), which are used for:
 - a) control system,
 - c) on-line transformer monitoring system.
2. two (2x) potential free contacts (indication of excessive oil level), which are used for:
 - a) control system,
 - d) on-line transformer monitoring system.

4.2.8 Current transformers

Instrument current transformers must have the appropriate accuracy class and rated power. They must be manufactured in accordance with the latest approved standards. Current transformers (CTs) must be installed and designed to suit their purpose. The secondary windings must be wired to the appropriate terminal blocks in the cooling system cabinet. The terminals used to connect the CTs must be equipped with removable short-circuit connections. They must be suitable for external calibration by forcing current into the secondary circuit of the CTs. The minimum cross-sections of the measuring circuit conductors are $\geq 2.5 \text{ mm}^2$.

The scope of supply shall include at least the following CTs:

1. one (1): class 3 Fs 5 in phase V of the HV winding for measuring the thermal image of the WTI winding (must not be class P),
2. one (1): class 3 Fs 5 in phase V of the HV winding for connection to the on-load tap changer control system,
3. three (3): class 1 Fs 5 in each phase of the HV winding for connection to the transformer monitoring system.

4.2.9 Winding temperature optical sensors

At least 12 optical sensors for direct temperature measurement at hot spots in all three phases must be installed in the HV and LV windings of the transformer. The system must be of the same or higher quality than devices manufactured by FISO Nortech EasyGrid LT.

Equipment for measuring winding temperature via optical sensors must contain:

1. optical sensors (at least twelve),
2. the locations of the optical sensors must be agreed upon and confirmed by the Customer,
3. connection part on the tank wall,
4. winding temperature indicator mounted on the transformer tank,
5. must display the values of all 12 sensors,
6. remote display of winding temperatures must be enabled via the transformer on-line monitoring system.

4.2.10 Tap changer monitoring equipment

Tap changer monitoring equipment (e.g., MR ETOS) must enable the evaluation and recording of operating data of the tap changer, such as:

1. position of the tap changer,
2. number of switchings of the tap changer switch including selector and preselector,
3. switching time of the tap changer,
4. torque of the drive motor,
5. information important for focused planning of maintenance of the on-load tap changer,
6. etc.

The tap changer monitoring equipment must be equipped with a suitable communication interface for integration with the transformer monitoring system

4.3 ELECTRIC MOTORS

The operating voltage and connected power of all AC electric motors must comply with the following conditions:

1. rated voltage: three phase 400/231 V, 50 Hz,
2. starting method: direct-on-line (DOL) starting.

Direct current motors are not permitted. All alternating current induction motors must have squirrel cage rotors and be designed for direct starting.

The operating factor (reserve load power) must be 1.2, representing the ratio between the motor power and the maximum load power on the motor drive shaft, with:

1. required operating class: S1,

2. required power class: maximum power in continuous operation.

All electric motors must be designed for continuous operation under the following electrical power parameters:

1. between 95 % and 105 % nominal frequencies,
2. between 90 % and 110 % nominal voltage,
3. they must withstand short-term overvoltages of 130% of the rated voltage.

The motors must be capable of stable operation at 70% of the rated voltage for at least 10 seconds. The maximum direct starting currents of the motors must not exceed 6 times the rated current. They must also start with a 20% transient voltage drop at start-up.

Tripping times for motor faults (short circuit, overload) must be ensured by appropriate motor protection devices.

Motors installed outdoors must be designed to be waterproof and provide means for draining condensed moisture.

All motors must be completely enclosed, fan-cooled (TEFC) and equipped with self-lubricating ball or roller bearings with raceways.

The design of cable boxes and all connections must comply with the rated current and short-circuit current ratings of the AC supply system for the auxiliary power.

The insulation of all motors must comply with IEC Class F specifications, while the motor temperature must remain within the limits specified for Class B according to IEC standards.

4.4 CABLES ON THE TRANSFORMER

All cables with voltage levels of 231/400 V AC and 220 V DC used on the transformer must meet the following requirements:

1. operating temperature range from -25 °C to 120 °C,
2. suitable for outdoor installation with appropriate UV and weather resistance,
3. copper conductors shall be flexible, class 5 stranded conductors in accordance with IEC 60228,
4. insulation must be oil resistant and of fireproof grade FRNC (Flame Retardant Non-Corrosive),
5. cables must have tinned copper shielding covering at least 80% of area over the circumference,
6. all materials used must be free of halogen impurities.

Cables must be properly supported, routed, and secured. For mechanical protection along cable routes on the transformer, protective metal pipes or covered cable trays made of stainless steel must be provided. Cable routes should be arranged so that they do not obstruct regular maintenance.

Cables must not come into contact with sharp edges or hot surfaces of equipment, which could damage the insulation and create hazards. Where appropriate, cable glands or bushings must be used to prevent any risk of cable damage.

Power cables and cables intended for control and process signaling must be strictly separated and laid in separate routes. Each cable or cable connection must be properly marked on both ends in accordance with the markings from the cable lists and drawings.

Cables included in the scope of delivery:

1. all cables between measuring, control and protection equipment and:
 - a) transformer cooling system cabinet,
 - b) control box of the regulating switch,
 - c) transformer on-line monitoring system cabinet, and
 - d) waste heat recovery system cabinet.
2. all cables between the following cabinets:
 - a) transformer cooling system cabinet,
 - b) control box of the regulating switch,
 - c) transformer on-line monitoring system cabinet, and
 - a) waste heat recovery system cabinet.
3. all cables between the transformer monitoring system cabinet and the transformer monitoring system server cabinet,
4. transformer on-line monitoring system cabinet power cables,
5. transformer on-line monitoring system server cabinet power cables,
6. communication cables from the transformer on-line monitoring system server cabinet to the telecommunications room in the S/S control building,
7. cables from the instrument transformer protection circuit breaker cabinet on the HV side of the transformer to the transformer monitoring system cabinet,
8. power cables between the power supply selection cabinet and the cooling system cabinet.

4.5 IDENTIFICATION PLATES

Every important piece of equipment must be provided with a durable identification plate made of stainless material, placed in a visible location, containing basic information about the manufacturer, serial number, date of production, and main technical data. The plates and fastening elements must be resistant to corrosion and other external influences.

The inscriptions on the identification plate (of equipment, cabinets, elements in cabinets, devices, etc.) must be clearly legible and in the Slovenian language.

The following identification plates must be supplied with the transformer:

1. a identification plate in accordance with IEC 60076 requirements, showing impedances at the maximum, minimum, and middle positions of the control switch, along with voltage and current values at each position,
2. an identification plate standardized to show internal connections and voltage vector groups of individual windings according to IEC 60076, additionally including a floor plan of the transformer that clearly shows the arrangement of external connections,
3. an identification plate showing the arrangement and function of all valves, including a warning for operating personnel to follow instructions when vacuuming the transformer oil.
4. an identification plate with markings and descriptions for all valves, fans, vents, dryers and other elements on the transformer,
5. an identification plate showing all electrical circuits and terminal blocks, which should be mounted on the cabinets,
6. an identification plate showing support and attachment points, as well as relevant transport data, including necessary dimensions and permissible transport angles for the transformer.
7. all identification plates with bushing connection markings must be clearly visible and readable from the ground,
8. the inscriptions on the identification plates mounted on the valves must correspond to the inscriptions on the valve identification plates,
9. an identification plate for the main control cabinet showing the exact locations of the optical temperature sensors in the windings.

5 TRANSFORMER DESIGN

5.1 GENERAL REQUIREMENTS

The transformer design must allow for installation at the planned location, ensure compliance with all technical tender conditions, enable easy maintenance, and provide reliable and safe operation. The transformer must be designed and manufactured according to the latest technological standards for such equipment.

All devices and materials must be suitable for the climatic and operational conditions at the installation site.

The mechanical and electrical design of the device must take into account the following conditions and requirements:

1. the transformer dimensions must be adapted to the installation conditions and limitations defined by the location (see the chapter "*Transformer Foundation*"), in order to meet the requirements of standard SIST EN IEC 61936-1, section 8.8.1.3,
2. the installation of high-voltage and low-voltage connections must be in accordance with the intended layout, based on the attached drawings,
3. the maximum oil temperature rise must not exceed 55 K, and the average winding temperature rise must not exceed 60 K (with a maximum hot-spot temperature rise of 73 K). The fully assembled transformer must withstand short-circuit conditions in accordance with SIST EN 60076. All other fault scenarios that may occur during operation (e.g., inter-phase short circuits, two-phase-to-earth faults, etc.) must be considered in the design,
4. the transformer must be designed to minimize the generation of harmonic voltages and prevent high-frequency phenomena from interfering with communication systems,
5. the transformer should be designed as a three-phase, single-core type with separate HV, LV and tertiary windings ('core-type') for external installation,
6. the tertiary winding should be designed for voltage stabilization (if necessary, a choke should be installed to ensure resistance to extraordinary operating conditions). All four connections of the tertiary winding should be led from the tank (open delta). One terminal of the tertiary winding must be grounded to the tank. The terminals of the tertiary winding on the tank must be covered with a metal cover in such a way as to prevent the entry of any animal, including small birds. Other construction requirements must be the same as for other windings.

5.2 MAGNETIC CIRCUIT

5.2.1 Core

The core must be made of thin, oriented sheet metal produced from high-quality, low-loss, cold-rolled, oriented silicon steel. This material must be non-aging, uniform in quality across the entire

surface, and exhibit high magnetic permeability. The cutting technology used for the sheet metal must ensure smooth and burr-free edges. Each lamination must be coated with an insulating material that is mechanically and thermally resistant, as well as chemically resistant to transformer oil.

The core shall be clamped and braced with sticks and other elements to withstand, without damage or deformation, the forces caused by short-circuit stresses, earthquake, transportation, or handling, and to prevent the shifting of the core laminations. The column clamping structure shall be of a nonmagnetic type. The core must have a uniform light gray finish, free from corrosion, contamination, and other foreign substances.

Appropriate vertical cooling channels must be implemented to ensure free circulation of oil and efficient cooling the active part.

Angle joints must provide an adequate electrical and magnetic path, while also enabling disassembly in the event of major maintenance work. The design must be such that in the event of winding removal, the laminated core can also be removed. The individual core components must be equipped with appropriate lifting elements and designed to allow direct lifting with an external lift, without mechanical overloads. Appropriate bridges must be provided between individual sheet metal packages to ensure potential equalization.

To prevent the magnetic circuits from closing through the tank, the upper tensioning structure of the core must not be in contact with the tank. The magnetic circuit must be insulated from all structural parts and must be able to withstand a test voltage against the tensioning bolts of 2 kV effective for 1 minute. The main earthing connection must have a cross-section of at least 80 mm², and the connections between the laminations must have a cross-section of at least 20 mm².

The magnetic core must be earthed at one point, via an insulated conductor and terminals in the earthing box, which must be installed on the outside of the transformer tank.

5.2.2 *Flux density*

The magnetic flux density in the core must not exceed 1.6 T at the maximum operating voltage of 220 kV and a frequency of 50 Hz.

The core must be designed to prevent partial discharges and the formation of short-circuit paths either within the core itself or towards the grounded tension structure. It must be constructed from materials and designed in such a way that, even under the most unfavorable conditions defined in SIST EN 60076-7, disturbances in the magnetic field do not cause damage.

5.3 WINDINGS

High-conductivity electrolytic copper with IEC Class A insulation must be used for the manufacture of windings and other live parts. The insulation must consist of paper impregnated with insulating oil. When designing and manufacturing windings, all electrical and mechanical loads in operation must be taken into account. Windings shall be manufactured in accordance with the latest technological advancements and best practices in the field.

All windings must maintain consistent insulation strength along their entire length, except for high-voltage (HV) windings, which may have uneven insulation. The insulation must be free of components that would become unstable over time and operating conditions or would significantly change their main electrical or mechanical properties.

The manufacture of windings must ensure their mechanical resistance and dimensional stability during operation. Moisture must be removed from the windings by drying in accordance with the requirements in the technical data table. The joints of parts that permanently carry current must be welded or soldered to each other and properly designed and insulated so that excessive electric field gradients do not occur. The influence of eddy currents must be minimal. The windings must be designed in such a way that the optimum size of the series and mutual capacitances is achieved, ensuring an appropriate distribution of the various overvoltage.

The windings must be resistant to the consequences of a short circuit caused by the short-circuit power of the network, current overloads and voltage loads, without local overheating, which is proven by a type test in accordance with the standard. If the Tenderer does not have a type test for a transformer with the same characteristics, he may submit a type test of a similar transformer. A similar transformer is considered to be:

1. power transformer,
2. transformer with a power rating 150 MVA or more,
3. transformer with a HV winding designed for a voltage of 220 kV or more,
4. transformer with a load control switch built into the neutral point of the HV winding.

Additionally, a short-circuit strength calculation according to SIST EN 60076-5 must be provided.

The leads from the windings to the bushings must be equipped with appropriate supports to prevent damage due to vibrations and forces during short-circuit events. All other parts must also be properly fixed, tightened and supported so that they are able to withstand all loads during transport, installation and operation and to prevent their movement.

Appropriate barriers must be provided between the windings and between the windings and the core, and the end wraps must be additionally protected. The design of the windings must be such that unhindered oil flow in the cooling channels is enabled.

All windings must have adequate insulation strength according to SIST EN 60076-3.

5.4 ON LOAD TAP CHANGER

The transformer must be equipped with an on-load tap changer in the high-voltage winding, which allows voltage regulation on the low-voltage side in the event of voltage fluctuations on the high-voltage side. The tap changer (type: VACUTAP VRS III 700Y) must be an original product of MR Reinhausen (fully manufactured in Germany). It must consist of a selectable gradient tap changer with vacuum contacts, a driving mechanism, position indicators and control equipment, complete with all necessary auxiliary devices.

The tap changer unit conservator must be connected to the energy part of the tap changer by pipeline. The connection must be made via its own protection relay. A shut-off valve in the pipeline

must be installed on the conservator side of the oil flow relay. The tap changer conservator compartment must be equipped with its own magnetic oil level measuring device with low oil level alarm indication, filling valve, drain valve and air dryer at the prescribed height.

The tap changer switch must be designed for the same loads as the other elements of the power transformer. This applies to any position of the tap changer.

The current at which the tap changer can change taps must be at least 20% greater than the rated current of the transformer winding.

5.4.1 Tap changer control cabinet

The tap changer control cabinet, complete with all necessary equipment, must be mounted on the transformer tank in a location that is easily accessible from ground level.

The control cabinet of the on load tap changer must contain:

1. electric motor drive equipment. The motor must be suitable for operation at 400/231 V, 50 Hz, and equipped with appropriate mechanical and electrical protections, including a circuit breaker, limit switches, auxiliary switches, display and control elements, and all other necessary components and interlocks,
2. in emergency cases, safe operation must also be possible with a manual drive, which must be appropriately interlocked and protected when remote controlled,
3. control of the on load tap changer shall be performed by the MR ETOS device.

The switching of the on load tap changer must be initiated by a short-duration control pulse and must be completed automatically. A prolonged control pulse must not result in additional switching.

The on load tap changer control box must be equipped with a LOCAL/REMOTE selector switch, enabling:

1. local control via two buttons (RAISE/LOWER) for up and down switching,
2. RAISE/LOWER remote commands via the control system, where two potential-free inputs for Raise/Lower commands must be available at a voltage level of 220 V DC.

The position indicator should be implemented via a BCD encoder, the indication shall be routed to the corresponding relay housing on the control and protection cabinets. Position indicator scale shall be designed in a way that in the »1« position, all windings of the HV winding are included.

All components of the tap changer and control cabinet must comply with applicable international and local standards and safety regulations.

5.5 TRANSFORMER TANK AND EQUIPMENT

5.5.1 *Transformer tank*

The transformer tank must be of welded construction, made from high-tensile steel plates. It must be designed to ensure that full loading during assembly, lifting, transport, and operation does not cause overloading of any part or element.

The transformer tank must have a railway-compatible profile, suitable for railway transport. When designing, the maximum permissible dimensions for transport through railway tunnels must be considered.

All joints on the transformer tank, except those that are intended to be removable, must be welded to ensure complete oil tightness. O-ring seals shall be used for all removable parts. The oil tank must be equipped with three oil sampling valves located at the bottom, middle, and top of the tank. The quality of the sampling valves must be at least equivalent to that of the other valves used on the transformer.

The tank cover may be either bolted or welded to the tank. If welded, sufficient material must be left to allow the tank to be opened at least three times in the future. All screw material shall be protected against corrosion (hot dip galvanized or from inox material).

The selection of the oil sampling valves must be approved by the Customer. Therefore, the Tenderer must submit valve documentation with the tender, clearly showing the proposed valve quality. Each tank must be fitted with either an oil level or gas pressure indicator, featuring a marking for the normal operating level.

The tank must be completely watertight and oil-tight. All external and internal connections and supports—except those that are vulnerable to damage—must be welded.

The tank must pass a vacuum test in accordance with SIST EN 60076-1, section 11.11. Gas leakage or permanent deformation of the tank is not permissible. The fully assembled transformer must withstand, without any adverse effects, internal tank pressure exceeding the maximum operating pressure (as set on the protection system) by 35 kPa.

All external pockets on the transformer tank must be adequately protected to prevent water accumulation. Internal pockets must be equipped with an additional drain. The minimum internal diameter of all drain valves must be 25 mm.

Adequate access must be ensured to all external parts of the tank for painting and corrosion protection.

The tank cover must be equipped with six yellow safety eyes. Their positions will be determined during the design review.

The tank and expansion vessels must be equipped with appropriate access openings for the inspection of internal bushing connections, winding joints, tap leads, and earthing connections. These openings must be of suitable size and closed with bolted covers fitted with lifting lugs.

At least five pockets must be provided on the tank for the installation of resistance or capillary temperature sensors. These pockets must be located at the hottest oil points—typically above

phase V windings. The design must allow removal of the sensors without lowering the oil level in the tank. All pockets must be fitted with sealed covers to prevent water ingress when not in use.

The cover above the tertiary winding must include inspection openings to allow electrical measurements to be performed without removing the entire cover.

All pipe flanges must be made of stainless material in order to prevent rusting on the points where anticorrosion protection may be damaged.

5.5.2 Conservator, breathers, air dehumidifiers

The transformer must be equipped with a conservator installed above the highest point of the oil system. The connections to the conservator must be made at the highest point to prevent the accumulation of gas beneath the transformer tank cover.

The location of the conservator must be made in such a way that the passage of high-voltage conductors above the transformer is not obstructed. The layout of the high-voltage connections and the transformer location is shown in the relevant drawing.

The conservator tank must be capable of withstanding a vacuum of 10 kPa absolute pressure and must have sufficient volume to accommodate oil expansion for a temperature range from 0°C to 120°C.

The conservator must be connected to the transformer tank by an inclined pipe with a minimum internal diameter of 50 mm, ensuring unimpeded gas flow. A Buchholz relay or equivalent protection gas relay must be installed on this pipe. Suitable valves must be provided to allow removal of the relay without interrupting the connection between the conservator and the tank (a bypass must be implemented).

Sufficiently large openings must be made on the side surfaces of the conservator for inspection, cleaning and painting. The cover must be screwed onto the conservator and equipped with suitable handles or lugs for removal.

To prevent direct contact between the oil and external air, a synthetic, airtight, and oil-resistant diaphragm bladder must be used inside the conservator. The interior of the bladder must be in contact with external air through an air dryer, while the exterior surface of the bladder must be in direct contact with the oil. The conservator must allow for vacuum oil filling.

The conservator must be divided into two completely separate compartments—one for the transformer and one for the on-load tap changer—each with its own oil level indicator. The oil level indicators must be installed in the same cabinet as the dial-type thermometer and thermal imaging device.

Each compartment of the conservator must be equipped with an air dryer (breather) and an oil separator flap. The air dryers must be of the self-regenerating type (in the quality class of MR Reinhausen products), where silica gel does not need to be replaced. Each dryer must include a heater for silica gel regeneration, operating at 230 V AC, and equipped with signal contacts compatible with 220 V DC. The power supply circuit must be protected with undervoltage protection (<<I).

For air dryer maintenance and inspection, a three-way valve must be installed to ensure continuous operation of at least one dryer during service. All dryers and other service and maintenance devices must be installed at an accessible height between 80 cm and 180 cm above floor level.

5.5.3 Piping, valves, joints and gaskets

All drain and fill valves, shut-off and check valves, and air vent valves shall be provided in quantities appropriate to the size of the transformer, subject to the Customer's approval. All valves must comply with DIN 3230-3 (leakage rate 1).

Individual components must be designed for easy maintenance and replacement. They must be of high quality and made from selected materials that ensure resistance to environmental influences. For sizes up to DN 50 mm, valves shall be made of brass or bronze. For sizes above DN 50 mm, valves shall consist of cast iron bodies with bronze flanges.

Each valve must be equipped with a position indicator clearly showing whether the valve is in the open or closed position. All oil-tight joints must be made with machined flanges and approved gasket types. Measures must be taken to prevent excessive compression of gaskets. All mating surfaces must be designed to prevent water ingress or oil leakage.

All unused valves, pipe connections, or terminations shall be securely closed or sealed with appropriate flanges, screw caps, or cover plates.

All components must be clearly labeled and referenced on the transformer drawings.

The transformer shall be equipped with at least the following valves:

1. transformer tank
 - a) one DN 50 mm filter valve near the top of the tank, equipped for the connection of oil treatment devices, in accordance with IEC 60567,
 - b) one DN 50 mm filter valve at the bottom of the tank, diagonally opposite the valve under (a), also suitable for oil treatment in accordance with IEC 60567,
 - c) one DN 50 mm drain valve to allow complete oil drainage from the tank,
 - d) three valves for oil sampling: top, middle, and bottom levels,
 - e) Two DN 100 valves intended for pre-treatment use, with the option to install a heat exchanger. These valves shall be provided regardless of the exchanger's final installation location.
2. conservator
 - a) one valve for oil bypass of the Buchholz relay,
 - b) two valves for removing the Buchholz relay,
 - c) an oil filling connection,
 - d) a valve to drain each compartment of the conservator.
3. radiators

- a) Valves at each connection point to the tank, in accordance with the specifications outlined in the "Transformer Cooling and Waste Heat Systems" sections.

5.5.4 Earthing terminals

Four earthing terminals of appropriate size, capable of withstanding a short-circuit current at the lower voltage level for a duration of 3 seconds, must be installed diagonally near the bottom of the transformer tank. Cabinets, motor drives, and all other equipment must be visibly and properly earthed to the tank. All earthing conductors must be yellow-green in color.

5.5.5 Support structures and handling facilities

The bottom of the transformer tank must be reinforced with a robust welded steel mesh support. The base of the tank must be designed to allow movement of the entire transformer unit in any direction without causing damage. Movement is achieved by sliding the transformer on the foundation using built-in steel supports. The steel supports shall conform to the transformer drawings submitted by the Tenderer. Direction changes are performed by lifting the transformer using hydraulic equipment. When positioned, the transformer must rest directly on its foundation, without any wheels or similar devices.

The jacking pads must be installed at a sufficient height to enable jacking and lifting of the oil-filled transformer. Each support must be designed to bear at least 50% of the total weight of the transformer. Support points must be clearly marked in black.

The Tenderer is required to submit data for the construction of the transformer foundation, including the geometry of the support points and foundation loads.

5.6 TRANSFORMER COOLING

Transformer cooling must primarily be carried out in ONAN/ONAF mode, using radiator banks mounted on the transformer tank. Both the radiator banks and the transformer tank must be equipped with appropriate shut-off valves to allow radiator replacement without draining the transformer oil. The number and capacity of radiators must be sized for an ambient temperature of 40 °C (air temperature in the shade).

The cooling system must be designed and manufactured to provide ONAN cooling mode for transformer loads up to 60% under the specified oil temperature conditions. For loads above 60% up to 100%, cooling shall operate in ONAF mode under the prescribed oil temperature conditions.

Radiator bank sections and oil pipelines must withstand the same overpressure and vacuum requirements as the transformer tank, in accordance with SIST EN 60076-1 clauses 11.8 and 11.11. Radiator groups must be galvanized.

Fans with individual motors shall be arranged evenly and symmetrically, mounted under the radiators. The fan blades must be dynamically balanced to avoid vibrations. Fan mounting must prevent transmission of any vibrations to the radiator banks. Mechanical protection made of galvanized mesh with a minimum mesh size of 15 x 15 mm must prevent accidental contact with rotating fan parts.

Fan motors shall be asynchronous squirrel-cage type, suitable for outdoor installation, fully enclosed, and adequately protected against environmental influences. They must be designed for direct start and continuous operation, and connected to a three-phase supply of 400/230 V, 50 Hz.

The mounting method for each fan must allow removal and replacement of individual units without interrupting operation of the remaining units.

The cooling system shall be equipped with the following minimum standard equipment:

1. one (1) valve on each oil inlet and outlet pipe to each radiator,
2. one (1) drain valve on the oil pipe at the lowest point for each radiator,
3. one (1) vent valve for each radiator at the highest point,
4. one (1) thermometer pocket with screw cap on each tank inlet and outlet pipe,
5. all necessary flanged pipes between the radiators and the tank, connecting, expansion and sealing elements, supporting and supporting structure and the like.

5.6.1 Cooler system control cabinet

The transformer must be equipped with a cooling system cabinet mounted on the transformer tank. The cabinet must contain the following equipment:

1. low-voltage switchgear,
2. automatic cooling control equipment, and,
3. measuring, control and protection equipment.

In addition to the cooling system cabinet, the delivery also includes a power distribution cabinet from which the cooling system cabinet is powered.

5.6.1.1 Low-voltage switchgear

The power supply for all equipment installed on transformer shall be provided from the cooling control cabinet via a supply disconnecting switch. The voltage failure signal is provided by an undervoltage relay. Manual disconnection of the cabinet power supply must be possible at all times.

At least the following power outlets shall be provided for the power supply of individual devices:

1. separately for each cooling fan motor,
2. control switch control box,
3. monitoring system box,
4. waste heat recovery system box,
5. cooling control system circuits,
6. separately for each set of measuring equipment,

7. cabinet lighting and anti-condensation heater power supply,
8. service socket,
9. other auxiliary equipment.

Electric motor drives for cooling fans must have dedicated circuit breakers and motor protection switches. Circuit breakers, motor protection switches, and other switches must be equipped with auxiliary contacts for position/operation indication. These auxiliary contacts must be wired to the terminal block.

5.6.1.2 Cooling system automation

Automatic cooling control system must ensure operation of the required number of fans. Switching on and off shall be controlled by a relay combination that takes into account both winding and oil temperatures. The criterion for automatic switching on shall be the winding temperature, and for automatic switching off the oil temperature. The hysteresis between switching on and off shall be at least 5 to 20 °C.

The radiator fans shall be arranged in two groups to allow staged switching on and off. Fans in each group shall switch on and off simultaneously according to the above criteria. The switching sequence of individual fan groups must be adjustable. Each motor must be replaceable without shutting down the other motors, which shall be ensured by the method of their electrical connection.

The control system shall enable manual operation mode (manual-automatic switching). Manual mode shall allow operation of the cooling system regardless of oil and winding temperatures. In automatic mode, the cooling control system must run each fan for at least 20 minutes once per month.

At least the following indicator lights must be used to indicate the status of the cooling system:

1. fan failure (for individual group),
2. fan activation (for individual group),
3. cooling system controlled manually,
4. cooling system controlled automatically.

Automatic cooling control via temperature sensors and local or remote control must be implemented with AC contactors/relays.

5.6.2 Power supply selection cabinet (only in S/S Divača)

In addition to the cooling system cabinet, the transformer T212 in S/S Divača must also be equipped with a power supply selection cabinet, which shall be mounted on the transformer tank. This cabinet must enable the selection between two three-phase 400/230 V AC power sources for the transformer-mounted equipment.

The power supply selection cabinet must contain at least the following equipment:

1. switch for selecting the power source (source 1 / off / source 2),
2. connection terminals for source 1 supply, source 2 supply and outlet for connection to the cooling system cabinet.

5.7 MAESURING, MONITORING AND PROTECTION EQUIPMENT

The transformer must be equipped with at least the following measuring, control, monitoring, and protection equipment, all of which must be wired to the appropriate terminal blocks in the cooling system cabinet:

3. one (1) Buchholz relay,
4. one (1) on load tap changer protection relay,
5. one (1) transformer tank oil level gauge,
6. one (1) on load tap changer oil level gauge,
7. one (1) winding thermal image measurement (WTI),
8. one (1) dial type capillary thermometer (OTI),
9. two (2) pressure relief valves,
10. resistance temperature detectors (RTD) – for use in the control system,
 - b) one (1) for measuring oil temperature with a 4-20 mA current loop transducer,
1. resistance temperature detectors (RTDs) – for use in a transformer on-line monitoring system:
 - a) one (1) for ambient temperature measurement,
 - b) one (1) for oil measurements above,
 - c) one (1) for oil measurements below,
 - d) at the cooling system collector inlets,
 - e) at the cooling system collector outlets.
2. resistance temperature detectors (RTDs) – for the control system of the tap changer switch:
 - c) one (1) for oil temperature measurements above,
 - d) one (1) for oil temperature measurement of the on load tap changer.
3. equipment for measuring winding temperature via optical sensors,
4. equipment for monitoring on load tap changer,
5. current measuring transformers,
6. measuring transducers for monitoring electrical quantities (UL1, UL2, UL3, IL1, IL2, IL3, etc.),
7. monitoring of dissolved gases and moisture,

8. monitoring of bushings.

5.8 TRANSFORMER ON-LINE MONITORING SYSTEMS

ELES operates a central on-line monitoring system, DAC SCADA, intended for direct monitoring and diagnostics of power transformers.

The power transformer must be equipped with a on-line transformer monitoring system, including all associated components:

1. transformer on-line monitoring system cabinet,
2. monitoring system server cabinet, and
3. application software.

The supply of a transformer monitoring system includes the following services and electrical installation work:

1. connection of measuring, control and protection sensor equipment and implementation of communication links between:
 - a) measuring, control and protection equipment and cabinet for the transformer on-line monitoring system,
 - b) transformer on-line monitoring system cabinet and transformer on-line monitoring system server cabinet,
 - c) transformer on-line monitoring system server cabinet and diagnostic center in Ljubljana.
2. parameterization, calibration or setting of outputs from measuring, control and protection equipment to alarm and shutdown levels,
3. connection and calibration of optical sensors for winding temperature measurement,
4. parameterization/calibration of equipment for controlling the on load tap changer,
5. installation of software on the system server and user computers, which will be connected to the server via the intranet/internet,
6. power supply and installation of optical cables for connection between:
 - a) transformer monitoring system cabinet and transformer monitoring system server cabinet,
 - b) transformer monitoring system server cabinet and telecommunication equipment,
 - c) including all necessary auxiliary equipment (e.g. FO/UTP patch cables, etc.).
7. commissioning of the transformer on-line monitoring system,
8. integration into the existing central transformer on-line monitoring system; the Tenderer must fully ensure the required communication with the diagnostic center in Ljubljana. In addition to communication, the delivery also includes parameterization of the existing COLM system to display this data,

9. preparation of technical documentation, including the design of the optical connection:
 - a) documentation for execution (PZI),
 - b) as-built documentation (PID).
10. training of customer personal.

5.8.1 Transformer on-line monitoring system cabinet

The transformer shall be equipped with a transformer on-line monitoring system cabinet, mounted on the transformer tank in an easily accessible location. The cabinet shall contain the following equipment:

The transformer on-line monitoring system shall contain microprocessor-based monitoring device which must enable:

1. on-line data capture and monitoring to at least the following extent:
 - a) ambient temperatures,
 - b) winding temperatures,
 - c) top and bottom oil temperatures,
 - d) top and bottom cooling system collector temperatures,
 - e) temperatures from the on load tap changer,
 - f) signaling from the Buchholz relay - gas accumulation alarm,
 - g) signaling from the oil sight glass in the transformer tank - indication of too low oil level and indication of too high oil level,
 - h) signaling from the oil level indicator of the on load tap changer – indication of low oil level and high oil level,
 - i) monitoring of dissolved gases (hydrogen, carbon monoxide) and moisture (systems of equal or higher quality than Morgan Schaffer Calisto 2 are required),
 - j) monitoring of the transformer cooling system, which includes at least:
 - signaling of operation and failure of cooling system devices (e.g. fans, pumps),
 - cooling efficiency and operating time of individual components,
 - k) monitoring of electrical quantities:
 - operating current from all three internal CTs,
 - operating voltages from external VTs,
 - power factor.
 - l) Monitoring of the waste heat recovery system:
 - oil pump signaling,
 - motorized flap signaling,

- automatic failure signaling,
 - cooler oil indication (leakage, flow,...),
 - inlet and outlet temperature,
 - calorimeter data (pulses, serial connection),
- m) vibration sensor (measuring range 5 Hz to 10 kHz (e.g. WISE-2460)) – (3) three pieces.
- n) transient overvoltages, capacitance and dissipation / power factor of high-voltage bushings (systems of the same or better quality as Omnicron Montrano or MR MSENSE BM are required),
- o) monitoring of the operation of the load control switch; data acquisition available in the MR ETOS device e.g.: position, number of switching operations (switch, selector, pre-selector), switching time, drive motor status, etc....

Where possible, the provider should use sensors with serial communication capabilities (Modbus TPC, DNP3 or IEC 61850).

5.8.2 Server cabinet of the transformer on-line monitoring system

The scope of delivery includes (if applicable):

1. server equipment to be installed in the server cabinet,
2. all necessary equipment parameterization,
3. supply and installation of the server cabinet on site, including all required works,
4. execution of all necessary cable connections for power supply and communication between the server cabinet, the transformer on-line monitoring system, and the control building, including cable routing, terminations, etc...
5. all necessary equipment parameterization.

System and application software must enable:

1. visualization of captured process values,
2. calculations as required for application software,
3. archiving of measurements and events,
4. communication with the transformer on-line monitoring system installed on the transformer,
5. communication with the central monitoring system (DAC SCADA) in Ljubljana.
6. The system server must communicate with the diagnostic center (DAC SCADA). To implement this connection, the offered system must support the following communication protocols:
 - a) web services,

- b) Modbus,
 - c) IEC 61850.
7. The offered system must enable full interoperability with the above-described DAC SCADA. The central system captures data in raw format (analog values, events, alarms). The scope of delivery also includes parameterization of the DAC SCADA, which includes displays of the transformer, which is included in the scope of delivery.

5.8.3 *Application software*

All software provided must be reviewed, user-friendly.

The software must include a software model/models for evaluation/calculations of:

1. hot spot temperature according to SIST EN 60076-7,
2. relative moisture content of the paper insulation,
3. degree of insulation ageing according to SIST EN 60076-7,
4. remaining service life according to SIST EN 60076-7,
5. actual losses,
6. withstand voltage of the insulation system,
7. oil bubbling temperature,
8. detection and recording of overvoltage phenomena of the standard full-scale amplitude of the impulse wave 1.2/50 μ s,
9. detection and recording of overcurrent phenomena with a minimum sampling time of 20 ms in all three phases,
10. operation, cooling efficiency and operating time of all fans,
11. cooling efficiency (heat resistivity),
12. wear of the contacts in the tap changer (taking into account the actual current and the tap changer steps),
13. cumulative degree of the transformer ageing,
14. transformer bushing capacity variation, on the basis of all three phases voltage measurement values,
15. simulation software tool for automatic calculation of simulated parameters and display of diagnostic data.

The software must enable:

1. archived data and report examination,
2. main trends review,
3. statistical data analysis,

4. data and analyses results archivation,
5. sensors – server connections monitoring,
6. sensor operation monitoring,
7. connected equipment status examination,
8. archiving data in a standardized database (MS SQL),
9. automatic backup of stored data (back up),
10. on-screen display and printout of arbitrarily combined data for one or more transformers connected on the monitor,
11. access from the common screen display to the screens/databases for each transformer or cross-transformation unit that has been included in the system for direct transformer monitoring,
12. that data on the operating status and any alarm conditions of all transformers or of cross-transformation units that were included in the OLM are simultaneously visible on the same screen,
13. that the screen display for each transformer/unit is equipped with an image of the actual transformer/unit,
14. the possibility of importing limit values for process values (e.g.: too low, low, high, too high, etc.) from the DAC SCADA,
15. parameter settings (changing alarm levels, processing the historical database and similar specific interventions) by the user,
16. display of alarm status and notification of the responsible person (internet/intranet, mobile phone, etc.),
17. connection of personal computers to the appropriate server via the internet/intranet, through which the user can use all display and control functions of the server.

Data with high time resolution shall be stored in the server's working memory, but after a certain time interval, the average values of individual measurement quantities must be automatically stored in a long-term database. The data collection resolution is proposed by the provider and confirmed by the Customer.

All asynchronously occurring phenomena, such as alarms or changes in the position of the control switch, must be stored separately, with the exact date, time and measured value.

Key elements of the equipment that will capture data on the transformer must be the product of an equipment manufacturer with appropriate references in this field (in the energy sector). The equipment must be designed in such a way that it ensures servicing and elimination of potential defects using standard components, so that interventions/servicing of the equipment at the manufacturer are not necessary.

The data acquisition equipment must be designed in such a way that data is not lost in the event of a short communication failure. The data must be archived locally during the connection failure

and then automatically transferred to the DAC SCADA when the connection is established. The software and all on-screen displays must be in Slovene language.

Software updates shall be provided to the Customer free of charge for at least three years after the initial installation. The OLM provider shall provide service interventions on the server unit by well-trained personnel on the Customer's side, and the system must be designed in such a way that it can be repaired by the Customer's or its authorized Tenderer's professional personnel using the operating and maintenance instructions.

It must enable the connection of personal computers via the appropriate server via the Internet/intranet. Connected users shall have the ability to use all display and control functions of the server.

5.9 ANTICORROSION PROTECTION

Departures or additions to this Technical Specification shall be specified clearly in the tender documentation.

Transformer tank and all associated equipment require anticorrosion protection with epoxy-polyurethane coatings, RAL 7038, according to **Table 2** and recommendations acc. SIST EN ISO 12944-7. The anti-corrosion protection shall be performed after a leak test. The construction of the tank and equipment must allow access to all parts for painting.

Transformer radiators require hot-dip galvanizing, according to **Table 1** and recommendations acc. to SIST EN ISO 14713-2 and SIST EN ISO 1461.

Inspection plan shall at least cover inspections according to **Table 3**. Inspection personal must be certified according to NACE Level II or III, FROSIO Level II or III, another equivalent competence combined with many years of documented and qualified professional experience.

Table 1: Anticorrosion protection of transformer radiators

Expected service life of corrosion protection (SIST EN ISO 14713-1)	VH (VERY HIGH)
Corrosivity (SIST EN ISO 14713-1)	C4 (HIGH)
Design recommendations	Recommendations acc. SIST EN ISO 14713-2 shall be followed.
Surface treatment Zinc Layer Thickness ⁽¹⁾ :	Hot-dip galvanizing acc. SIST EN ISO 1461 ⁽¹⁾ 85µm (Table 2, SIST EN ISO 14713-2)

(1) Acceptance criteria: average coating thickness min. 85µm, local coating thickness min. 70µm (Table 2, SIST EN ISO 1461)

Table 2: Anticorrosion protection of transformer tank

Expected service life of corrosion protection (SIST EN ISO 12944-1)	H (HIGH)	
Corrosivity (SIST EN ISO 12944-2) Special Exposure:	C4 (HIGH) External: Sun light (UV) Internal: Transformer oil	
Design considerations and pretreatment: a. Design requirements b. Design recommendations c. Pretreatment requirements prior surface preparation (SIST EN 1090-2)	Design features must be acc. Annex C, SIST EN 12944-3 Best examples acc. Annex A, B and D SIST EN ISO 12944-3 shall be followed Preparation grade min. P2 acc. SIST EN ISO 8501-3 ⁽¹⁾	
Surface preparation requirements: a. Surface preparation (SIST EN ISO 8501-1) b. Surface roughness (SIST EN ISO 8503-2)	A Sa 2 ¹ / ₂ or B Sa ¹ / ₂ Medium G (Grid)	
<u>Protective coating specification</u> (Table C.4, Annex C, SIST EN ISO 12944-5)		
Type of coating	Internal surfaces	External surfaces (system C4.10)
1. Primer Dry Film Thickness:	Epoxy polyamide primer 80µm	Zinc-rich epoxy primer ⁽²⁾ 60µm
2. Intermediate Coating Dry Film Thickness:	None	Epoxy poly-amid with micaceous iron oxide 80µm
3. Top-coat Dry Film Thickness:	None	Acryl-isocyanate (polyurethane) topcoat, RAL 7038 60µm
Total Dry Film Thickness ⁽³⁾:	80µm (max. 120µm)	200µm

(1) Prior to transport to surface protection facility, preparation grade P2 acc. SIST EN ISO 8501-3 shall be checked.

(2) Zinc dust pigment content equal or greater then 80%, by mass, in dry film. Zinc dust pigment must comply with ISO 3549.

(3) Acceptance criteria for total Dry Film Thickness acc. to ISO 19840, rule 80/20

Table 3: Inspections

Type of inspection	Methods	Requirements	Scope (minimum)	Comment
Cleanliness compressed air	ASTM D4285	According to ASTM D4285	Random testing	Test is done with white cotton cloth
Oil and grease in abrasives	ASTM D7393	According to ASTM D7393	Every quarter	Applies to circulating abrasives
Climatic conditions	SIST EN ISO 8502-4 Air temp.: Surface temp.: Dewpoint: Rel. Humidity:	min. 10°C min. 10°C min. 3°C above surface temp. max. 85%	Before and after each step, at least two times per shift	Coating suppliers can, and in some cases should set other requirements
Rust grades	SIST EN ISO 8501-1	A or B	100% of whole surface	Prior to start of surface preparation
Preparation grade	SIST EN ISO 8501-3	P2	100% of whole surface	Prior to start of surface preparation
Blast-cleaned surface	SIST EN ISO 8501-1 SIST EN ISO 8503-2 SIST EN ISO 8502-3	Sa 2 ^{1/2} Medium grit density max. 2 size max. 1	100% of whole surface	Prior application of 1 st layer (primer). The Client shall have opportunity to perform inspections.
Visual inspection of the painted surface	All coats/layers shall be covering and continuous (runs, drops, pores, and other surface defects)	Each coat/layer regarding surface defects	100% of whole surface	Applies to both surfaces and edges
Dry film thickness	ISO 19840	According to coating specification	ISO 19840	
Adhesion	SIST EN ISO 16276-1	Min. 5MPa	SIST EN ISO 16276-1	Not for hot-dip galvanizing

5.10 BUSHINGS AND TERMINALS

5.10.1 Bushings

Transformer bushings for rated voltages of 220 and 110 kV must be of the condenser type, manufactured in the EU. The insulator must be made of composite material, manufactured by Hitachi Energy, Sweden.

The bushings must be resin impregnated and must not contain any oil. Only high-temperature resistant vulcanized silicone rubber (HTV) or liquid silicone rubber (LSR) is permitted. It must contain at least one third of pure silicone rubber and must be resistant to UV light, therefore it must not have additives that are not resistant to UV (ethylene vinyl acetate EVA, ethylene propylene rubber EPR, etc.). Silicone composite insulators must comply with the requirements of SIST EN IEC 61462 and SIST EN 62217. The insulators (construction and type test) shall be checked in accordance with the SIST EN IEC 61462 standard. A routine test shall be also carried out for each insulator in accordance with the same standard. The hydrophobicity recovery must comply with IEC TS 62073 (restoration of hydrophobicity WC 1-3 48 hours after complete loss of hydrophobicity).

Insulators on HV and LV should be made of composite silicone. The tertiary bushings shall have a porcelain insulator.

The insulation strength shall correspond at least to the values of the basic insulation level (BIL) of the other equipment in the switchgear and the test withstand voltage of the mains frequency of the associated winding.

The bushings shall be completely oil-tight and equipped with connections for measuring the loss angle $\tan \delta$ without removing the primary connections. Their replacement shall be possible with a minimum reduction in the oil level in the transformer tank. Each completed bushing shall be permanently marked with the manufacturer's name or identification mark, year of manufacture, serial number, electrical and mechanical characteristics according to IEC 60137 and the maximum permitted angle of inclination if greater than 30°.

The tertiary winding shall have four bushings: 3W2 and 3U1, which shall be short-circuited, 3U2 and 3V2. Tertiary bushings must be protected by a protective insulating cover in which there must be openings that allow electrical measurements without removing the cover. The triangle grounding is performed by the manufacturer. All bushing oil seals must be oriented in the direction of view from the HV or LV winding. The Tenderer must prepare a drawing with the orientation of the phases on the HV and LV parts (see drawing R4PO01-6E4191).

5.10.2 Transformer terminals

The transformer terminals of both high voltage windings (220 kV and 110 kV) and the neutral point terminals of both windings must be suitable for connection of Al alloy conductor terminal ends. The design of the 220 kV and 110 kV terminals including the neutral point terminals must be of bolted type, with a diameter of at least 40 mm.

5.11 SUPPORTING STRUCTURE FOR INSTALLATION OF SURGE ARRESTORS

On the 220 kV and 110 kV sides of the power transformer, a steel structure must be constructed for the installation of 220 kV and 110 kV surge arresters (supply and installation of surge arresters is not the subject of this tender). The surge arresters must be installed in such a way that they do not carry the load of the connection rope (the load of the conductors must be carried by the bushing).

The supporting structure must be prepared for the installation of 220 kV surge arresters:

- Height: maximum 2,2 m,
- Weight: maximum 150 kg/piece
- Bolt: $r=120$ mm, 4 screws on support insulators M12, 90° between holes.

The supporting structure must be prepared for the installation of 110 kV surge arresters:

- Height: maximum 1,4 m,
- Weight: maximum 70 kg/piece
- Bolt: $r=120$ mm, 4 screws on support insulators M12, 90° between holes.

The construction must be carried out in such a way that the Customer can subsequently remove it without major interventions.

To carry out measurements and diagnostics, there must be preparation for the subsequent installation of the operation meter (surge counter and surge arrester monitor), in an easily accessible place on the transformer tank (at a height of 80 - 180 cm from the ground). Also, preparation must be carried out from each surge arrester to the meter, according to the transformer construction, for the installation of a grounding cable. A grounding connection must be prepared on the transformer tank in the immediate vicinity of the meter. Surge arresters and operation meters are not within the scope of the tender.

5.12 TRANSFORMER OIL AND INSULATION PAPER

The transformer oil must be new, type Nynas Nytro 4000X or Ergon HyVolt III. Before the first filling, it must meet all the requirements specified in the Technical Data Table and the requirements of the SIST EN IEC 60296 standard – Table 3, type TVA1.

The transformer oil must be mineral, inhibited, naphthenic, high-grade insulating oil. It must not contain any PCBs.

The properties of the oil are checked according to standard IEC, DIN, ISO, ASTM methods and must meet the criteria prescribed in the Schedules of technical data.

In case that an antioxidant is added to oil, it shall not contain sulphur components. Oil shall not contain corrosive sulphur or potentially corrosive sulphur and shall be tested acc. to DIN 51353 and IEC 62535 standards to be considered non-corrosive.

Before the start of the transformer manufacturing, a test of the degree of polymerization of the paper insulation shall be performed (according to SIST EN 60450).

Customer requires that the same type of oil (fully inhibited high grade naphthenic oil) with which transformer was tested during factory tests shall be delivered to the facility together with the transformer.

The Tenderer shall submit all paper insulation and oil testing reports to the Customer. The Tenderer may fill the transformer with the oil used in the factory for FAT purposes. However, the oil used during the Factory Acceptance Tests (FAT) must be of the same origin as used for on-site filling. If a different type of oil is used then the miscibility and compatibility of the oils shall be verified by an accredited laboratory in accordance with IEC 60296:2020, Clause 5.3 – Miscibility and compatibility.

Before the initial oil filling of the transformer on site, an examination shall be carried out to verify that the insulating liquid complies with the requirements specified in the technical specification of this document. In addition, the oxidation stability of the batch of insulating liquid intended for filling the transformer shall be verified in accordance with IEC 61125.

The manufacturer must also provide a declaration that he has carried out compatibility tests with other materials in the transformer for both oils.

The transformer shall be delivered without oil, filled with dry air at a pressure higher than atmospheric, and the process of oil depletion and air filling shall be subject to the approval of the Customer. The oil removed from the transformer before transport shall be delivered in pressurized tanks. The quantity of oil delivered shall be sufficient to refill the transformer, including any losses that may occur during the filling process.

Before the first start-up, the transformer oil shall be tested in accordance with SIST EN IEC 60422 - Table 3 and the additional requirements specified in the Schedule of technical data. An FTIR spectral comparison of oil samples shall also be carried out before the factory tests and before the first start-up of the transformer.

The thermally stabilized insulating paper used shall be from the manufacturer Weidmann. If the Tenderer wishes to use paper from another recognized manufacturer, the consent of the Customer must be obtained.

The test samples of the insulating paper used must meet the following requirements after drying the windings and final drying of the entire active part:

1. the average degree of polymerization of the paper samples taken must not be lower than 1100, and the value of each individual sample must be at least 1050,
2. the moisture content must be lower than 0.5%.

The sampling of insulating paper shall be carried out before the start of winding production (more than three samples are to be taken). The analysis of the degree of polymerization of the samples shall be carried out on new (undried) paper and after the final drying of the active part of the transformer, with the samples taken accompanying the transformer windings through the first and second drying.

The sampling of transformer oil shall be carried out before the first filling, after the dielectric tests have been performed, after the factory tests have been completed and before the first start-up. Sampling and testing shall be carried out by an authorized and accredited independent institution.

5.13 SUPPORT REACTIONS

The Tenderer must provide documentation showing the magnitude and direction of loads/reactions in all supports of the equipment structure. The aforementioned data must be provided for normal operation (permanent load due to the weight of the equipment) and for the case of an earthquake. The impact of loads in an earthquake condition must be analyzed for all three orthogonal directions separately (x, y and z). The results must be presented in a table (Table 12, Technical characteristics of the transformer - data for foundation calculating s), separately for each support of the equipment structure (point or line). For line supports, the impact value must be determined at the beginning and end of the support or the loaded part of the support. If the line supports are not loaded along their entire length, the length of the loaded part of the support must also be provided.

5.14 RECOVER HEAT GENERATED (SIOT)

5.14.1 *General*

The Customer intends to use the waste heat of the transformer for heating various facilities in the substation. To recover heat generated, the transformer must have water cooling via a built-in transformer oil/water heat exchanger. Since heat removal for heating purposes will not be possible continuously and completely, the transformer must also be equipped with independent transformer oil/air cooling (ONAN/ONAF), which will enable complete heat removal. The transformer must be built in such a way that parallel operation of ONAN/ONAF cooling and heat removal for heating purposes of the substation facilities is possible. Heat regulation should be controlled via the temperature of the upper oil as an input value for regulation. The Tenderer must submit a proposal for its heat regeneration solution together with the regulation principle with the offer.

The transformer heating test will be carried out in all combinations of cooling regimes.

5.14.2 *Requirements for OFWF operation*

The transformer supplied must include all the necessary equipment also for OFWF operation, including the oil/water heat exchanger. The supply shall also include the supply and installation of all the necessary piping, cabling and other equipment necessary for all cooling operation modes. The supply limit is the flange for the water connection on the oil/water heat exchanger. The transformer supplier is obliged to design the transformer and heat exchanger in such a way that the oil flow in the transformer and in the heat exchanger is optimal in ONAN/ONAF + OFWF mode.

The oil/water heat exchanger must be designed for outdoor installation and for operation in a closed loop with a 60/40% water/glycol mixture, while ensuring that contact between water and transformer oil is reliably prevented in all cases.

The cooling capacity of the oil/water heat exchanger must correspond to at least a thermal power of 150 kW obtained from the exchanger in winter conditions at an ambient temperature of -25 °C.

The technical data of the exchanger must be enclosed with the offer together with the thermal calculation.

The outlet water temperature from the heat exchanger will be set to 25 °C under normal operating conditions. The inlet water temperature to the heat exchanger will be set to 5 °C under normal operating conditions. Thermometer pockets must be installed in the oil and water supply and discharge pipes before the flange for the external cooling circuit. They must be equipped with thermometers and a calorimeter.

The oil temperature should be regulated in such a way that a sufficient difference between the lower and upper oil temperatures is maintained, regardless of the transformer load. The regulation principle must be proposed by the Tenderer.

The oil flow indicator must provide a signal (alarm) in the case of no oil flow and a signal in the case of too low oil flow.

The refrigerant leak indicator must provide an alarm for refrigerant leaks from the heat exchanger.

5.14.3 Heat recovery system cabinet

The transformer must be equipped with a heat recovery system cabinet mounted on the transformer tank. The cabinet must contain the following equipment:

1. low-voltage switchgear,
2. heat recovery system automation, and,
3. measuring, control and protection equipment.

5.14.3.1 Low-voltage switchgear

Following power supply must be provided for the individual devices or systems:

1. separately for the oil pump and each motorized damper,
2. heat recovery control system circuits,
3. separately for each set of measuring equipment,
4. cabinet lighting and anti-condensation heater power supply,
5. other auxiliary equipment.

Electric motor drives must have their own circuit breaker and motor protection switch.

Circuit breakers, motor protection switches, changeover switches, etc. must be equipped with auxiliary contacts for position/operation indication. The auxiliary contacts must be wired to the terminal block.

5.14.3.2 Measuring, control and protection equipment

Measuring, control and protection equipment is described in the chapter "Requirements for OFWF operation".

All signaling from this equipment must be routed to appropriate terminals, where it will be available to the system for controlling the operation of heating facilities within the S/S substation.

5.14.3.3 *Heat recovery system automation*

The automation of the heat recovery system shall include the following elements:

1. heat exchanger,
2. oil pump to ensure oil circulation through the heat exchanger,
3. heat exchanger leakage indicator,
4. oil flow indicator,
5. contact thermometers.

The heat recovery system must be designed so that it can be disconnected and dismantled at any time by closing the valves without interfering with the transformer itself.

Protection of the OFWF exchanger must be ensured in case of low media temperatures (oil, glycol-water) and blocking of the OFWF exchanger operation in case of a trip function of the transformer protective elements.

It must be possible for the oil pump to be controlled via a switch (local - remote) for selecting the operating mode. The system must be designed so that both ONAN/ONAF and ONAN/ONAF+OFWF cooling systems can operate simultaneously. In the event of an oil pump failure or a radiator leakage, the SIOT is switched off with a delay of 10 seconds; the motorized dampers must be placed in the optimal position that ensures uninterrupted operation of the transformer.

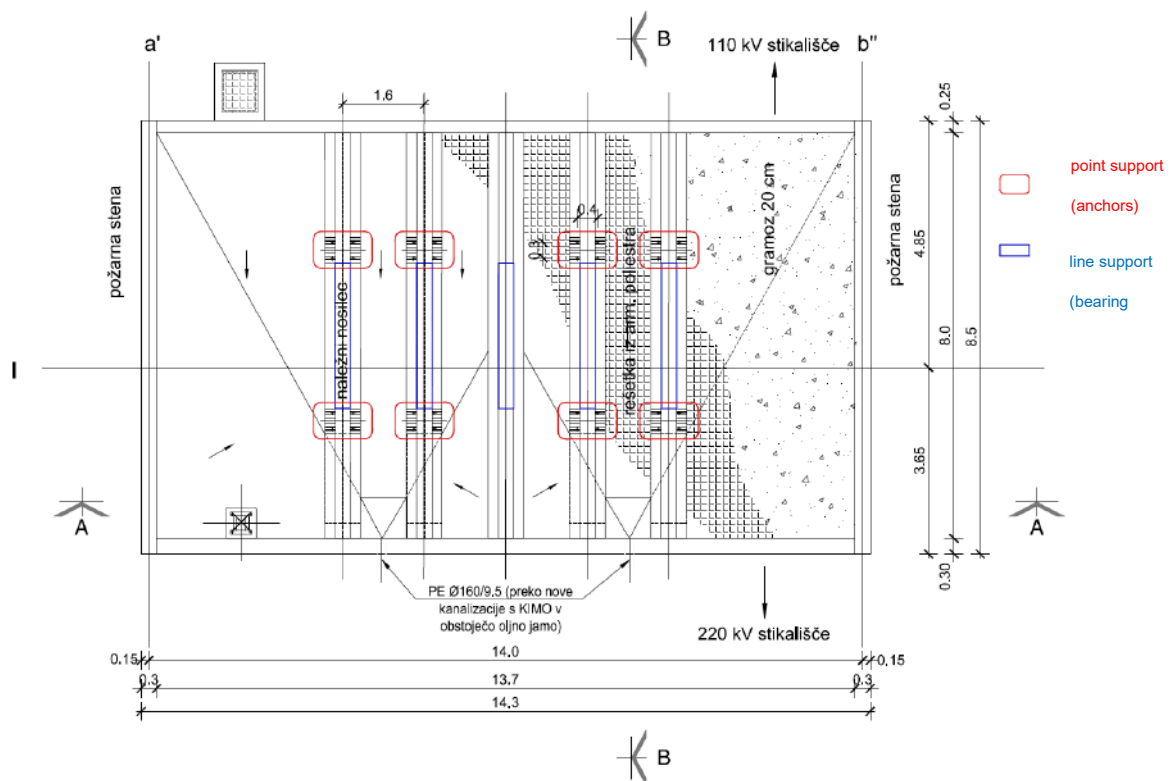
The motorized dampers must have adequate redundancy so that in the event of a failure of one of the dampers, sufficient cooling capacity is still ensured.

5.15 TRANSFORMER FOUNDATION

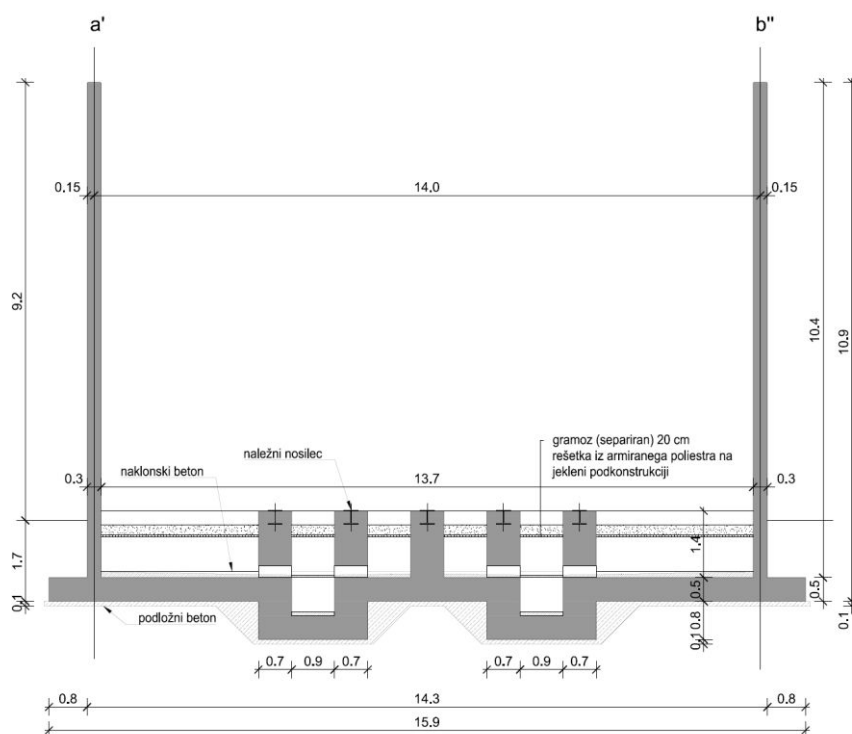
The transformer will be installed on a concrete foundation with line supports for the transformer. Overturning and sliding of the transformer in the event of an earthquake shall be prevented by installing anchors on each of the longitudinal sides of the transformer.

The figure below shows an example of a foundation showing line supports and anchorages. The number and location of the supports shall be specified by the Tenderer, whereby the axial distance between the line supports must be a minimum of 1.60 m, and the distance between the anchors and the axis of the line support must be a minimum of 0.2 m. If the minimum axial distance between the line supports cannot be ensured, a single flat support (single block foundation) may be provided to support the equipment structure.

Picture 2: Longitudinal cross-section of the foundation with fire walls (cross-section A-A, dimensions in m) Picture 2 shows a cross-section of a transformer foundation with fire walls, the dimensions of which the manufacturer must consider when designing the transformer.



Picture 1: Foundation floor plan with support beams and anchor locations (dimensions in m)



Picture 2: Longitudinal cross-section of the foundation with fire walls (cross-section A-A, dimensions in m)

The external dimensions of the foundation with an oil catch basin shall not exceed 14.3 m (length or longer side) x 8.5 m (width or shorter side).

6 CONSTRUCTION AND ASSEMBLY QUALITY CONTROL, INSPECTION AND TESTING

The purpose of this chapter is to determine the compliance of the construction and installation of the transformer with applicable standards, specifications and regulations with the aim of ensuring appropriate characteristics of the equipment and installation, which will be reflected in the reliable operation of the device over its entire service life.

6.1 QUALITY ASSURANCE AND QUALITY CONTROL (QA/QC)

The Tenderer must have and shall use instructions for quality assurance and control (QA/QC) for its activity, which includes production and installation, including the implementation of inspections during production and testing without and in the presence of the Customer or its authorized representative.

For each activity or activities, the instructions for quality assurance and control must include drawings and other documents that will show the standards and procedures used for testing materials, production, quality control and determining guaranteed characteristics in all stages of production - from the procurement of materials to the finished and installed transformer.

No inspection will be valid if the Tenderer does not have all the necessary approved drawings and procedures for the parts of the transformer or the whole to be tested. The Tenderer must provide the Tenderer with a copy of the drawings and other documentation upon request before the tests.

6.1.1 *Review of the suitability of production processes*

To ensure a long service life of the transformer, the manufacturer must have a production process that ensures the cleanliness of the production premises and prevents the introduction of impurities in the production premises of the magnetic core assembly, winding manufacturing, winding assembly, assembly of the active part and final assembly. The manufacturer must have internal standards aligned with the ISO 9001, ISO 14001 and ISO 45001 standards. The manufacturer must have procedures in place to ensure the cleanliness of production in its QA/QC. ELES reserves the right to carry out a suitability check at the manufacturer in the form of an assessment of the production premises and processes before concluding the contract - an audit. It also agrees to obtain the opinion of an independent institution. The suitability check will also be carried out during the manufacture of the transformer itself in the form of interphase checks.

6.1.2 *Final assembly*

The final assembly process of the transformer from the completed drying process of the active part of the transformer (opening the furnace) to the hermetic sealing of the transformer tank must be carried out under controlled conditions of humidity and air temperature.

The manufacturer must submit a description and evidence of the process of performing the final assembly of the transformer in the factory based on ambient conditions as part of the tender documentation. ELES reserves the right to verify with the manufacturer the adequacy of ensuring

the conditions for final assembly during the tender phase, before concluding the contract – audit. It also reserves the right to obtain the opinion of an independent institution.

ELES reserves the right to verify management of the conditions for final assembly of the transformer in the manufacturer's factory. In the event of a longer period of exposure of the active part to air with a higher moisture content or a longer final assembly process or in case of poor ambient conditions, according to QC, ELES reserves the right to enforce a contractual penalty and/or the right to request re-drying of the active part once during assembly. Re-drying shall be performed maximum once. The Tenderer must plan activities to prevent this from happening no more than once.

6.2 ERECTION REQUIREMENTS

6.2.1 *Erection works on site*

For the erection and installation of the transformer in the S/S, the Tenderer shall provide:

1. transformer installation,
2. specialist personnel to supervise installation and put the transformer into operation,
3. special and other tools and devices for installation,
4. all start-up and functional tests.

The installer proposed by the Tenderer will have to be approved by the Customer.

The installation of the transformer should be completed to the greatest extent possible in the factory. All installation work on the transformer and its cooling system that will need to be carried out at the installation location will be provided by the Tenderer. The installation work shall be carried out with installation tools that will be provided by the Tenderer. The Tenderer shall organize the transport and lifting of all transformer equipment that will need to be installed on the transformer. The Tenderer or installer must organize the installation at the installation location in such a way that the Customer will not have any additional costs and obligations other than the presence at the location. The Tenderer or installer shall comply with all relevant health and safety regulations, environmental protection requirements and the safety plan. The Tenderer shall be fully responsible for safety (occupational safety, fire protection, environmental protection) during manipulations, during transport and installation and during operation with the equipment and materials supplied under this contract. The responsibility also applies to all stages of preparation of documentation - from calculations and selection of appropriate materials to preparation of instructions for installation and maintenance. During transport within the RTP and during installation of the transformer, the Tenderer must fully comply with the safety plan provided by the Customer. It must also take into account that during installation of the transformer, all RTP systems will be under voltage and will operate normally.

6.2.2 *Erection supervision*

The installation supervision shall be provided by the Tenderer. For the installation supervision, the Tenderer shall also prepare a supervision program in which the required time of supervisors

will be estimated, their number with indication of specialties and their price, all of which will also be included in the offered price of the transformer.

6.3 INSPECTIONS AND TESTS

All tests used to verify the material, and equipment must be carried out in a way that takes into account the influence of operating conditions. All tests must be carried out in accordance with the requirements of SIST EN, IEC standards. Tests shall be carried out at the manufacturer and at the installation site. Inspections and tests shall also be carried out for certain components of the transformer (OLTC, bushings, etc.) at the equipment manufacturer site. The Tenderer shall organize all work related to the performance of inspections and tests in such a way that representatives of the Customer can attend inspections and tests.

The Customer will determine the inspection points at which it wishes to be present, based on the instructions for quality assurance and control. The Customer shall also have the right to decide to be present at any inspection during the production of the transformer, therefore the Tenderer shall inform the Customer in writing of the dates when individual parts of the transformer equipment will be ready for inspection or testing. The Tenderer shall also provide test samples of oil, insulated wires and sheet metal, which the Customer will send for testing to an independent institution. At the request of the Customer, the Tenderer shall also be obliged to carry out tests not specified in the SIST EN, IEC standards, if such tests are necessary to determine the completeness and safety of the equipment offered. The Tenderer shall inform the Customer of the date, time and scope of testing at least four (4) weeks before the testing, and the testing date must be approved at least 14 days before the performance. All test results shall be submitted to the Customer for control and approval immediately after the tests are performed. The Customer reserves the right to obtain a second independent opinion (verification of the correctness of the results of measurements, tests, type tests, etc.).

If, after the acceptance testing at the factory or at S/S Podlog, for any reason, it is necessary to repair the equipment or replace any part of the transformer, the Tenderer shall complete all work as soon as possible.

The Tenderer shall provide the Customer with all results of repeated tests. All test equipment shall be provided by the Tenderer.

6.3.1 *Factory acceptance tests*

Factory acceptance tests shall verify the functionality of the equipment and compliance with the guaranteed and other design-defined characteristics. Factory acceptance tests (FAT) will be performed at the factory in the presence of the Customer. The Tenderer shall prepare all procedures for the FAT in accordance with the latest standards and applicable technical regulations. The FAT program is subject to the Customer's approval.

The Tenderer shall organize the FAT tests in such a way that Customer representatives can attend. It is required that 48-hour no-load losses be measured at a higher voltage (107% of the nominal voltage) using HPLC and gas chromatography, in order to check for any local overheating of the core.

The adequacy of the EMC compatibility measurements will have to be reviewed and confirmed by an EMC expert.

The Tenderer shall have to submit to the Customer evidence of the equipment's flawlessness at the FAT.

Any deviations from the required values shall be documented in the transformer production log. The representatives of the Customer and the Tenderer will jointly sign a report on the necessary repairs to the transformer or its equipment. In the event of deviations, the Customer's representative has the right to request the termination of the tests and their re-performance.

The costs of the Customer or the institution authorized by the Customer that would arise from any necessary repeated FATs shall be covered by the Tenderer / equipment manufacturer. The same applies to costs that would arise from the extension of the FAT as a result of problems with the measuring equipment or for any other reason that the Customer cannot influence.

The Tenderer is, regardless of the fact that he has approved the results of the Customer's tests, still responsible for its proper operation even after the installation of the transformer.

6.3.1.1 *Factory tests*

The required factory tests/examinations must include the following:

1. visual inspection,
2. main dimensions check of the transformer,
3. measurements of the voltage ratio and check the phase displacement,
4. measurements of the winding Ohmic resistance at all stages,
5. measurements of no-load loss and current (supply from the secondary side, at a voltage of 0.9, 1.0 and 1.11 U_n),
6. measurements of short-circuit voltage impedance and load losses,
7. measurements of the zero sequence impedances (in all combinations),
8. separate source AC withstand voltage test, 50 Hz, 60 sec,
9. long duration induced AC voltage test (IVPD),
10. tests of the on load tap changer,
11. lighting impulse test (LI) for the line and neutral terminals,
12. switching impulse test (SI) for the line terminal,
13. measurement of partial discharges,
14. measurement of insulation resistances,
15. HPLC and gas chromatography tests before and after dielectric tests and after transformer thermal testing,
16. analysis of the polymerization degree (DP) of the insulating paper before and after the final drying of the transformer,

17. heating test for the windings in all cooling combinations and thermography system test,
18. heating test of the core at 107% of the nominal voltage for 48 h and control by thermography,
19. test with lightning impulse voltage with a chopped wave,
20. measurements of capacitance and loss angle $\tan \delta$,
21. measurements of capacitance and loss angle $\tan \delta$ on HV and LV bushings,
22. FRA measurement,
23. measurement of sound levels at nominal voltage U_n in all cooling combinations, in accordance with the sound pressure method according to IEC,
24. measurement of higher no-load harmonic currents,
25. measurement of magnetic currents at 400 V, 50 Hz voltage,
26. measurement of all auxiliary systems,
27. measurement of current transformers,
28. measurement of breakdown voltage of transformer insulating oil,
29. oil examination according to IEC 60422,
30. vacuum test of the entire transformer,
31. test with an overpressure of 35 kPa of the entire transformer,
32. functional test of cooling, protection and control equipment on the transformer,
33. determination of efficiency,
34. functional test of the on-line monitoring system operation.

6.3.1.2 *Quality control tests and documents*

All measurements and tests performed on individual components must be performed and carefully recorded in accordance with the quality plan.

The results of the tests performed on individual components must be delivered in the form of certificates no later than the acceptance tests of the transformer, namely:

1. Quality certificates:
 - a) copper insulated conductors,
 - b) core sheet,
 - c) hard insulating material,
 - d) insulating oil,
 - e) structural steels,
 - f) wiring cables,

- g) paint and its resistance to oil.
- 2. Test reports:
 - a) bushings,
 - b) OLTC,
 - c) OLM,
 - d) current transformers,
 - e) coolers,
 - f) auxiliary cabinets.
- 3. Performance tests and quality certificates:
 - a) MR RS2001 relay,
 - b) Buchholz relay,
 - c) Bushing sensors,
 - d) Safety valve,
 - e) MR ETOS control system,
 - f) Top oil temperature indicator,
 - g) Pt 100 temperature measuring probes,
 - h) On-line monitoring system,
 - i) Gas sensors,
 - j) Humidity sensors,
 - k) Optical temperature sensors,
 - l) Winding temperature measuring system,
 - m) Magnetic oil gauges,
 - n) Contact capillary thermometer,
 - o) OLTC,
 - p) OLTC drive motor,
 - q) Voltage regulation,
 - r) Fans,
 - s) Air bags in the conservator and air dryers,
 - t) Fire detectors,
 - u) Excess heat system components.
- 4. tank inspection documents,
- 5. complete transformer overpressure and vacuum test report,

6. anti-corrosion protection inspection report,
7. interphase inspection report:
 - a) magnetic core,
 - b) windings,
 - c) bushings,
 - d) stray,
 - e) active part,
 - f) drying of active part.
8. report on measurements and tests in the factory and tests in accordance with the chapter on "tests on site",
9. manufacturer's declaration that the transformer is manufactured from materials and according to procedures compliant with EU environmental directives.

6.3.2 Site acceptance tests

The purpose of the on-site acceptance tests is to verify compliance with the functional requirements and specifications of the tender and to determine the correct and safe operation of the device.

Site acceptance tests shall be carried out after the completion of the installation and before the technical acceptance of the transformer. Before the start of the on-site tests, the Tenderer will submit to the Customer for approval the proposed test procedures, which shall also take into account all instructions from the equipment manufacturers, generally applicable standards and the requirements of the Customer. Before the start of the tests, the Tenderer and the Customer will agree on the details of the measurement methods, the conditions for carrying out the tests and their implementation and on the special conditions for the tests (for example, network requirements).

If the transformer does not meet all the required acceptance conditions, the Tenderer and the Customer will draw up a written agreement on the consequences of not meeting the conditions.

At least the following measurements, tests and inspections must be carried out on the installation site:

1. pressure test of the tank and the attached cooling system,
2. measurement of capacitance and loss angle $\tan \delta$,
3. measurement of the inductance,
4. measurement of winding resistance,
5. measurement of insulation resistance,
6. measurement of capacitance and $\tan \delta$ of capacitor bushings,
7. measurement of reverse voltage (RVM),

8. magnetizing current at 400 V,
9. measurement of FRA,
10. measurement of FDS (frequency analysis of dielectrics),
11. measurement of dielectric strength and water content in insulating oil,
12. recalibration and current injection on temperature indicators,
13. voltage test with a voltage of 2 kV on wiring, control and monitoring devices,
14. functional test of the on load tap changer,
15. functional test of control and monitoring equipment,
16. functional test of the cooling system, including temperature measurements,
17. functional test of on-line monitoring,
18. functional test of optical sensors for direct measurement of winding temperature,
19. visual inspection,
20. inspection of final anti-corrosion protection,
21. HPLC analysis of oil from a new transformer,
22. gas chromatographic examination of the transformer.

After successfully completed and documented tests, the transformer is ready for trial operation.

7 DOCUMENTATION

Before the start of the transformer manufacturing, the Tenderer must submit to the Customer a list of all planned documents (drawings, calculations, graphs, curves, instructions, short-circuit calculation, etc.) indicating the format of the original document. The list of documents must also indicate the dates of submission of documents to the Customer and the original formats of documents already approved. From the submitted list, the Customer will determine the documents that he will check and approve in accordance with the agreed time schedule.

All documentation must comply with the requirements of Slovenian legislation and international standards in terms of form, content and language used. It must be delivered in Slovenian or in English.

The documentation for the design of construction works (transformer foundation) must be submitted to the Customer no later than three (3) months after signing the contract.

All identification plates and warnings, maintenance and operating manuals, installation instructions, testing and commissioning instructions, test certificates and "As-Built" drawings must be in Slovenian language.

Before the start of the manufacture of the transformer and its devices, the documentation must be submitted to the Customer for approval in accordance with the schedule for submission of documentation. The documentation review will be carried out within a jointly agreed deadline, estimated at two (2) weeks. In the event of justified comments on the tender requirements, the Tenderer will correct the tender documentation in a timely manner and return the corrected documentation to the Customer within two (2) weeks for re-review. Any disagreements or ambiguities will be resolved at joint meetings. Confirmation of the documentation by the Customer will not relieve the Tenderer of its responsibility for ensuring compliance of the equipment with the operating conditions.

All documents shall be submitted in paper and electronic versions, taking into account that individual documents shall be submitted separately in one of the common electronic formats. Electronic formats must be appropriately marked for opening and easier search in the document system. The Tenderer must submit all technical documentation (confirmed and signed by the Customer and the Tenderer) to the Customer in two (2) paper copies and on a USB key (DWG, PDF, DOCX, XLSX, 3D BIM (LOD 400), STP,...).

The bidder and/or manufacturer shall provide information on the estimated carbon footprint generated during the manufacturing of the transformer. The scope of the calculation shall be an LCA (Life Cycle Assessment) in accordance with ISO 14040/ISO 14044. The LCA results shall be prepared in a format suitable for possible subsequent EPD (Environmental Product Declaration) calculations.

The bidder shall provide information on the feasibility of developing a dynamic thermal model of the transformer, enabling monitoring of the thermal state of the equipment during operation and assessment of the permissible loading or short-term overloading capability based on actual operating and ambient conditions.

Where applicable, the model should consider at least the following:

1. actual transformer loading;
2. ambient temperature;
3. thermal inertia of the active part and cooling system;
4. oil and winding temperatures, or equivalent hot-spot temperature;
5. cooling mode;
6. previous operating regime;
7. permissible temperature limits and ageing of the insulation system.

The bidder shall specify whether such a model can be developed on the basis of the transformer design, type-test and/or factory data, and shall identify the input measurements and signals required for its use during operation. The bidder shall also state whether the model can be integrated into the purchaser's existing monitoring, diagnostic, SCADA and/or EMS systems.

7.1 TENDERER DOCUMENTATION

Set of required documents:

1. document classification plan for all documentation with a list of documents and the dates of issue of this list,
2. dimensional drawing of the transformer,
3. list of components and devices on the transformer (in Slovenian),
4. list of all seals on the transformer (with indication of type, dimensions and material),
5. transport drawing,
6. transport plate,
7. identification plate and wiring diagram (in Slovenian),
8. dimensional drawing of bushings,
9. dimensional drawings of cabinets on the transformer (cooling, protection and signaling control cabinet, OTLC cabinet, transformer on-line monitoring system cabinet, SIOT cabinet, etc.),
10. plates of all valves and position markings,
11. operating diagrams of the cooling system, measurement system and primary protection of the transformer,
12. diagram of permissible short-term and long-term overloads,
13. technical documentation of the on load tap changer,
14. documents for reviewing the winding plan and active part,
15. calculation of the efficiency of the cooling system,
16. no-load and short-circuit characteristics (calculated data),

17. noise calculation,
18. calculation of transformer resistance to forces arising in a short circuit,
19. list of equipment and materials of the active part with indication of manufacturers,
20. calculation of earthquake resistance,
21. proposal for the transformer foundation (in accordance with the drawing from this tender),
22. preliminary list of alarms and signaling with a description of the transmitters,
23. data on the power of the cooling system consumers and other motor drives,
24. control switch operation diagrams,
25. report on the drying process,
26. method of performing core grounding,
27. plan for laying control, signal, measurement and power cables through the transformer,
28. anti-corrosion protection system,
29. QC protocols of input materials of the active part and tank,
30. instructions for QA/QC (for transformer tank, for the transformer as a whole),
31. detailed description of the testing program during the manufacture of the transformer,
32. detailed description of the testing program during transformer installation,
33. detailed information on the monitoring system,
34. location of winding temperature sensors,
35. technical documentation of the winding temperature measurement system using optical sensors,
36. detailed description of testing after installation of transformers at S/S Podlog, S/S Kleče and S/S Divača,
37. the Tenderer must deliver documents (drawings) of the transformer in open BIM 3D format (.IFC format) - (LOD 400). In addition to 3D drawings of transformer elements, the BIM model must also contain all technical data from the transformer design (voltages, weight, etc.),
38. test equipment,
39. test reports and any other documentation related to testing,
40. instructions for operation and maintenance of the transformer and its equipment in Slovenian,
41. impedance model of the transformer for inclusion in Neplan analyses,
42. specification of cables installed on the transformer (own use, control, signaling cables, etc.),
43. transformer installation log at the substation,

44. training program,
45. copy of the technical documentation of the transformer and its equipment with a record of all modifications that were made during manufacture and installation, necessary for the preparation of documentation of the work performed.

When signing the contract, the Tenderer and the Customer will determine the dates for submitting all documents important for tracking the transformer production deadlines (transformer production schedule).

7.2 DOCUMENTATION THAT MUST BE ATTACHED TO THE OFFER

The Tenderer must enclose at least the following documentation with the bid:

1. documents required elsewhere in the tender specification,
2. specification of equipment and parts and completed technical data tables,
3. routine and type tests reports for the same or similar transformer,
4. calculation of cooling system efficiency,
5. no-load and short-circuit characteristics (calculated data),
6. noise calculation,
7. calculation of transformer resistance to forces arising in a short circuit,
8. earthquake resistance calculation,
9. description of the production of the magnetic core and windings and the manufacturing process of the transformer,
10. description and evidence of the adequacy of production processes in accordance with the requirements of Chapter 6,
11. description and evidence of the procedure for performing the final assembly of the transformer in the factory in accordance with the requirements of Chapter 6,
12. preliminary drawings of the transformer,
13. preliminary diagrams of permissible short-term and long-term overloads,
14. data on materials that will be used for the manufacture of cores, windings and winding insulation,
15. drawings, catalogues and brochures of standard elements installed on the transformer and are not specifically required in the tender documentation with a specific manufacturer and type,
16. proposed schedule for the manufacture and delivery of the transformer (schedule in the latest version of MS-Project, in digital and printed form),
17. description of the offered transformer with a description of the operation of the transformer equipment and catalogues and brochures of the equipment,

18. proposed schedule for the submission of documentation for information and approval,

Any deviations from the requirements of the tender documents and the values required in the technical data tables must be stated in the List of Deviations, which must be attached to the tender. If there are no deviations from the required characteristics, this must be clearly stated in the List of Deviations. If the Customer finds that the deviations from the required Technical Specifications are unacceptable, the tender will be rejected as non-compliant.

8 DISASSEMBLY OF THE TRANSFORMER T211 AND T212

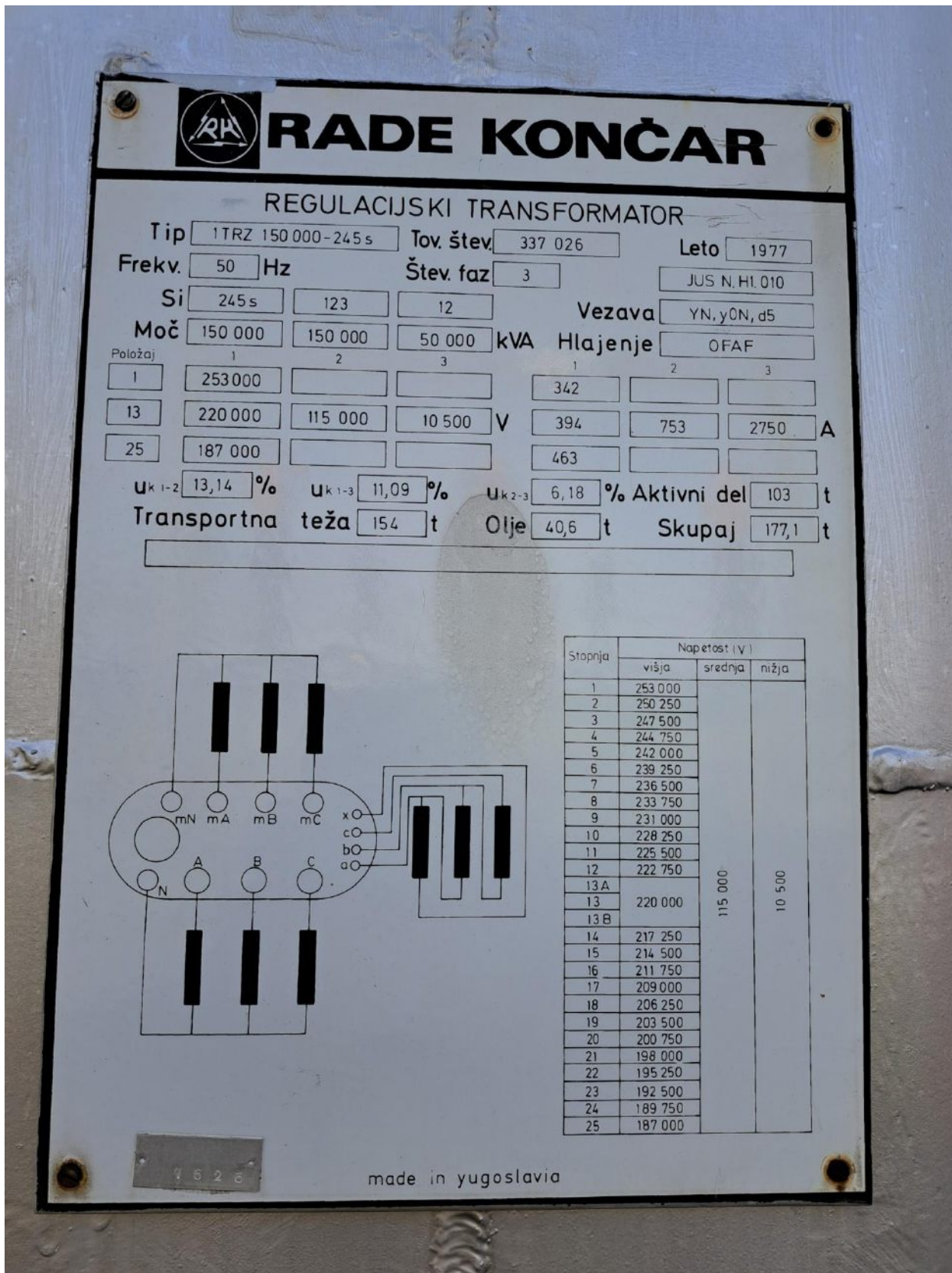
8.1 DESCRIPTION OF THE CURRENT SITUATION IN S/S PODLOG

On the plateau between the 220 kV and 110 kV switchyards in S/S Podlog, two power transformers, T211 and T212 – 220/110 kV with a rated power of 150 MVA – are installed. The tertiary windings of both transformers are connected via busbars to the tertiary house, which is located between the two transformers. Both transformers are included within the scope of dismantling.

8.1.1 *Existing power transformer 220/110 kV - T211*



Picture 3: power transformer 220/110 kV - T211

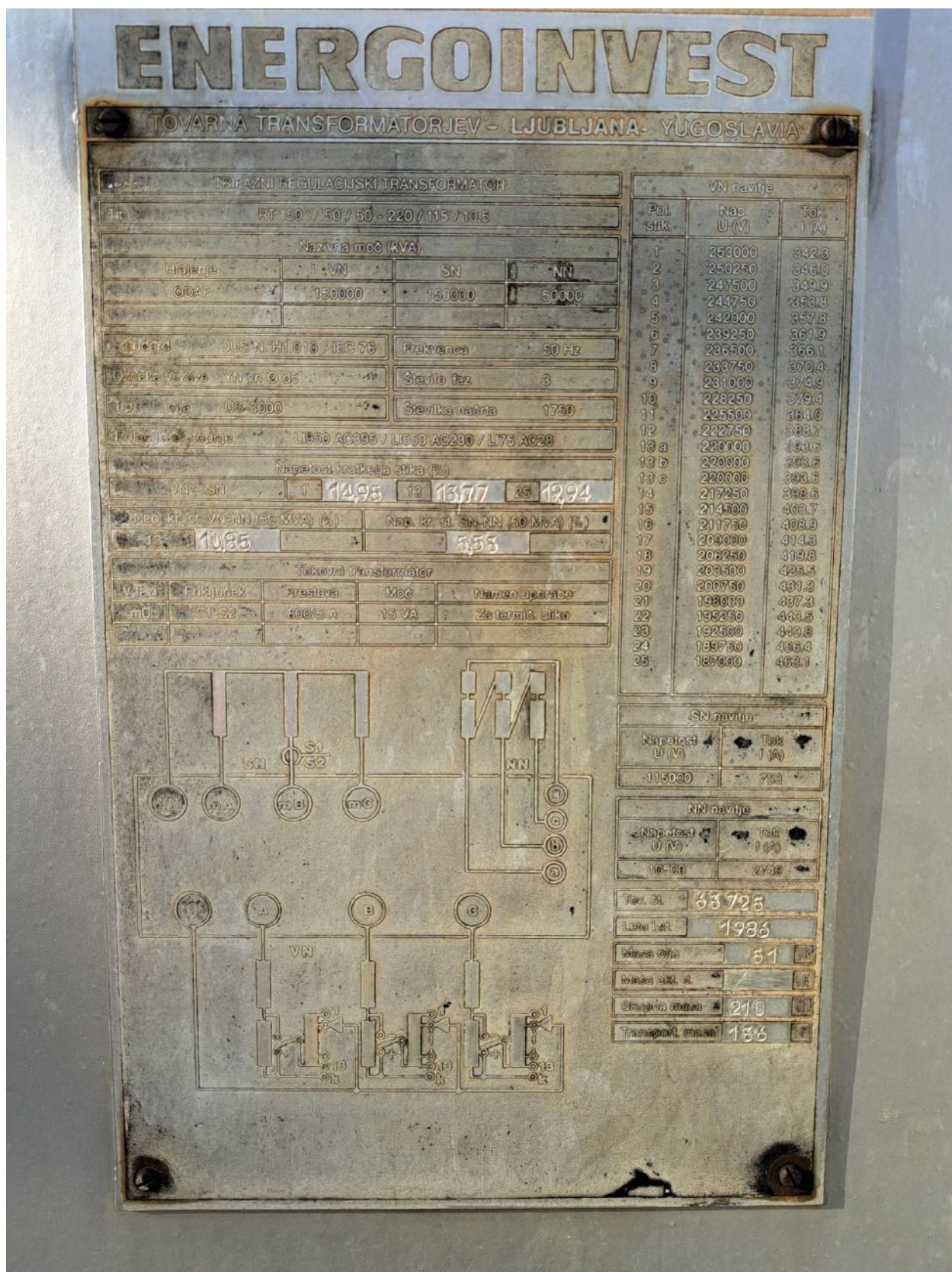


Picture 4: nameplate of power transformer 220/110 kV - T211

8.1.2 Existing power transformer 220/110 kV - T212



Picture 5: power transformer 220/110 kV - T212



Picture 6: nameplate of power transformer 220/110 kV - T212

Due to bad visibility of the nameplate there is also a table with common data of the transformer unit T212:

Rated power:	150 MVA
Vector group:	YN,yn0,d5
Tertiary winding:	50 MVA, 10,5 kV
Short-circuit voltage:	U _{kI-II} 14,95%
	U _{kI-III} 13,77%
	U _{kII-III} 19,94%
Oil weight:	51000 kg
Total weight:	210000 kg

8.2 SCOPE OF WORKS

The subject of this tender documentation is the following electrical installation and other works related to the removal of the existing/old power transformers 220/110 kV T211 and T212:

- dismantling of tertiary connections on the transformers,
- disconnection of grounding connections on the 220/110 kV transformers unit – T211 and T212,
- removal of transformers oil from the transformer units,
- dismantling of all bushings (high-voltage and medium-voltage) and the cooling system,
- dismantling of the conservator and associated pipe connections,
- preparation of the transformer units for transport (protection of the dismantled equipment from possible leakage of insulating oil residues, etc.),
- removal of all equipment to a landfill for dismantling or destruction.

For all equipment delivered, the service provider must obtain records of dismantling and destruction at the landfill, which must be handed over to the Customer after the entire service has been performed. All procedures for delivery to the landfill and destruction must be carried out in accordance with applicable legislation in the field of waste management and other hazardous substances.

8.3 ENVIRONMENTAL PROTECTION

The Customer is obliged to provide all necessary services in accordance with the SIST EN ISO 14001 standard. All procedures for providing the service must be carried out in accordance with the requirements arising from this standard and its subordinate standards. The Tenderer is responsible for environmental protection on the construction site, for which he must prepare an environmental protection report, which must be in line with the requirements arising for the Customer from the SIST EN ISO 14001 standard and its subordinate standards, and approved

by the Customer. A copy of the approved report must be given to everyone who will carry out work on the construction site. The report must also address the handling, storage and transport of various oils and other hazardous substances.

The Tenderer must provide equipment and procedures for action in the event of a spill of oil or other chemicals.

The Tenderer is responsible and obliged to arrange the collection, sorting and disposal of waste on the construction site that would arise during the dismantling and removal of equipment.

When implementing environmental protection measures, the Tenderer must comply with at least all laws and regulations in this area in the Republic of Slovenia, as well as the Customer's internal procedures and requirements.

8.4 TRANSPORT WITHIN THE SUBSTATION FENCE

The transport routes for the removal of old transformers and the delivery of new ones outside the S/S are clear. The Podlog S/S is accessible via the E57 motorway to the exit Žalec or Ločica ob Savinji towards Podlog and then via the regional roads of the second order to the facility. All transport must comply with the regulations governing the planning and construction of roads and bridges and road safety regulations. Within the S/S, transport along the routes that were planned for the transport of transformers during the construction of the switchyard is possible.



Picture 7: display of the existing transport route for 220/110 kV power transformers with rails

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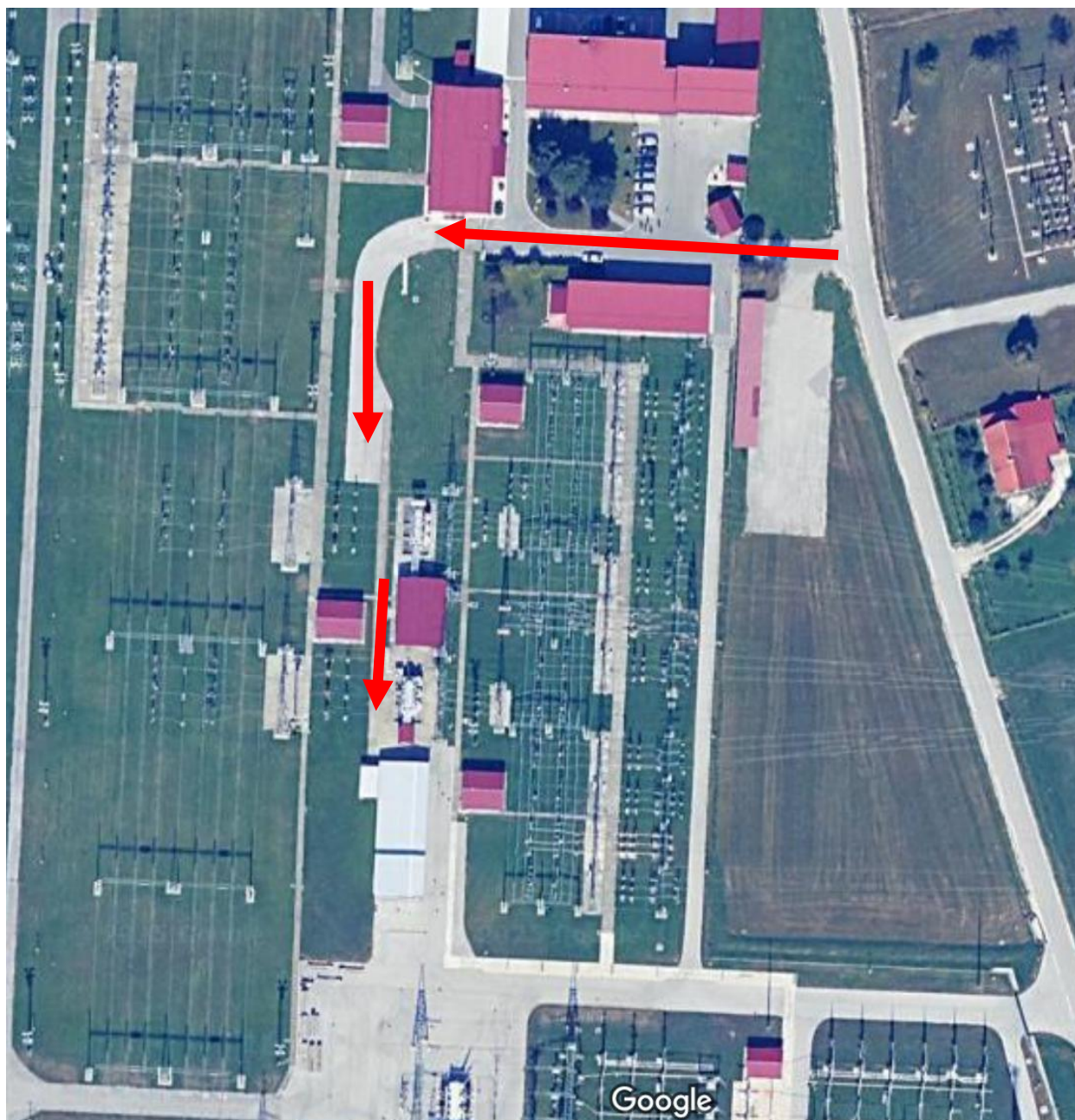
However, the transport of transformer units (removal of old and delivery of new ones) is possible via an internal route and rails, which bypasses the S/S's auxiliary facilities and provides access to both transformer units.



Picture 8: display of the existing transport route for 220/110 kV power transformers with rails



Picture 9: display of the transport route with rails



Picture 10: floor plan of the new transport route for both 220/110 kV power transformers

The bidder must view the entire transport route or all necessary handling areas before submitting the bid.

8.5 S/S KLEČE – T211

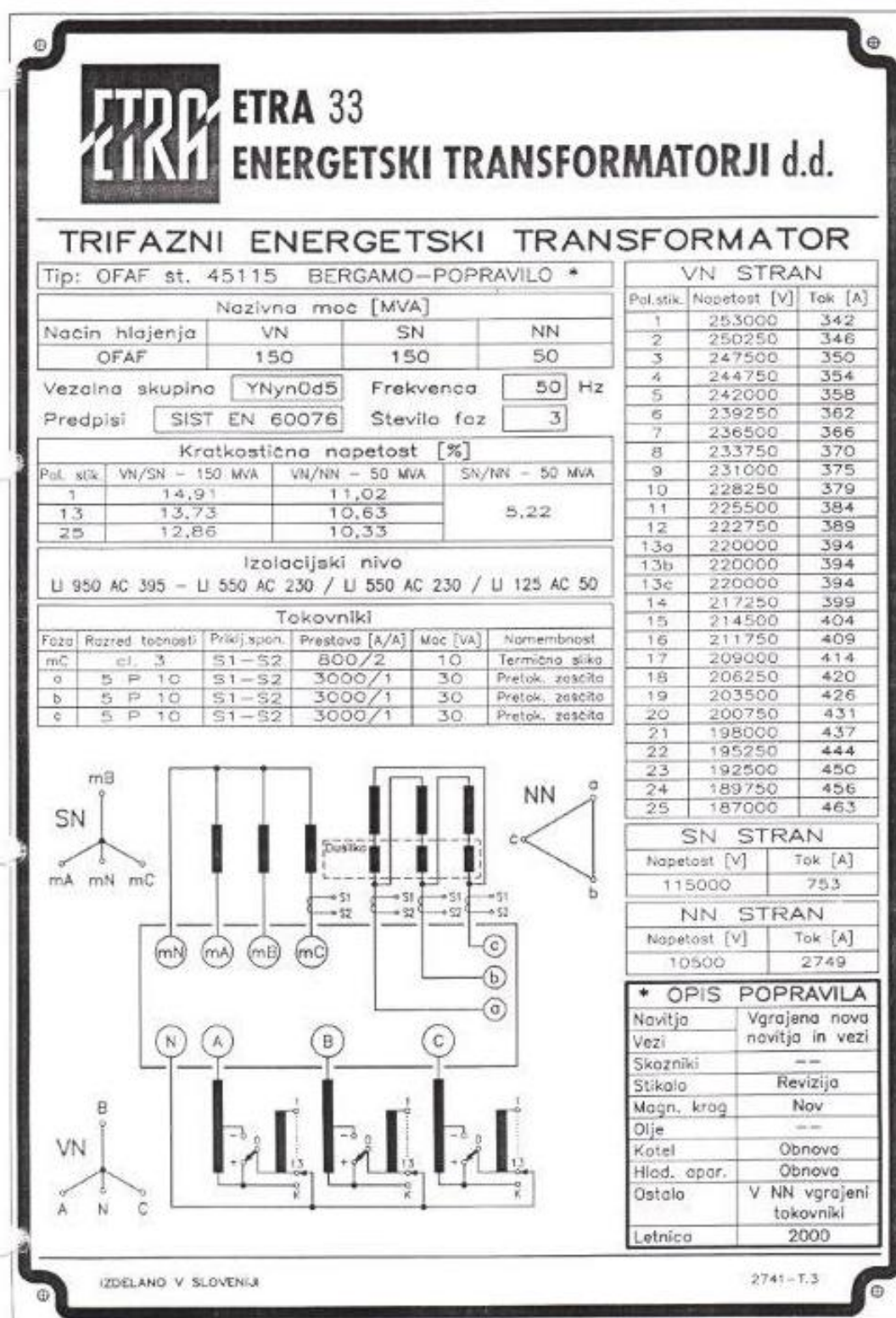
8.5.1 *Description of the current situation*

On the plateau between the 220 kV and 110 kV switchyards, two power transformers, T211 and T212 – 220/110 kV with a rated power of 150 MVA – are installed. The tertiary windings of both transformers are connected via busbars to the tertiary house, which is located between the two transformers. Transformer T211 is included within the scope of dismantling.

8.5.2 *Existing power transformer 220/110 kV - T211*



Picture 11: power transformer 220/110 kV - T211



Picture 12: nameplate of power transformer 220/110 kV - T211

Rated power:	150 MVA
Vector group:	YN,yn0,d5
Tertiary winding:	50 MVA, 10,5 kV
Short-circuit voltage:	U _{kI-II} 14,91%
	U _{kI-III} 13,73%
	U _{kII-III} 12,86%
Oil weight:	40600 kg
Total weight:	177100 kg

8.5.3 *Scope of works*

The subject of this tender documentation is the following electrical installation and other works related to the removal of the existing/old power transformer 220/110 kV T211:

- dismantling of tertiary connections on the transformers,
- disconnection of grounding connections on the 220/110 kV transformer unit – T211,
- removal of transformer oil from the transformer unit,
- dismantling of all bushings (high-voltage and medium-voltage) and the cooling system,
- dismantling of the conservator and associated pipe connections,
- preparation of the transformer unit for transport (protection of the dismantled equipment from possible leakage of insulating oil residues, etc.),
- removal of all equipment to a landfill for dismantling or destruction.

For all equipment delivered, the service provider must obtain records of dismantling and destruction at the landfill, which must be handed over to the Customer after the entire service has been performed. All procedures for delivery to the landfill and destruction must be carried out in accordance with applicable legislation in the field of waste management and other hazardous substances.

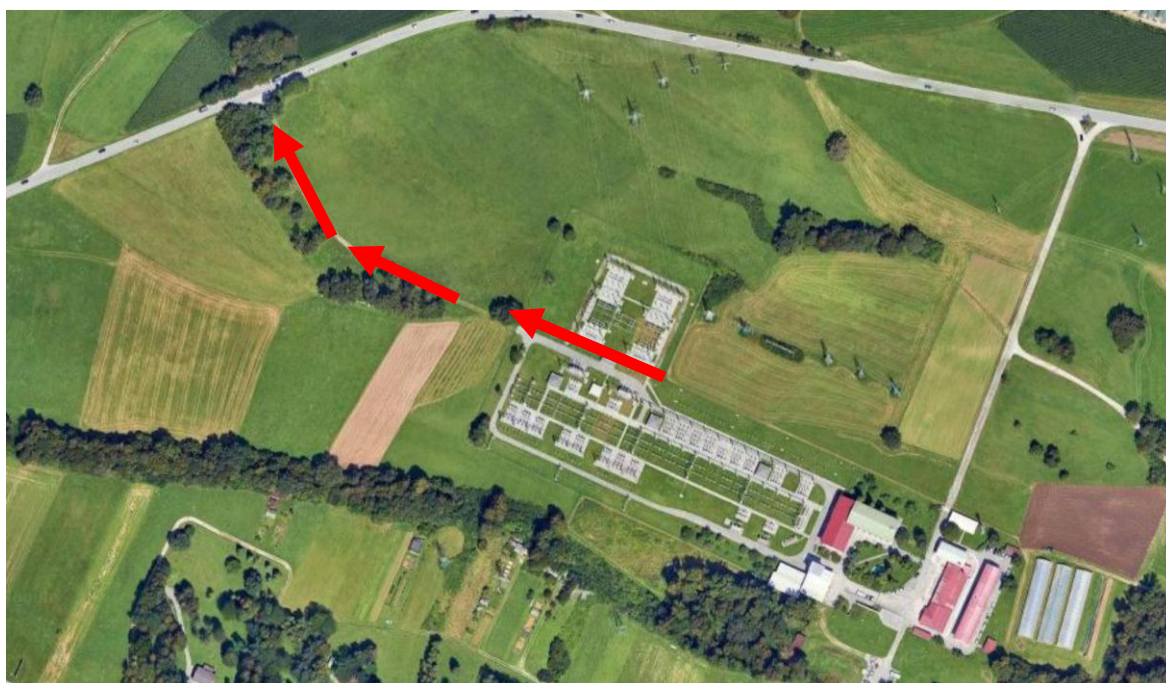
8.5.4 *Transport within the substation fence*

The transport routes for the removal of old transformer and the delivery of new ones outside the S/S are clear. The S/S Kleče is accessible via the E61 motorway towards Kleče and then via the regional road Nemška cesta to the facility. All transport must comply with the regulations governing the planning and construction of roads and bridges and road safety regulations. Within the S/S, transport along the routes that were planned for the transport of transformers during the construction of the switchyard is possible.

However, the transport of transformer unit (removal of old and delivery of new ones) is possible via an internal route.



Picture 13: display of the existing transport route for 220/110 kV power transformer



Picture 14: floor plan of the new transport route for both 220/110 kV power transformer

The bidder must view the entire transport route or all necessary handling areas before submitting the bid.

8.6 S/S DIVAČA – T212

8.6.1 Description of the current situation

The existing power transformer T212 is a unit manufactured by Rade Končar. The transformer is three-phase and equipped with an on-load tap changer; it was manufactured in 1982.

Two transformer units (T211 and T212) are installed on the transformer platform between the 110 kV and 220 kV outdoor switchyards. The scope of dismantling and installation of the new transformer T212.

8.6.2 Existing power transformer 220/110 kV - T212



Picture 15: power transformer 220/110 kV - T212

Rated power:	150 MVA
Vector group:	YN,yn0,d5
Tertiary winding:	220+-12x1,25/115 kV
Short-circuit voltage:	50 MVA, 10,5 kV
	U _{KI-II} 13,22%
	U _{KI-III} 11,25%
Oil weight:	U _{KII-III} 6,17%
Total weight:	40600 kg
	177100 kg

8.6.3 *Scope of works*

The subject of this tender documentation is the following electrical installation and other works related to the removal of the existing/old power transformer 220/110 kV T212:

- dismantling of tertiary connections on the transformers,
- disconnection of grounding connections on the 220/110 kV transformer unit – T212,
- removal of transformer oil from the transformer unit,
- dismantling of all bushings (high-voltage and medium-voltage) and the cooling system,
- dismantling of the conservator and associated pipe connections,
- preparation of the transformer unit for transport (protection of the dismantled equipment from possible leakage of insulating oil residues, etc.),
- removal of all equipment to a landfill for dismantling or destruction.

For all equipment delivered, the service provider must obtain records of dismantling and destruction at the landfill, which must be handed over to the Customer after the entire service has been performed. All procedures for delivery to the landfill and destruction must be carried out in accordance with applicable legislation in the field of waste management and other hazardous substances.

8.6.4 *Transport within the substation fence*

Within the substation, transport along the routes originally intended for transformer delivery during the construction of the 220 kV switchyard is no longer feasible. At that time, transport into the switchyard was carried out via rail tracks from the yard between the substation buildings, through the erection tower, and between the 110 kV and 220 kV switchyards to the transformer foundation locations. These rail tracks have since been removed, transport through the erection tower is no longer possible, and road transport along the (now too narrow) route between the 110 kV and 220 kV switchyards is also not feasible due to both width constraints and height restrictions imposed by the 110 kV outgoing feeders.



Picture 16: Layout of the existing transport route for 110/35 kV and 220/110 kV power transformers

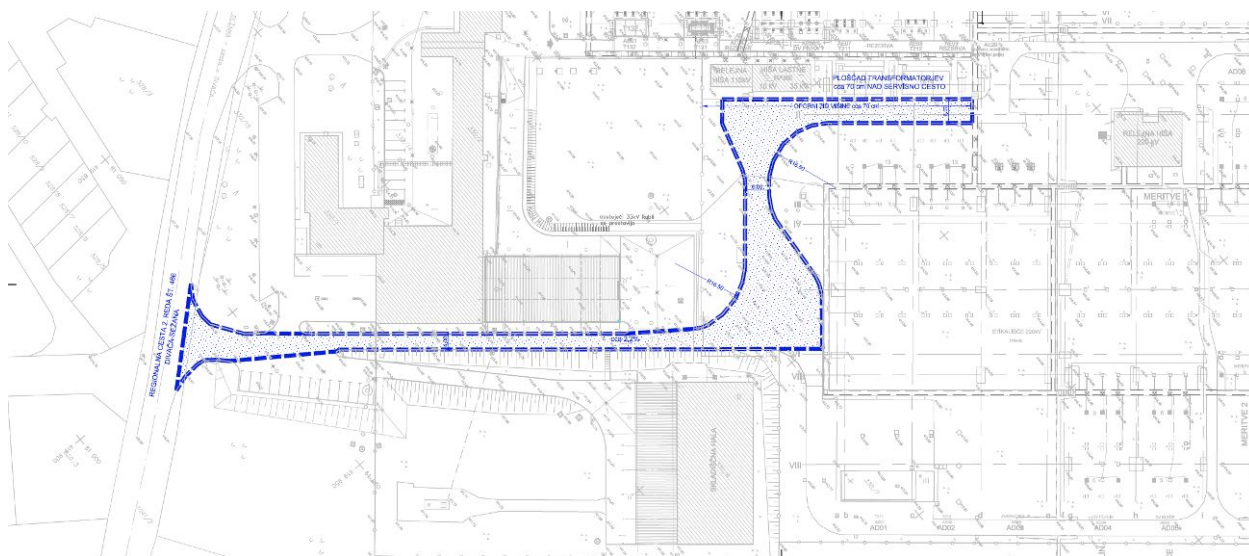
However, transport of transformer units (removal of existing units and delivery of new ones) is feasible via an internal route that bypasses the auxiliary facilities of the S/S Divača and provides access to both transformer units from the southeast side (i.e., from the 220 kV switchyard side).

It should be noted that the elevation of this route is approximately 80 cm lower than the elevation of the transformer foundation level, which will require appropriate adaptation of the logistics for both the removal of existing units and the installation of new transformer unit.

Along the edge of the 220 kV switchyard runs the existing 110 kV overhead line Pivka–Divača 110 kV transmission line.



Picture 17: Layout of the new transport route for both 220/110 kV power transformers



Slika 18: Floor plan of the new transport route for both 220/110 kV power transformer

The bidder must view the entire transport route or all necessary handling areas before submitting the bid.

8.7 OTHER INFORMATION



The Tenderer must take into account the phasing of the works, the schedule and the current energy situation. The Customer may also request work during night hours and Saturday and Sunday work, while the Tenderer must take into account the Customer's working hours (from 7:00 to 15:00). All work outside regular working hours must be coordinated with the Customer.

8.8 DISASSEMBLY REQUIREMENTS

Regardless of the description given below and the specifications in the tender list of prices, the Tenderer for the removal of the existing power transformer is obliged to carry out all work that will enable its safe disassembly and removal. Before the start of work related to the removal of the power transformer, the Tenderer for the electrical installation works will, under another contract, carry out some electrical installation work that will enable the removal of the power transformers (dismantling of high-voltage connections from the power transformer connections, dismantling of all control, signal and power supply connections).

Before the start of the work, the service provider is obliged to coordinate all its activities related to the removal of the power transformer with other Tenderers who will be present at the S/S Podlog, S/S Kleče and S/S Divača facilities during the performance of its work.

If the Tenderer determines that any task is not specified in the tender estimate and that this work is urgently needed, it must adjust the unit price accordingly to the most reasonably similar unit price in the Tender Estimate.

Revision:		Revision note:		Revision date:		Signature:	
Investitor:				Facility:			
				S/S 400/220/110 kV Podlog			
Projektant:				Part of facility/system:			
 IBE, svetovanje, projektiranje in inženiring Ljubljana, Slovenija				Supply of power transformer 220/110 kV, 150 MVA			
				Type of design:			
				3 ELECTRICAL INSTALLATION AND ELECTRICAL EQUIPMENT			
		First name/Name:		Id. No.:		Title of document:	
Approved by:		mag. Marko Testen, univ. dipl. inž. el		E-1293			
Confirmed by:		mag. Marko Testen, univ. dipl. inž. el		E-1293			
Checked by:				Desogn doc. No.:		R4PO01-A025/645	
Designed by:		mag. Marko Testen, univ. dipl. inž. el		E-1293		Vrsta projekta: DZR	
				Classification No.:		Stran/ strani: 0/8	
Date:		25.05.2026		Scale:		Identification No.:	
						R 4 P O 0 1 - 6 E 2 0 0 6 , Spr.:	

1. INSTRUCTIONS FOR COMPLETING SCHEDULES OF TECHNICAL DATA

The Tenderer must fill in all data boxes in the schedules.

When filling in the schedules, it is necessary to take into account that satisfying the parameters listed in the "Requested data" column is mandatory.

If all the boxes in the schedule in the "Tenderer data" column are not filled in, the table will be invalid and the bid will be eliminated. Where the boxes in the "Requested data" column are empty, the tenderer must indicate the value of the equipment offered in the "Tenderer data" column. Where the boxes in the "Requested data" column are filled in, the bidder must indicate a value in the "Tenderer data" column that is at least equal to the requested value, otherwise the bid will be eliminated.

Compliance with the values required in the schedules must also be evident from other technical documentation attached to the offer (equipment descriptions, other data tables, diagrams, copies of type and other tests, etc.)

Example:

No.	Description	Unit	Requested data	Tenderer data (guaranteed value)
1	Rated output power	MVA	150	150

Transformer technical data

NOTE: Transformer 220/110 kV with power rating 150 MVA with technical data as requested in the schedule bellow

Schedules of technical data

No.	Description	Unit	Requested data	Tenderer data (guaranteed value)
GENERAL DATA				
1	Manufacturer / Country of origin			
2	Type			
GUARANTED VALUES				
NOMINAL VALUES				
3	Rated power	MVA	150	
4	Rated voltage (U_r), no-load:			
	- High voltage (HV)	kV	220	
	- Low voltage (LV)	kV	115	
	- tertiary winding (TV)	kV	10,5	
5	Short time withstand current (2 sec):			
	- HV winding	kA	50	
	- LV winding	kA	50	
	- Tertiary winding	kA		
6	Vector group		YNyn0+d5	
7	Manufacturer / Type		Reinhausen, tip Vacutap VRS III 700Y	
8	On load tap changer	%	$\pm 12 \times 1,25$	
9	Tertiary winding rated power	MVA		
10	Homopolar impedance (Z_0) - at any winding combination	%		
11	Short circuit voltage HV-LV at 75°C in percentage of the rated voltage at the following tap changer steps:			
	- at the higher position (+15 %)	%		
	- at the neutral position (+0 %)	%	13 \pm 7,5 %	
	- at the lower position (-15 %)	%		
12	Short circuit voltage HV-Tertiary winding at 75°C in percentage of the rated voltage, at the neutral tap changer position (+0 %)	%		
13	Short circuit voltage LV-Tertiary winding at 75°C in percentage of the rated voltage, at the neutral tap changer position (+0 %)	%		
14	No load current in percentage of the rated current at:			
	- 90 % rated voltage	%		
	- 100 % rated voltage	%		
	- 105 % rated voltage	%		
	- 111 % rated voltage	%		
15	Grounding of the neutral point			
	- HV winding - isolation level		Li 750/325	
	- HV winding - type		effectively	
	- LV winding - isolation level		Li 550/230	
	- LV winding - type		effectively	
LOSSES (acc. to Technical specifications)				
16	No load losses at rated voltage, 50 Hz, $P_o(U_r)$	kW	≤ 60	
17	No load losses at 111% of rated voltage, 50 Hz (245 kV)	kW	$\leq 1,3 P_o(U_r)$	
18	Short circuit losses at winding temperature 75°C and neutral tap changer position	kW		
19	PEI (acc. to: »Commission Regulation (EU) 2019/1783« including revisions)	%	$\geq 99,787$	
TEMPERATURE RISE				
20	Max. temperature rise at rated power (S_r) and highest environment temperature:			
	- upper oil (measurement with thermometer on the top of the tank)	K	50	
	- windings (calculated value, based on measured resistance)	K	55	
21	Temperature rise at the winding hot spot	K	70	
INSULATION LEVELS				
22	Insulation level of:			
	- HV winding and neutral (non uniform insulation)	kV	245	
	- LV winding (uniform insulation)	kV	123	
	- tertiary winding	kV	24	

Schedules of technical data

No.	Description	Unit	Requested data	Tenderer data (guaranteed value)
23	Separate-source power-frequency over voltage 50 Hz, 60 s:			
	- HV neutral	kV rms	325	
	- LV winding and neutral	kV rms	230	
	- Tertiary winding	kV rms	50	
	- test time duration	s	60	
24	Induced over voltage withstand level of:			
	- HV winding	kV rms		
	- LV winding	kV rms		
	- Tertiary winding	kV rms		
	- test voltage	Hz		
	- test time duration	s		
25	Impulse over voltage withstand level of:			
	- HV winding - lightning impulse	kV	1050	
	- HV winding - switching impulse	kV	850	
	- HV neutral point - lightning impulse	kV	750	
	- LV winding - lightning impulse	kV	550	
	- LV neutral point - lightning impulse	kV	550	
	- tertiary winding - lightning impulse	kV	125	
TRANSFORMATOR OIL AND PAPER				
26	Insulating paper after transformer drying:			
	- transformer paper manufacturer		Wiedmann	
	- degree of polymerisation (DP) - average value		≥1100	
	- degree of polymerisation (DP) - value for particular sample		≥1050	
	- moisture content	%	≤0,5	
27	Transformer oil (before filling):			
	- quantity of oil per transformer	t		
	- manufacturer		Nynas or Ergon	
	- supplier's designation		Nytro 4000 X or HyVolt III	
	- grade of oil		IEC 60296, type TVAI	
28	Factory tests:			
	Additional criteriums of transformer oil to be performed after heat run, dielectric test and all other tests:		max. increase	
	- H ₂ (hydrogen)	μl/l (ppm)	< 10	
	- CH ₄ (methane)	μl/l (ppm)	< 5	
	- C ₂ H ₆ (ethylene)	μl/l (ppm)	< 5	
	- C ₂ H ₄ (ethylene)	μl/l (ppm)	< 2	
	- C ₂ H ₂ (acetylene)	μl/l (ppm)	< 0,1	
	- 2 FAL (2-furfural)	μl/l (ppm)	< 0,01	
29	Transformer oil after filling in transformer before energization			
	Oil quality level acc to IEC 60422 Tabel 3, with the exception of additional requirements from the client:			
	- moisture content acc. to IEC 60814	mg/kg (ppm)	max. 5	
	- acidity acc. to IEC 62021-1	mg KOH/g	max. 0,01	
	- interfacial tension aac. to ASTM D971	mN/m	min. 40	
	- antioxidant content acc. to IEC 60666	% (m/m)	min. 0,37	
	- FTIR fingerprint spectral matching of oil samples taken from the transformer before FAT and after filling the transformer		matching spectral overlap	

Schedules of technical data

No.	Description	Unit	Requested data	Tenderer data (guaranteed value)
BUSHINGS				
30	HV bushings:			
	- manufacturer		Hitachi Energy	
	- type			
	- material		Composite	
	- insulation level	kV	245	
	- rated voltage	kV		
	- rated current	A		
	- power frequency over voltage withstand test - on dry	kV rms		
	- power frequency over voltage withstand test - on wet	kV rms		
	- impulse over voltage withstand voltage - lightning impulse	kV		
	- cantilever force maximum	N		
	- creepage distance	mm/kV	≥27,8	
	- creepage distance	mm		
	- terminal design (1U, 1V, 1W):			
	-material		Aluminium	
	- diameter	mm	40	
31	HV neutral bushing:			
	- manufacturer		Hitachi Energy	
	- type			
	- material		Composite	
	- insulation level	kV	170	
	- rated voltage	kV		
	- rated current	A		
	- power frequency over voltage withstand test - on dry	kV rms		
	- power frequency over voltage withstand test - on wet	kV rms		
	- impulse withstand voltage - lightning impulse	kV		
	- cantilever force maximum	N		
	- creepage distance	mm/kV	≥27,8	
	- creepage distance	mm		
	- terminal design (1N):			
	-material		Aluminium	
	- diameter	mm	40	
32	LV bushings:			
	- type			
	- manufacturer			
	- material		Composite	
	- insulation level	kV	123	
	- rated voltage	kV		
	- rated current	A		
	- power frequency over voltage withstand test - on dry	kV rms		
	- power frequency over voltage withstand test - on wet	kV rms		
	- impulse withstand voltage - lightning impulse	kV		
	- cantilever force maximum	N		
	- creepage distance	mm/kV	≥27,8	
	- creepage distance	mm		
	- terminal design (2U, 2V, 2W):			
	-material		Aluminium	
	- diameter	mm	40	

Schedules of technical data

No.	Description	Unit	Requested data	Tenderer data (guaranteed value)
33	LV neutral bushing:			
	- manufacturer		Hitachi Energy	
	- type			
	- material		Composite	
	- insulation level	kV	123	
	- rated voltage	kV		
	- rated current	A		
	- power frequency over voltage withstand test - on dry	kV rms		
	- power frequency over voltage withstand test - on wet	kV rms		
	- impulse withstand voltage - lightning impulse	kV		
	- cantilever force maximum	N		
	- creepage distance	mm/kV	≥27,8	
	- creepage distance	mm		
	- terminal design (2N):			
	-material		Aluminium	
	- diameter	mm	40	
34	TV bushing:			
	- manufacturer			
	- type			
	- material		Porcelain or Composite	
	- insulation level	kV	24	
	- rated voltage	kV		
	- rated current	A		
	- short time current (1s)	kA		
	- power frequency over voltage withstand test - on dry	kV rms		
	- power frequency over voltage withstand test - on wet	kV rms		
	- impulse over voltage withstand voltage - lightning impulse	kV		
	- cantilever force maximum	N		
	- creepage distance	mm	min. 480	
COOLING SYSTEM ONAN/ONAF				
35	Relation between ONAN/ONAF	%	60/100	
36	Number of radiators			
37	Rated power of cooling fan motor	kW		
38	Total number of cooling fans per transformer			
39	Number of cooling fans per step			
40	Total load of cooling system, at the same time operation	kW		
41	Max. number of cooling fans started at the same time			
WASTE HEAT REGENERATION				
42	The oil/water heat exchanger will fit the following closed loop	%	60/100	
43	Number of radiators			
44	Oil/water heat exchanger capacity at an outdoor temperature of -25 °C	kW	150	
45	Water outlet temperature from the heat exchanger	°C	25	
46	Water inlet temperature to the heat exchanger	°C	5	
47	Oil flow indicator			
48	Leak indicator			
49	Regulation oil temperature			
50	Temperature pocket			
MECHANICAL CONSTRUCTION				
51	Maximum withstand pressure in transformer tank (over operation pressure) and pertinent oil pipelines and accessories for 24 hours without leakage - acc. to IEC 60076-1-11.8	kPa		
52	Minimum vacuum in transformer tank and in pertinent oil pipelines nad accessories without permanent distortion - acc. to IEC 60076-1-11.11	kPa		
53	Sound level measured acc. to IEC 60076-10 at Ur - ONAN	dB (A)	≤ 66	
54	Sound level measured acc. to IEC 60076-10 at Ur - ONAF	dB (A)	≤ 70	

Schedules of technical data

No.	Description	Unit	Requested data	Tenderer data (guaranteed value)
55	Gross weight and maximum dimensions of the heaviest single part to be transported and lifted during site erection works:			
	- weight	t		
	- length	m		
	- width	m		
	- height	m		
56	Gross weight and maximum dimensions of completely assembled transformer, including oil:			
	- weight	t	≤ 250	
	- length	m		
	- width	m		
	- height	m		
57	Total power consumption of all transformer auxiliaries at continuous full load operation	kW		

Schedule 12: Data for transformer foundation calculation - equipment reactions
REACTIONS IN POINT SUPPORTS



Impact/burden	F_x [kN]	F_y [kN]	F_z [kN]
Equipment weight			
Earthquake X			
Earthquake Y			
Earthquake Z			

REACTIONS TO LINE SUPPORTS

Impact/burden	f_{xa} [kN/m]	f_{xb} [kN/m]	f_{ya} [kN/m]	f_{yb} [kN/m]	f_{za} [kN/m]	f_{zb} [kN/m]
Equipment weight						
Earthquake X						
Earthquake Y						
Earthquake Z						

4. DEVIATION LIST

No.	Description of the deviation
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/		/		/			
Sprememba:		Opis spremembe:		Datum spr.:		Podpis:	
Investitor:				Gradnja/Objekt:			
				RTP 400/220/110 kV Podlog / Rekonstrukcija transformacije 220/110 kV			
Projektant:				Del objekta/sistem:			
 IBE, svetovanje, projektiranje in inženiring Ljubljana, Slovenija				/			
/				Vrsta načrta:			
				3 NAČRT S PODROČJA ELEKTROTEHNIKE			
		Ime in priimek:		Ident. št.:		Vsebina risbe (dokumenta):	
Vodja projektiranja:		mag. Marko Testen, univ. dipl. inž. el.		IZS E-1293		Ponudbeni predračun - Dobava transformatorja T211 in T212	
Pooblaščen strokovnjak:		mag. Marko Testen, univ. dipl. inž. el.		IZS E-1293			
						Številka projekta: R4PO01-A025/645	
						Vrsta dokumentacije: DZR	
Izdelal:		/		/		Klasifikac. oznaka: - -	
						Stran/strani: 1/5	
Datum izdelave:		03.2026		Merilo:		/	
						Identifikac. oznaka: R 4 P O 0 1 - 6 E 2 0 1 5	



Rekapitulacija ponudbe JN: Dobava in montaža transformatorjev 220/110 kV, 150 MVA	
Specifikacije	Znesek (brez DDV)
TRANSFORMATOR 220/110 KV	0,00
REZERVNI DELI	0,00
OSTALI STROŠKI	0,00
PONUDBENA VREDNOST	0,00
Nepredvidena dela [%]	1
Vrednost nepredvidenih del	0,00
SKUPNA VREDNOST	0,00



Poz.	Opis opreme ali storitve	Enota	Količina	Vnos cene na enoto	Cena na enoto	Vrednost
	TRANSFORMATOR 220/110 kV					
1	Transformator 220/110 kV, 150 MVA, z regulacijskim stikalom, z vso pomožno opremo	kos	4	0,00	0,00	0,00
2	Montaža transformatorja in spuščanje v pogon	kompl.	4	0,00	0,00	0,00
3	Demontaža starega transformatorja 220/110 kV, 150 MVA, odvoz, razgradnja, predaja na deponijo in odprodaja materiala (strošek/dobiček od prodanega materiala je na strani Ponudnika)	kompl.	4	0,00	0,00	0,00
Skupaj:						0,00



Poz.	Opis opreme ali storitve	Enota	Količina	Vnos cene na enoto	Cena na enoto	Vrednost
	REZERVNI DELI					
4	Skoznji izolator (bushing), Hitachi Energy type: GSA 245-OA/1600 LF	kos	1	0,00	0,00	0,00
5	Skoznji izolator (bushing), Hitachi Energy type: GSA170-OA/1600 LF	kos	1	0,00	0,00	0,00
6	Skoznji izolator (bushing), Hitachi Energy, type: GSA-OA 123/1600 LF	kos	1	0,00	0,00	0,00
				Skupaj:		0,00



Poz.	Opis opreme ali storitve	Enota	Količina	Vnos cene na enoto	Cena na enoto	Vrednost
	OSTALI STROŠKI					
7	Tehnična in tovarniška dokumentacija	kompl.	4	0,00	0,00	0,00
8	Šolanje	kompl.	3	0,00	0,00	0,00
9	Embalaža	kompl.	4	0,00	0,00	0,00
10	Transport	kos	4	0,00	0,00	0,00
11	Zavarovanje	kos	4	0,00	0,00	0,00
12	Garancije	kos	4	0,00	0,00	0,00
Skupaj:						0,00

TEHNIČNI PRIKAZI

INVESTITOR

INVESTITOR 1

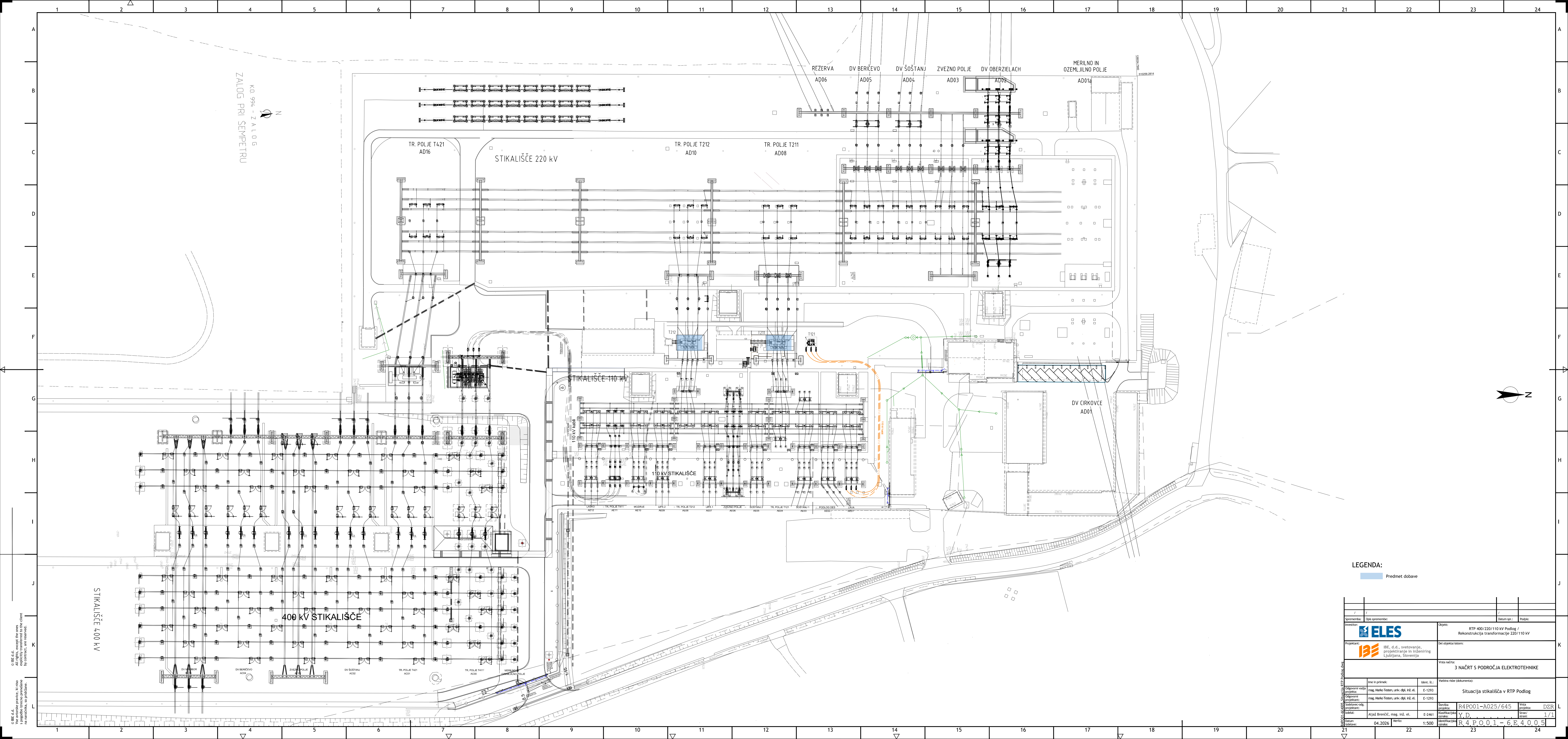
ime in priimek ali naziv družbe	ELES, d.o.o.
naslov ali poslovni naslov družbe	Hajdrihova ulica 2, 1000 LJUBLJANA

PODATKI O GRADNJI

naziv gradnje	RTP 400/220/110 kV Podlog / Rekonstrukcija transformacije 220/110 kV
---------------	--

PODATKI O PROJEKTNIM DOKUMENTACIJAM

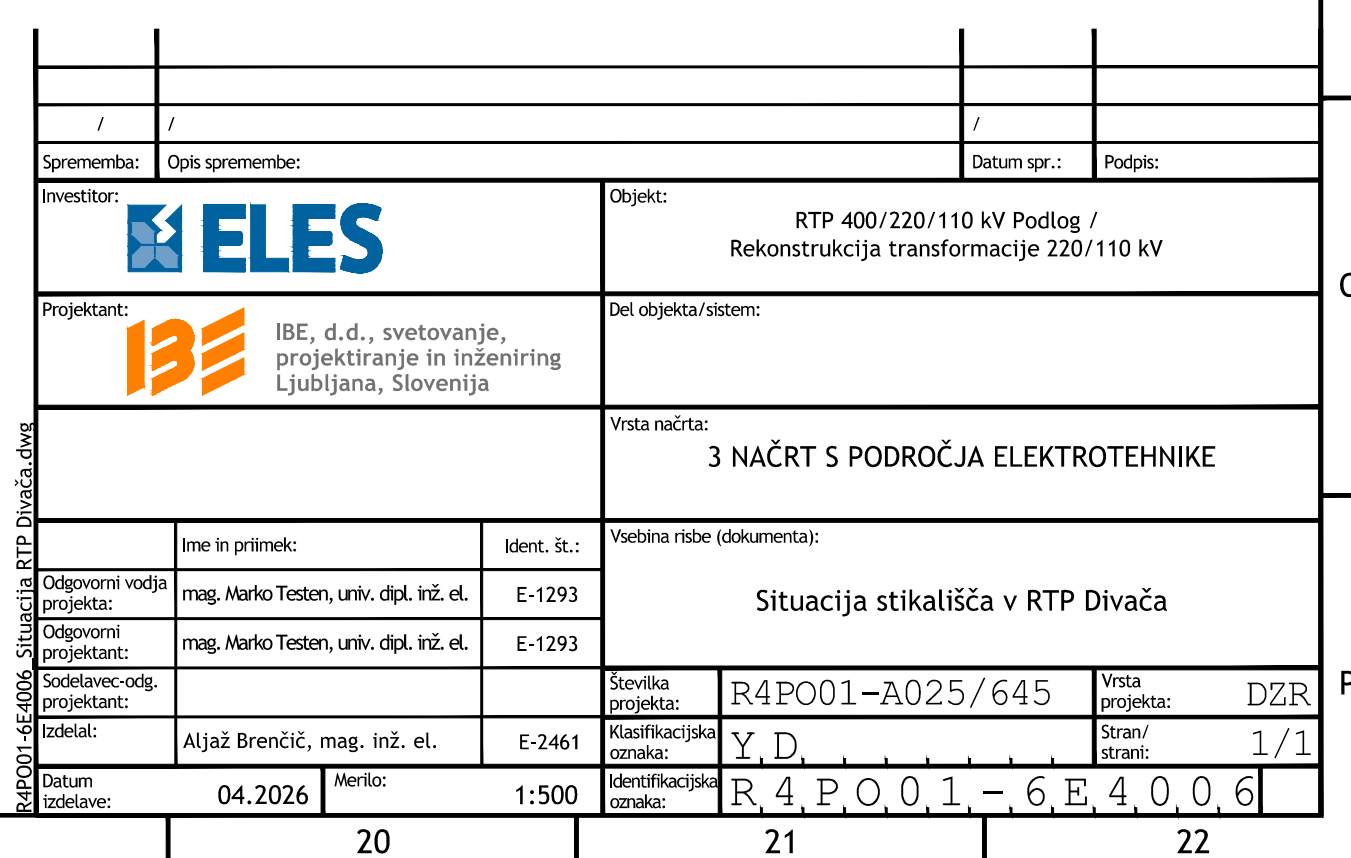
vrsta dokumentacije		Dokumentacija za razpis (DZR)
številka projekta		R4PO01-A025/645
strokovno področje načrta	3	NAČRT S PODROČJA ELEKTROTEHNIKE
naziv načrta	3/5	Dobava transformatorjev T211 in T212
številka načrta		R4PO01-6E/11



LEGENDA:

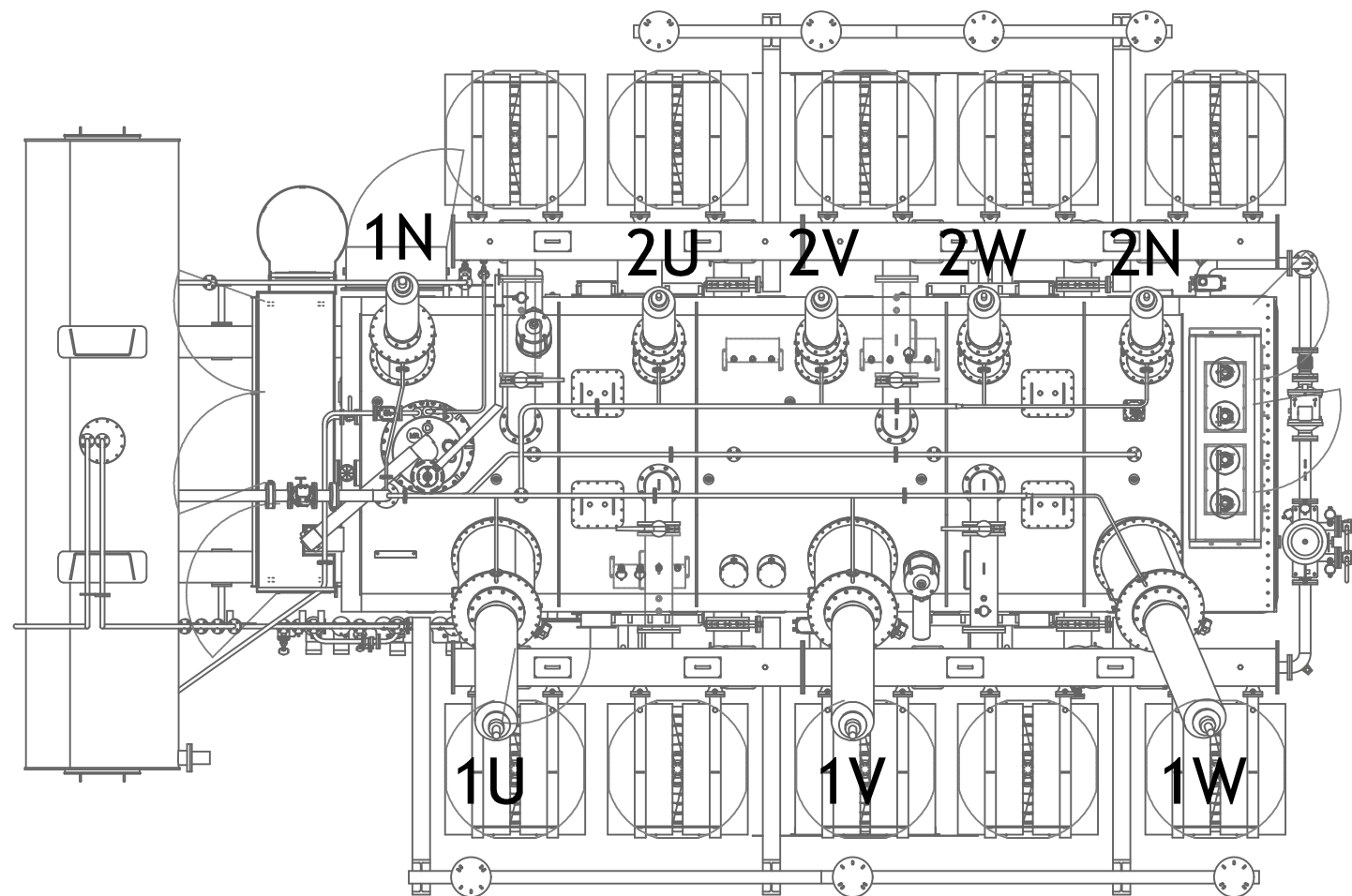
Predmet dobave

Spremembe:		Datum spr.:	
Investitor:		Projekt:	
Projektor:		Del objekta/sistem:	
Vrsta račna:		3 NAČRT S PODROČJA ELEKTROTEHNIKE	
Ime in priimek:		Ident. št.:	
Odgovorni vodja projekta:		Vrednotenje dokumenta:	
Odobreni projektor:		Situacija stikališča v RTP Podlog	
Sodržniški del projekta:		Vrsta projekta:	
Izdelal:		Klasifikacijska oznaka:	
Datum izdaje:		Identifikacijska oznaka:	
		Vrsta projekta:	
		Stran:	
		Stran:	
		1/1	
		R 4 P O 0 1 - 6 E 4 0 0 5	







SPLOŠNA SKICA TRANSFORMATORJA



OPOMBA:

Splošna skica transformatorja velja za dobavo transformatorjev:

- T211 in T212 v RTP Podlog,
- T212 v RTP Divača in
- T211 v RTP Kleče

Sprememba:		Opis spremembe:				Datum spr.:		Podpis:			
Investitor:						Objekt: RTP 400/220/110 kV Podlog / Rekonstrukcija transformacije 220/110 kV					
Projektant:		 IBE, d.d., svetovanje, projektiranje in inženiring Ljubljana, Slovenija				Del objekta/sistem:					
						Vrsta dokumentacije: 3 NAČRT S PODROČJA ELEKTROTEHNIKE					
		Ime in priimek:		Ident. št.:		Vsebina risbe (dokumenta): Fazno zaporedje transformatorja v RTP Podlog, RTP Divača in RTP Kleče					
Vodja projektiranja:		mag. Marko Testen, univ. dipl. inž. el.		IZS E-1293							
Pooblaščen inženir:		mag. Marko Testen, univ. dipl. inž. el.		IZS E-1293							
						Številka projekta:		R4PO01-A025/645		Vrsta projekta: DZR	
Izdelal:		Aljaž Brenčič, mag. inž. el.		IZS E-2461		Klasifikacijska oznaka:		Y_D_		Stran/ strani: 1/1	
Datum izdelave:		06.2025		Merilo:		/		Identifikacijska oznaka:		R_4_P_O_0_1_-_6_E_4_1_9_1	
										spr.	

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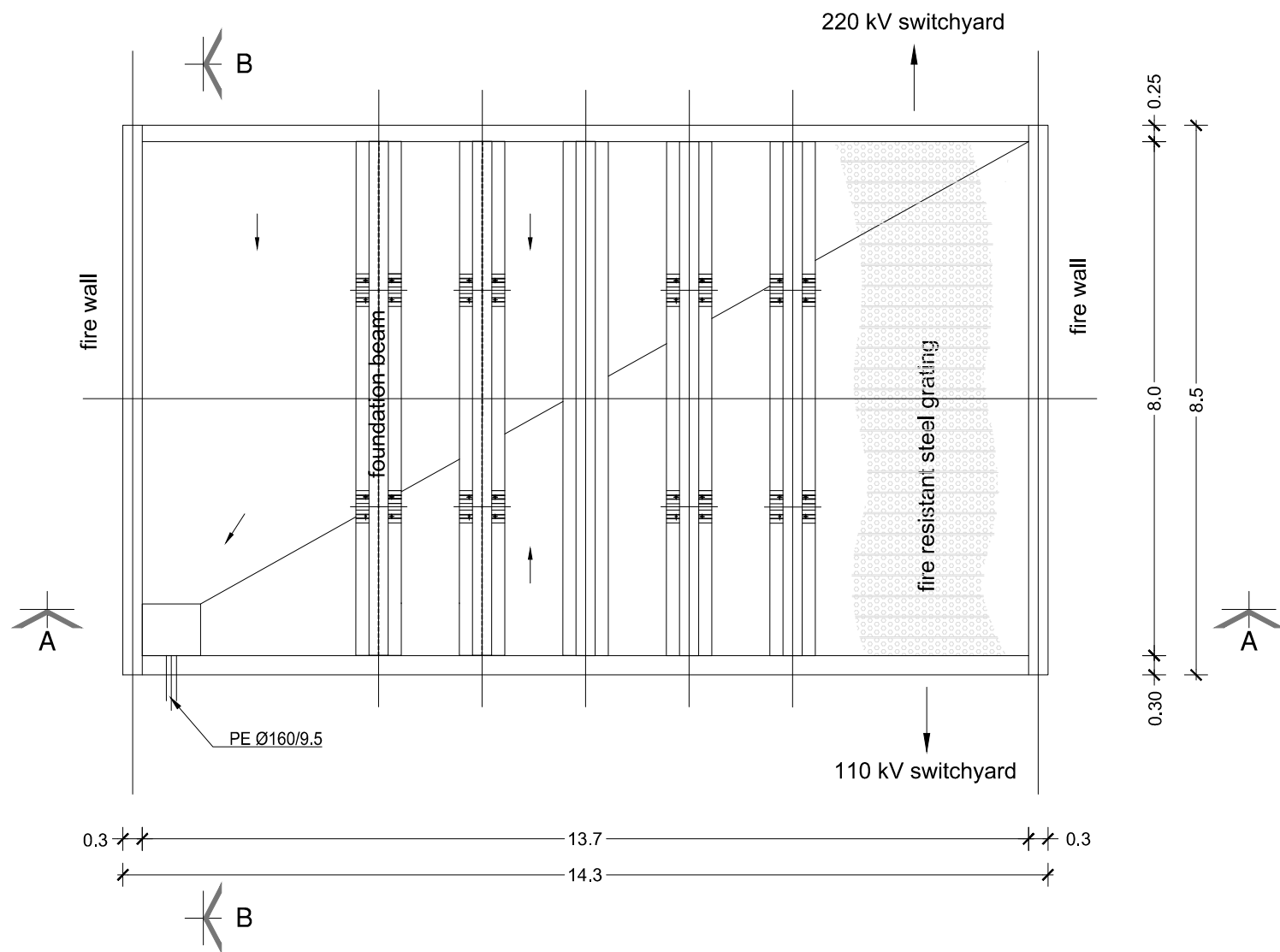
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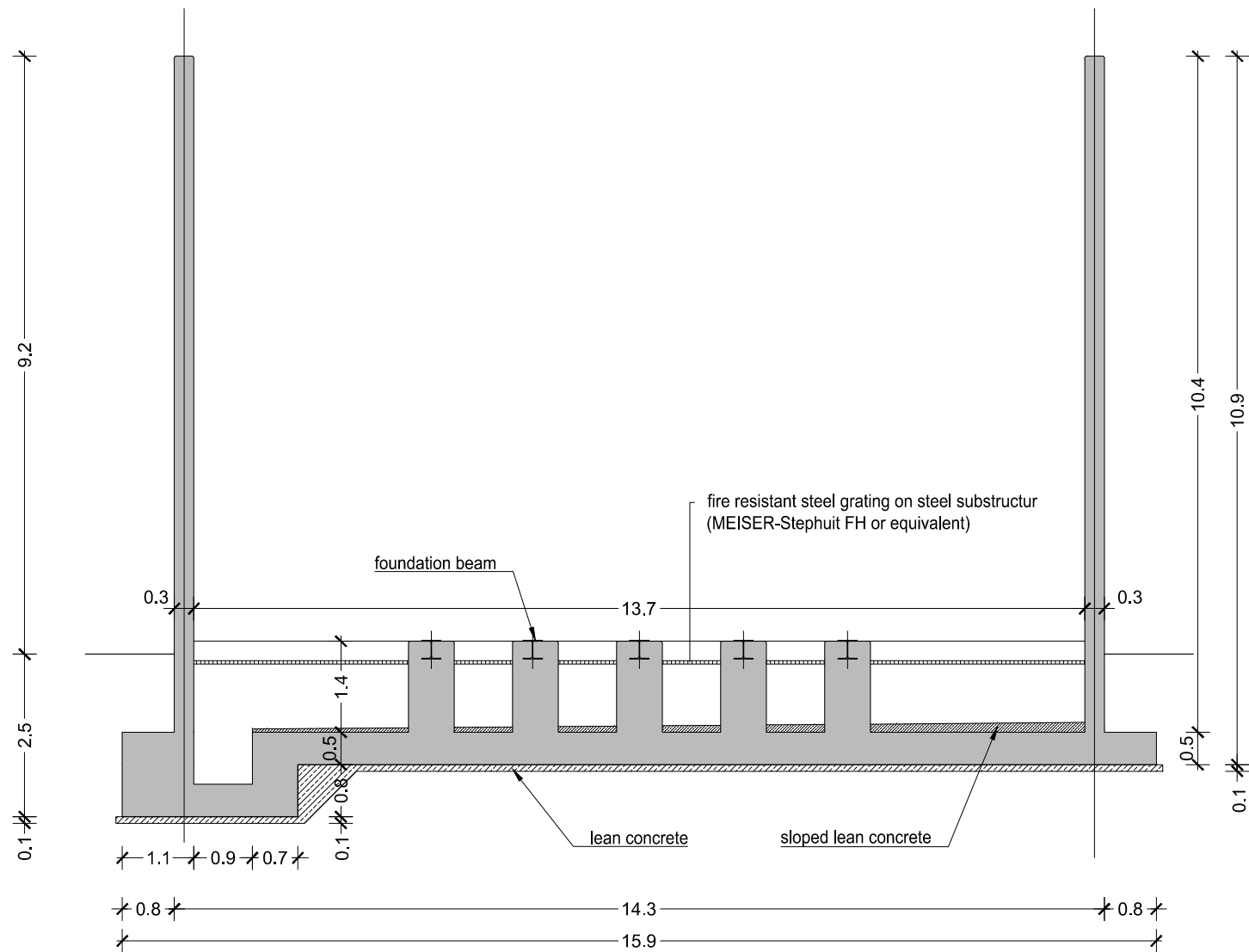
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TRANSFORMER FOUNDATION WITH FIRE WALLS

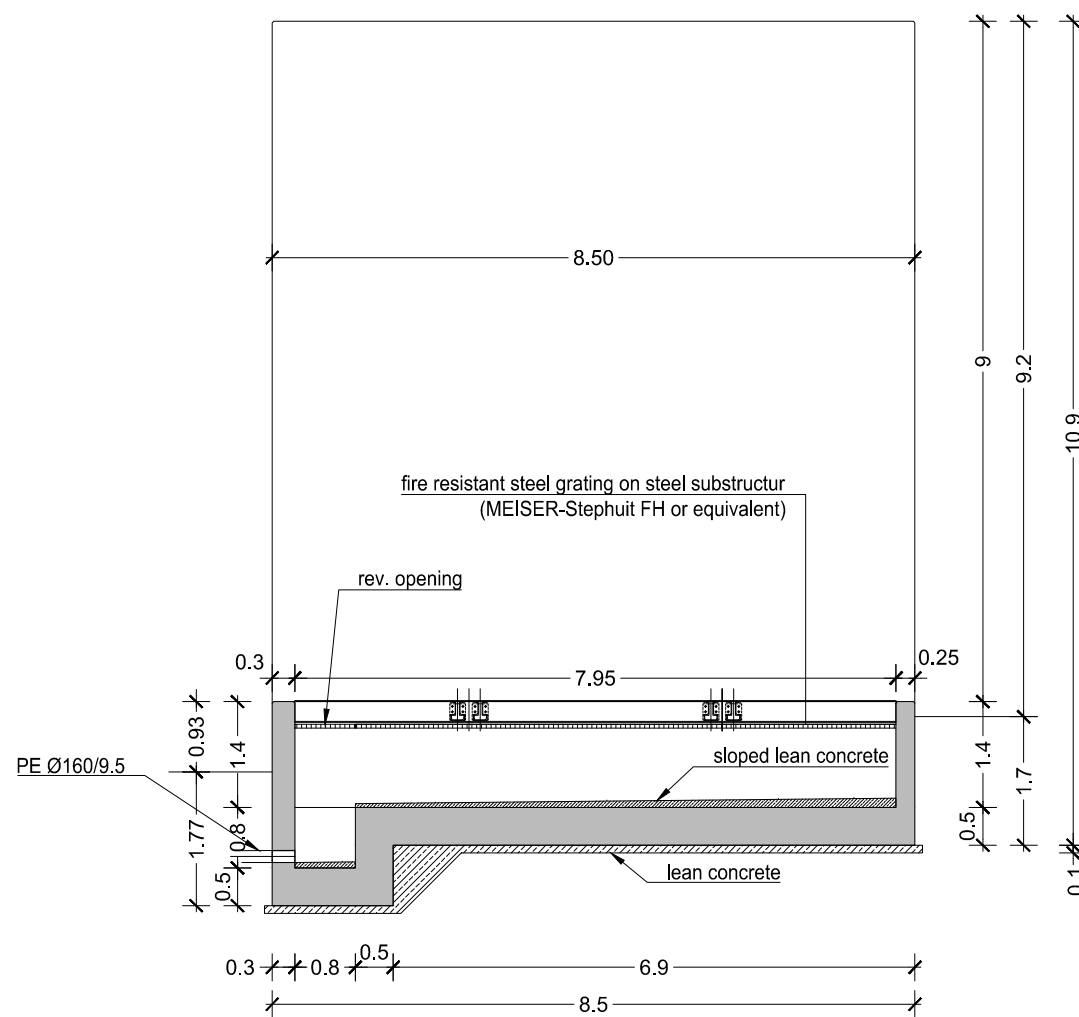
Plan (dimensions in m)





Section A-A



Section B-B



R4P001-6X8901_T211_T212.dwg

/		/		/	
Revision:			Revision note:		Revision date: Signature:
Client:			Facility:		
					
Design engineer:			Part of facility/system:		
 IBE, d.d., svetovanje, projektiranje in inženiring Ljubljana, Slovenija			/		
/			Type of design:		
			/		
	First name/Name:	Id. No.:	Title of document: Transformer foundation with fire walls		
Approved by:	mag. Marko Testen, univ. dipl. el. inž.	IZS E-1293			
Confirmed by:	Barbara Bukvič, univ. dipl. inž. grad.	IZS G-3015			
Checked by:	/	/			
Designed by:	/	/	Design doc. No.:	R4P001-A025/645	Type of documentation: DZR
			Classification No.:	- -	Page/ pages: 1/1
Date:	april 2025	Scale:	1:100	Identification No.:	R,4,P,O,0,1,-,6,X,8,9,0,1
					Rev.: