SYSTEM REQUIREMENTS

FOR

170 kV
AIS VOLTAGE TRANSFORMERS
(OIL INSULATED)

Chen Digitally signed by Chen Date: 2025.01.02 10:01:31 +02'00'

NOGA	Name	Signature	Date
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Project Description	Name	Company	Date
Customer			
Design body (if applicable)			
Manufacturer			

Project name: _____

Manufacturer's factory address: _____

Type of Voltage Transformer: _____

Number of units (Quantity): _____

Doc. revision: 1

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1. GENERAL

1.1. This document can serve as a guide to those interested in carry out a detailed Specification for an appropriate Voltage Transformer that meets the Local Regulations and purchase requirements. This document focuses on the threshold requirements and should not be considered as a "Voltage Transformer Specification".

1.2. All subclauses in this system requirements for 170 kV Voltage Transformer are compulsory requirements, the required ratings of the 170 kV Voltage Transformer shall be respectively at least of the values stated in chapter 3. Manufacturer's/Customer's proposal will be almost certainly disqualified, if its proposal does not meet with the "SYSTEM REQUIREMENTS" by NOGA'S demand.

1.3. **As part of the equipment approval inspection process, the required technical documents must be submitted to NOGA in accordance with Grid Code clause 3.8.3 (Version 1).**

2. APPLICABLE STANDARDS

2.1 Unless otherwise specified all equipment shall be designed, constructed and tested in accordance with the requirements of the latest relevant published Recommendations of the International Electrotechnical Commission (IEC) as amended up to date.

2.2 All aspects, tests, etc. not covered by IEC Recommendations, should be executed according to the latest published issue of official, or otherwise approved standards of Manufacturer's country. In such cases, the standards themselves shall be supplied.

2.3 The terminology used in this SYSTEM REQUIREMENTS, except where otherwise indicated, in accordance with IEC Publications:

1. IEC 61869-1/2023 - Instrument transformers.
2. IEC 61869-3/2011 – Inductive Voltage transformers.
3. IEC 62155/2003 -Hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1000 V.
4. IEC 61462/2007- Composite hollow insulators.
5. IEC 60721 series - Classification of environmental conditions.
6. IEC 60529/2013 - Degrees of protection provided by enclosures (IP Code).
7. IEC 62262/2021- Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code).
8. IEC 60137/2017- Insulated bushings for alternating voltages above 1000 V.
9. IEC TR 62039/2021 - Selection guide for polymeric materials for outdoor use under HV stress.
10. IEC 62217/ 2012- Polymeric HV insulators for indoor and outdoor use.
11. IEC 60085/2007 - Thermal evaluation and designation.
12. IEC 60815 series - Selection and dimensioning of high-voltage insulators intended for use in polluted conditions.
13. IEC 62073/2003 - Guidance on the measurement of wettability of insulator surfaces.
14. IEC 60417/2004 - Graphical symbols for use on equipment.
15. IEC 60296/2020- Fluids for electrotechnical applications – Unused mineral insulating oils for transformers and switchgear.
16. IEEE 987/2001- Guide for Application of Composite Insulators.
17. IEEE 693/2018 - Seismic Design of Substations.
18. IEEE C57.13/2016- Standard Requirements for Instrument Transformers.

3. TECHNICAL REQUIREMENTS AND REQUIRED INFORMATION

#	Description	Required Value /Standard	Manufacturer's Confirmation or Proposal
3.1.	**SYSTEM DATA**	Grid Code	
3.1.1.	Rated system voltage (line to line)	161 (kV)	
3.1.2.	Highest system voltage (line to line)	170 (kV)	
3.1.3.	Neutral connection in the 170 kV systems	Effectively earthed	
3.1.4.	Earth fault factor	1.3	
3.1.5.	Frequency	50 (Hz)	
3.1.6.	Symmetrical short circuit current	50 (kA r.m.s)	
3.1.7.	Surge impedance	375 (Ω)	
3.2.	**CLIMATIC CONDITIONS**		
3.2.1.	Permissible ambient air temperature:		
3.2.1.1.	Maximum	+50 (˚C)	
3.2.1.2.	Minimum	-5 (˚C)	
3.2.1.3.	Average measured over a period of 24 hours	+35 (˚C)	
3.2.2.	Permissible humidity:		
3.2.2.1.	Low relative/absolute humidity	4% / 0.9 g/m3	
3.2.2.2.	High relative/absolute humidity	100% / 27 g/m3	
3.2.3.	Rain intensity	15 (mm/min)	
3.2.4.	Low/high air pressure	84 kPa / 106 kPa	
3.2.5.	Solar radiation: Heating effects of solar radiation	1120 (W/m2)	
3.2.6.	Maximum wind velocity measured 10m above grade (bare area) at 3 sec duration	44 (m/sec)	
3.3.	**ENVIRONMENTAL CONDITIONS**		
3.3.1.	Site Pollution Severity (SPS, for dimensioning purposes)	Class E, IEC TS 60815-1 – 2008, Clause 8.3	
3.3.2.	Site Pollution Characterization	High Pollution/High NSDD site	
3.3.3.	Type of Pollution: Desert-Coastal, high inert content	mixed A+B,A - prevalent IEC TS 60815-1 - 2008	

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3.3.4.	Prevalent Pollution Type:	Saharan Blowing Dust	
3.3.5.	Environmental parameters:	4K25 & 4K26 IEC 60721-3-4/2019, par.5.2	
3.3.6.	Chemically active substances acc. to: Corrosively category acc. to:	IEC 60721-3-4/2019, par. 5.5 ISO 9223, C5	
3.3.7.	Mechanically active substances:	IEC 60721-3-4/2019, ed.3, Table 4, CLASS 4S13	
3.3.7.1.	Sand	18 (mg/m^3)	
3.3.7.1.1	Dust (suspension)	18 (mg/m^3)	
3.3.7.1.2	Dust particles size range	1-100 (μm)	
3.3.8.	Permissible altitude over the sea level	1000 (m)	
3.3.9.	The Inductive Voltage Transformer shall be vermin proof		
3.3.10.	**Electromagnetic Environment**		
3.3.10.1.	Electromagnetic compatibility (EMC) acc. to:	IEC 61869-1 cl. 6.11.2-5	
3.4.	**SEISMICITY OF SITE**	IEEE 693-2018 & Israeli Standard 413	
3.4.1.	Seismic Qualification level:	Moderate Level	
3.4.1.1.	Peak horizontal (x, y directions) ground acceleration (PGA) with an 85% probability not to be exceeded over a 50 years period:	0.5g	
3.5.	**RELIABILITY, AVAILABILITY, MAINTAINABILITY**	Appendix 1 - RAM requirements	
3.6.	**ELECTRICAL DATA**		
3.6.1.	Highest voltage for equipment Um	170 (kV r.m.s)	
3.6.2.	Rated primary voltage	161/ (kV)	
3.6.3.	Rated frequency	(Hz)	
3.6.4.	Secondary windings destination	Grid Code IEC 61869-3	

#	Description	Required Value /Standard	Manufacturer's Confirmation or Proposal
3.6.4.1.	Number of secondary windings for measuring, counting and protection	according to individual project parameters (need NOGA's permission) and according to Grid Code	
3.6.4.1.1.	Measuring windings shall be:	Class 0.2	
3.6.4.1.2.	Protection windings shall be:	Class 3P	
3.6.5.	Rated secondary voltage	115/√3 kV IEC 61869-3 cl.5.301.2	
3.6.6.	Rated output to be supplied to the secondary circuit at a power factor of 0.8 lagging	IEC 61869-3 cl.5.5.301	
3.6.7.	Rated burden (VA)	according to individual project parameters (need NOGA's permission) Burden calculations in worst case scenario shall be submitted to NOGA for examination and according to Grid Code	
3.6.8.	Total simultaneous load in specified accuracy class shall meet the appropriate requirement	IEC 61869-3	
3.6.9.	Accuracy class of secondary windings	IEC 61869-3 cl.5.6	
3.6.10.	Rated voltage factor	IEC 61869-3 cl.5.302 Table 304 Effectively earthed) neutral sys).	
3.6.10.1.	Continuous not less than	1.2	
3.6.10.2.	30 sec not less than	1.5	
3.6.11.	Class of insulation	IEC 60085/2007	
3.6.11.1.	For oil insulated VT with composite/porcelain insulator	A	
3.6.12.	Rated primary terminal insulation level:	IEC 61869-1& IEC 61869-3 cl.5.3	
3.6.12.1.	Rated lightning impulse withstand voltage for primary winding	750 (kV peak)	
3.6.12.2.	Rated power-frequency withstand voltage for primary winding	325 (kV r.m.s.)	

3.6.12.3.	Chopped lightning impulse withstand voltage for primary winding	860 (kV peak)	
#	**Description**	**Required Value /Standard**	**Manufacturer's Confirmation or Proposal**
3.6.12.4.	Rated power-frequency withstand voltage for the earthed terminal of primary winding	3 (kV r.m.s.)	
3.6.13.	The partial discharge level shall not exceed	IEC 61869-1 cl.5.4.3.1	
3.6.13.1.	At Um	10 (pC)	
3.6.13.2.	At 1.2 Um/√3 kV	5 (pC)	
3.6.14.	The dielectric dissipation factor (VT immersed in oil and hermetically sealed) shall not exceed at Um/√3	0.005	
3.6.15.	The rated power frequency withstand voltage of the insulation between sections	3 (kV r.m.s)	
3.6.16.	The rated power frequency voltage for secondary windings insulation	3 (kV r.m.s)	
3.7.	**OTHER REQUIREMENTS**		
3.7.1.	Limits of temperature rise of VT at +50 ˚C ambient air temperature acc. to:	IEC 61869-1 cl.6.4.1 (values in table 12: minus 10 ˚K)	
3.7.1.1.	Temperature rise at top of tank or housing not more than	45 (˚K)	
3.7.1.2.	Maximum temperature rise of windings at a burden corresponding to the thermal limiting output and continuous rated voltage factor shall not exceed	55 (˚K)	
3.7.2.	Each winding shall fulfill its respective accuracy requirements within its output range, while at the same time other winding has an output of any value from 0 to 100% of the upper limit of the output range specified for the other winding.		
3.7.3.	The voltage transformers shall be designed to withstand without damage when energized at rated voltage, the mechanical and thermal effects of an		

	external short-circuit of 50 kA r.m.s. for duration of 1 sec.		
#	**Description**	**Required Value /Standard**	**Manufacturer's Confirmation or Proposal**
3.7.4.	The RIV shall not exceed at	2500 (µV)	
3.7.5.	Transmitted overvoltage from the primary to the secondary terminals shall be less than	1.6 (kV) IEC 61869-1 table 9 Type A impulse	
3.8.	**DESIGN AND CONSTRUCTION**		
3.8.1.	GENERAL REQUIREMENTS		
3.8.1.1.	All inductive VT's must be designed so as to be able to drain the trapped charge. Initially assumed to be 1.5 p.u. to values lower than 0.2 p.u. in the following:		
3.8.1.1.1.	The VT connected directly to a 170 kV overhead line up to 125 km long.		
3.8.1.1.2.	The VT connected to a 170 kV by XLPE cable up to 20 km long.		
3.8.1.2.	The VT's shall have the capability to withstand thermally and mechanically two successive drainages of the line in above alternatives, the second of which occurs immediately after the first one.		
3.8.1.3.	The characteristics of the 170 kV double circuit transmission lines, to which VT's will be connected are as follow:		
3.8.1.3.1.	Overhead line: R1= 0.04 Ω /km (positive seq.) X1= 0.383 Ω /km (positive seq.) C1= 9.682 nF/km (positive seq.) R0= 0.186 Ω /km (zero seq.) X0= 1.479 Ω /km (zero seq.) C0= 6.145 nF/km (zero sequence) RM= 0.0487 Ω /km XM= 0.3653 Ω/km		

#	Description	Required Value /Standard	Manufacturer's Confirmation or Proposal
3.8.1.3.2.	Cable line: R1= 0.0138 Ω /km (positive seq.) X1= 0.1856 Ω /km (positive seq.) R0= 0.0639 Ω /km (zero seq.) X0= 0.0517 Ω /km (zero seq.) CE= 288 nF/km		
3.8.1.4.	Discharge withstand capability test will be performed. Describe method and supply the test report.		
3.8.1.5.	Voltage transformer is guaranteed suitable for discharge withstand capability taking into account line characteristics as stated above.		
3.9.	**INSULATING MEDIUM**		
3.9.1.	The VT oil shall meet the requirements indicated in:	Appendix 4 IEC 60296	
3.9.2.	The mixability between oils must be in accordance with:	IEC 60296 IEC 60422	
3.10.	**EARTHING TERMINALS**		
3.10.1.	Each Voltage Transformer shall be equipped with	Two terminals for earthing	
3.10.2.	The earthing terminals shall be marked with appropriate graphical symbols acc. to	IEC 60417	
3.10.3.	The earthing terminals shall be designed to withstand for 1 sec a short-time current of	50 (kA)	
3.11.	**INSULATORS**		
3.11.1.	Rated voltage	170 (kV)	
3.11.2.	Voltage test values for insulator:		
3.11.2.1	Dry lightning impulse 1.2/50 µs wave	750 (kV peak)	
3.11.2.2	Power frequency voltage withstand test 1 min	325 (kV r.m.s.)	

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3.11.3.	All other relevant tests shall be carried out, acc. to:	IEC 62155	
3.11.4.	Reference unified specific creepage distance (RUSCD):	53.7 mm/kV	
3.11.4.1	Phase to ground (Creepage Distance) not less than:	5270 (mm)	
3.11.4.2	Arcing distance not less than:	1500 (mm)	
3.11.4.3	The insulator profile (Design and Construction) shall be acc. to:	IEC 60815-2 Appendix 2	
3.12.	**STRESSES ON MOUNTED VOLTAGE TRANSFORMERS**		
3.12.1.	Permissible values of loading for terminals connected to other equipment by rigid or flexible conductors:		
3.12.1.1.	Static terminal load (sum of all loads occurring simultaneously in service: conductor pull, conductor weight and wind force on conductor) in any direction in space not less than	2400 (N)	
3.12.1.2.	Testing load for 60 sec. Applied to the midpoint of the terminal, perpendicular to the insulator axis	3500 (N)	
3.12.1.3.	Short - time load (sum of all loads occurring simultaneously in case of short-circuit) in any direction in space not less than:	5500 (N)	
3.12.2.	Safety factors of VT insulators taking into consideration the requirements under subcl 3.12.1 for each item of offered VT including steel pedestal		
3.12.2.1.	Condition 1– routinely expected load including: - design pressure 100% - mass 100%, -rated terminal load 100% (tensile force on conductors, weight of conductors and load due to wind on conductors) -load do to wind on VT 30%	> 2.1	

#	Description	Required Value /Standard	Manufacturer's Confirmation or Proposal
3.12.2.2.	Condition 2 – rarely occurring extreme loads including: -design pressure 100% - mass 100%, -rated terminal load 50% (tensile force on conductors, weight of conductors and load due to wind on conductors), -load do to wind on VT 100%, -short circuit load 100%	> 1.5	
3.12.2.3.	Condition 3 – rarely occurring extreme loads including: -design pressure 100% - mass 100%, -rated terminal load 70% (tensile force on conductors, weight of conductors and load due to wind on conductors), -load do to wind on VT 10%, -seismic load 100%	> 1.2	
3.12.3.	Dynamic seismic withstand capability (simultaneous earthquake acceleration applied at the base of the support VT):	Moderate Level PGA: 0.5 g	
3.12.3.1.	The dynamic seismic analysis report shall be done for voltage transformer including support structure acc. to:	IEEE 693-2018 cl.A1.4.7 &A.6.1	
3.12.3.2.	Testing methods acc. to	IEEE 693-2018	
3.12.3.3.	Qualification by combined test and dynamic analysis: The calculation will take into consideration also the support structure of VT with height of min. 2.5m and weight of 460kg.		
3.12.3.4.	The test report to prove the seismic qualification level and a dynamic analysis report for each alternative as per clause 3.4 shall be submitted.		
3.13.	**SECONDARY TERMINAL BOX**		
3.13.1	The entire control box which includes the coating must be designed to withstand the Climatic and Environmental Conditions acc. to:	Clause 3.2 – 3.3	

#	Description	Required Value /Standard	Manufacturer's Confirmation or Proposal
3.13.2	All wiring for connection to Purchaser's cable shall be terminated at terminal blocks enclosed in a terminal box having environmental protection shall be at least:	IP 55 IEC 60529/2013	
3.13.3	The protection against mechanical impact shall be at least:	IK10 IEC 62262	
3.13.4	Cross section of secondary circuits connected to voltage transformers.	2.5 (mm2)	
3.13.5	All wiring insulation and terminal blocks shall be flameproof protected, acc. to:	ASTM D635	
3.13.6	The destination of each winding shall be clearly indicated at the terminals		
3.13.7	Electromagnetic Control box code shall be at least:	EM4677xx IEC 61000-5-7	
3.13.8	The control box shall be supported by suitable vibration damping device designed to withstand the seismic characteristics described in:	Clause 3.4	
3.13.9	Thermal calculations of the control box must be performed acc. to:	IEC 61439	
3.14.	**NAMEPLATE**		
3.14.1	All voltage transformers shall carry the markings specified in:	IEC 61869-1 Cl.6.13 Appendix 3	
3.14.2	The nameplates shall be written in English, with metric units, with the quote: "all symbols and characters engraved by laser".		
3.14.3	The nameplates material shall be no corrosive stainless steel and they shall be mounted with no corrosive type stainless steel screws, bolts or rivets. Mounting of the nameplates with adhesive is not acceptable.		

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3.15.	**TESTS**		
3.15.1.	GENERAL:		
3.15.1.1	Contractor shall perform Production Tests to check the quality and uniformity of the workmanship and materials used in the manufacture of the Inductive Voltage Transformer.		
3.15.1.2	The Manufacturer is required to submit type test reports of offered type of VT performed by a neutral laboratory accredited to the last applicable accreditation requirements of ISO/IEC 17025/2005 by an Accreditation body which is a member of ILACMRA (eg. APLAC, EA, IAAC, A2LA). Furthermore the Laboratory scope of accreditation must include the required specific test methods used for the mentioned type tests.		
3.15.1.3	Contractor shall submit a list of all tests to be performed on site, after mounting of the Voltage Transformer and during operation.		
3.15.1.4	Contractor shall submit with the test reports a list of all measuring instruments, including their accuracy class and type, test equipment and test circuits.	IEC 61869-1 and IEC 61869-3	
3.15.1.5	Contractor shall indicate permissible tolerance for each test value.		
3.15.2.	**TYPE TESTS**		
3.15.2.1	Type Test Reports for offered types acc. to the provision of the latest relevant issue of IEC recommendations acc. to:	IEC 61869-1 Cl.7.2 IEC 61869-3 Cl.7.2 Table 10	
3.15.2.2	Temperature-rise test acc. to: The temperature rise values will be maximum values specified under cl. 3.7.1	IEC 61869-3 Cl.7.2.2	

#	Description	Required Value /Standard	Manufacturer's Confirmation or Proposal
3.15.2.3	Impulse voltage withstand test on primary terminalsa acc. to: Phase to ground test voltage:	IEC 61869-3 Cl.7.2.3.1 IEC 61869-1 Cl.7.2.3 and Table 2 750 (kV peak)	
3.15.2.4	Wet test for outdoor transformers acc. to: One-minute power frequency test on primary winding phase to ground :	IEC 61869-1 Cl.7.2.4 325 (kV r.m.s.)	
3.15.2.5	Electromagnetic compatibility (EMC) tests:	IEC 61869-1 Cl. 7.2.5	
3.15.2.5.1.	RIV test at 108 kV (1.1xUm/ kV) shall not exceed Um = highest system voltage	IEC 61869-1 Cl.7.2.5.1 2500 (µV)	
3.15.2.6	Test for accuracy acc. to:	IEC 61869-3 Cl.7.2.6	
3.15.2.7	Type test for limits of voltage error and phase displacement for measuring winding shall be performed acc. to:	IEC 61869-3 Cl.7.2.6.301	
3.15.2.8	Type test for limits of voltage error and phase displacement for protective winding shall be performed acc. to:	IEC 61869-3 Cl.7.2.6.302	
3.15.2.9	Verification of the degree of protection of secondary terminal box:	IEC 61869-1 Cl.7.2.7	
3.15.2.9.1	Verification of the IP coding (IP 54)	Cl.7.2.7.1	
3.15.2.9.2	Mechanical impact test (IK 10)	Cl.7.2.7.2	
3.15.2.10	Mechanical tests are carried out to demonstrate that the VT is capable to withstand the required values under subcl. 3.12.1	IEC 61869-1 Cl.7.2.10	
3.15.2.11	Voltage withstand test of low-voltage components and secondary terminals	IEC 61869-1 Cl.7.2.11	
3.15.2.12	Storage climatic environmental tests	IEC 61869-1 Cl.7.2.12	
3.15.2.13	Vibration test	IEC 61869-1 Cl.7.2.13	
3.15.2.14	Durability of markings	IEC 61869-1 Cl.7.2.14	
3.15.2.15	Tests for accuracy for harmonics	IEC 61869-1 Cl.7.2.15	

#	Description	Required Value /Standard	Manufacturer's Confirmation or Proposal
3.15.2.16	Tests for anti-aliasing	IEC 61869-1 Cl.7.2.16	
3.15.2.17	Short-circuit withstand capability test acc. to:	IEC 61869-3 Cl.7.2.301	
3.15.2.18	Type tests of porcelain insulators acc. to:	IEC 62155 IEC 60137/2017	
3.15.2.19	Type tests of composite insulators acc. to:	IEC 61462 IEC 60137/2017 IEC 62217/ 2012 IEC 62073/2003 IEEE 987/2001 IEC TR 62039/2021	
3.15.3.	**ROUTINE TESTS**		
3.15.3.1	General		
3.15.3.1.1	Manufacturer shall perform all Routine Tests for each Inductive Voltage Transformer acc. to the provisions of IEC Recommendations and submit all relevant test reports acc. to:	IEC 61869-1 Cl.7.3 Table 10 IEC 61869-3 Cl.7.3	
3.15.3.1.2	Manufacturer shall submit the routine test reports to NOGA for approval one month prior to delivery. The equipment can be delivered only after approval of routine test reports.		
3.15.3.2	Routine test reports shall include:		
3.15.3.2.1	Power frequency voltage withstand tests on primary terminals for 1 min acc. to: Phase to ground	IEC 61869-3 Cl.7.3.1 325 (kV r.m.s)	
3.15.3.2.1.1	Induced voltage withstand test acc. to:	IEC 61869-3 Cl.7.3.1.303	
3.15.3.2.1.2	Separate source withstand voltage test acc. to:	IEC 61869-3 Cl.7.3.1.302	
3.15.3.2.2	Partial discharge measurement test acc. to:	IEC 61869-1& 61869-3 Cl.7.3.2	
3.15.3.2.2.1	Pre-stress voltage/duration A or B acc. to:	IEC 61869-3 Cl.7.3.2.2	
3.15.3.2.2.2	Measuring of PD level at specified voltage test		
3.15.3.2.2.3	Partial discharge level at Um	<10 (pC)	

#	Description	Required Value /Standard	Manufacturer's Confirmation or Proposal
3.15.3.2.2.4	Partial discharge level at 1.2 x Um/	< 5 (pC)	
3.15.3.2.3	Power frequency voltage withstand tests between sections acc. to:	IEC 61869-1 Cl.7.3.3	
3.15.3.2.3.1	One-minute power frequency test between sections	3 (kV r.m.s)	
3.15.3.2.4	Power frequency voltage withstand tests on secondary terminals:	IEC 61869-1 Cl.7.3.4	
3.15.3.2.4.1	One-minute power frequency test between secondary terminals of each winding and earth	3 (kV r.m.s.)	
3.15.3.2.5	Power-frequency voltage withstand test for low-voltage components	IEC 61869-1 Cl.7.3.5	
3.15.3.2.6	Tests for accuracy	IEC 61869-1 Cl.7.3.6 IEC 61869-3 Cl.7.3.5	
3.15.3.2.6.1	Routine test for accuracy for **measuring** windings of Voltage Transformers, acc. to:	IEC 61869-3 Cl.7.3.5.301	
3.15.3.2.6.2	Routine test for accuracy for **protective** windings of Voltage Transformers shall be performed	IEC 61869-3 Cl.7.3.5.302	
3.15.3.2.7	Verification of terminal markings acc. to:	IEC 61869-1 Cl.7.3.7	
3.15.3.2.8	Oil-leakage test (Enclosure tightness test at ambient temperature)	IEC 61869-1 cl.7.3.8	
3.15.3.2.9	Measurement of primary and secondary winding resistance acc. to:	IEEE C57.13/2016 Cl.8.5	
3.15.3.2.10	Measurement of capacitance and dielectric dissipation factor (tan δ) test acc. to: A full description of the test method shall be supplied.	IEC 61869-1 cl.7.3.10 IEC 61869-3 Cl.7.4.3	
3.15.3.2.11	Test certificate (COT) of oil acc. to:	IEC 60296 Appendix 4	
3.15.3.2.12	**Routine and sample tests for each porcelain insulator acc to:**	IEC 62155/2003 Subclause:	
3.15.3.2.12.1	**Sample tests:**	9.2	
3.15.3.2.12.1.1	Verification of dimensions	7.1	
3.15.3.2.12.1.2	Control of the roughness of the ground parts	7.1	
3.15.3.2.12.1.3	Temperature cycle test	Cl.7.3	

#	Description	Required Value /Standard	Manufacturer's Confirmation or Proposal
3.15.3.2.12.1.4	Porosity test:	Cl.7.4	
3.15.3.2.12.1.5	Galvanizing test	7.5	
3.15.3.2.12.1.6	Pressure test	8.2.2	
3.15.3.2.12.1.7	Bending test	8.3.2	
3.15.3.2.12.2	**Routine tests:**	10.2	
3.15.3.2.12.2.1	Visual examination	10.3	
3.15.3.2.12.2.2	Electrical test	10.4	
3.15.3.2.12.2.3	Pressure test	10.6.1	
3.15.3.2.12.2.4	Bending test	10.6.2	
3.15.3.2.12.2.5	Other mechanical tests	10.6.3	
3.15.3.2.13	**Routine and sample tests on composite insulators:**	IEC 61462/2007 Subclause:	
3.15.3.2.13.1	**Sample tests**	9	
3.15.3.2.13.1.1	Verification of dimensions	9.3	
3.15.3.2.13.1.2	Mechanical tests	9.4	
3.15.3.2.13.1.3	Galvanizing test	9.5	
3.15.3.2.13.1.4	Check of the interface between end fittings and the housing	9.6	
3.15.3.2.13.2	**Routine tests**	10	
3.15.3.2.13.2.1	Visual examination	10.2	
3.15.3.2.13.2.2	Routine pressure test	10.3	
3.15.3.2.13.2.3	Routine mechanical test	10.4	
3.15.3.2.13.2.4	Routine tightness test	10.5	
3.15.4.	**SPECIAL TESTS**	IEC 61869-1 IEC 61869-3 Cl.7.4	
3.15.4.1.	General		
3.15.4.1.1	Manufacturer shall perform the following tests as a part of type test and in accordance with all type tests requirements above except where indicated otherwise, and supply test reports and curves accordingly:	IEC 61869-1 IEC 61869-3 Cl.7.4	

3.15.4.2.	Chopped lightning impulse test on primary windings, acc. to:	IEC 61869-1 Cl.7.4.1	
#	**Description**	**Required Value /Standard**	**Manufacturer's Confirmation or Proposal**
3.15.4.3.	Multiple chopped impulse test on primary terminals acc. to:	IEC 61869-1 Cl.7.4.1	
3.15.4.4.	Transmitted overvoltage test acc. to: Transmitted overvoltage	IEC 61869-1 Cl.7.4.2 <1.6 (kV peak)	
3.15.4.5.	Internal arc fault test acc. to:	IEC 61869-1 Cl. 7.4.3 IEC 61869-3 Cl. 7.4.6	
3.15.4.5.1	Arc fault duration in protection class:	IA2 (Table 16) 0.3 (sec)	
3.15.4.6.	Insulation resistance measurement on secondary terminals	IEC 61869-1 Cl. 7.4.5	
3.15.4.7.	Corrosion test acc. to:	IEC 61869-1 Cl.7.4.6	
3.15.4.8.	Fire hazard test acc. to:	IEC 61869-1 Cl.7.4.7	
3.15.4.9.	Thermo-mechanical endurance test	IEC 61869-1 Cl. 7.4.8	
3.15.4.10.	Vibration and shock test	IEC 61869-1 Cl. 7.4.9	
3.15.4.11.	Tests for accuracy versus harmonics	IEC 61869-1 Cl. 7.4.10	
3.15.4.12.	Seismic qualification test shall prove that the voltage transformer including all accessories will operate fully satisfactory during and after earthquake with ground acceleration indicated in clause 3.4.	IEEE 693-2018	
3.15.4.13.	Site tests: Manufacturer's recommended SAT program shall be submitted.		
3.16.	**TECHNICAL DOCUMENTAION**	Table in Cl. 4	
3.16.1	General		
3.16.1.1	All data (documents, drawings) and descriptive material shall be in English or Hebrew doc/pdf/dwg formats.		
3.16.1.2	Every document/drawing should include:Title document name,date, drawing number, revision number.		

4. REQUIRED DOCUMENTS

#	DESCRIPTION
4.1.	**ISO certificatess**
4.1.1.	ISO 9001 for Quality management system (QMS)
4.1.2.	ISO 14001 for environmental management system (EMS)
4.1.3.	ISO 14025 for environmental product declaration (EPD)
4.1.4.	ISO 17025 for testing and calibration laboratories
4.2.	**Main technical data schedule/datasheet**
4.2.1.	The document should include: all values that appear clause 3.1, 3.2.1, 3.3.1, 3.4.1, 3.6, 3.12.2, drawing numbers of Dimensional Insulator, Nameplate, Secondary terminal box, Insulator drawing.
4.2.2.	Project Details: Manufacturer's factory address, Manufacturer name.
4.3.	**Dimensional drawing**
4.3.1.	The document should include: Drawing of complete voltage transformer, showing all components, name of materials, HV & earth terminals, drawing number, revision number.
4.4.	**Manufacturer's insulator drawing**
4.4.1.	The document should include: all values that appear in clause 3.11, 3.12.
4.5.	**Nameplate drawings**
4.5.1.	The nameplates shall be provided with a weather and corrosion-proof nameplate, made of suitable material, including the mandatory markings according to clause 3.14 (See more detail and example in Appendix 3).
4.6.	**Stresses**
4.6.1	Calculations demonstrating that the Voltage Transformer complies with the Seismic Qualification Level (Static, dynamic and seismic calculation stresses) according to clause 3.12.
4.6.2	Seismic qualification test report according to clause 3.15.4.13.
4.7.	**Filled RAMs (see Appendix 1).**
4.8.	**Tests**
4.8.1.	INSPECTION AND TEST PLAN (ITP)
4.8.2.	A plan, specifying all the inspections and tests (from its initialing through design, in process inspection, type tests, final inspection/s and test/s, packing, transportation and supply to the Purchaser.
4.8.3.	Discharge withstand capability test according to clause 3.8.5.1.
4.8.4.	Measurement of capacitance and dielectric dissipation factor (tan δ) test acc.to clause 3.15.3.2.10.
4.8.5.	Test certificate (COT) of oil according to clause 3.15.3.2.11.
4.8.6.	TYPE TESTS reports according to clause 3.15.2.
4.8.7.	ROUTINE TESTS reports according to clause 3.15.3.
4.8.8.	SPECIAL TESTS reports according to clause 3.15.4.
4.8.9.	Manufacturer's recommended SAT program 3.15.4.14.
4.9.	**COMMITMENT BY MANUFACTURER (see Appendix 5).**

5. APPENDICES

5.1. APPENDIX 1 - RAMs REQUIREMENT

RELIABILITY, AVAILABILITY, MAINTAINABILITY and Safety (RAMs) for 170KV VOLTAGE TRANSFORMER Oil insulation:

1. Operational experience

1.1 The proposed Manufacturer's plant should have at least 9 years of experience in production of at least 170kV to 245kV VOLTAGE TRANSFORMERS

1.2 The bidder will provide contact details of at least 5 different customers of the bidder's 170-245 kV VOLTAGE TRANSFORMERS, whose purchase from the last 7 years (more than 1-year experience with bidder's 170 KV VOLTAGE TRANSFORMERS).

The reference list for the last 9 years shall include at least 50 units of such equipment supplied for at least 3 different countries and operated successfully for at least 1 year, and purchased during last 7 years. At least one of the countries must be from the EU (European Union) and/or OECD.

Only countries with an electrical transmission system of 170KV and above will be accepted.

1.3 In order to prove compliance with above mentioned, the bidder is required to submit (for example) the following table, duly filled and signed by a qualified officer.

No.	170-245 kV Voltage Transformer data (kV)	Quantity	Purchaser name & address	Supplied date	Energizing date	Contact details
1						
2						

1.4 SPARE PARTS - Spare parts shall be available for a period of life duration of 170KV VOLTAGE TRANSFORMER.

2. Reliability

The Bidder shall present the reliability tasks and methods which are used to improve the design for reliability, and evaluate the MTTF/MTBF for (*)**Major Failures** only, of the 170 kV Voltage Transformer oil insulated components.

The Bidder shall provide expected values for the relevant parameters of the 170 kV Voltage Transformer components, and shall add their distribution whenever possible.

3. Failure Analysis

From his Failure Reporting Analysis and Corrective Action System (FRACAS), Bidder shall present a failure report and the analysis of the failures which occurred during the service life of similar 170 kV Voltage Transformer oil insulated components **manufactured by him**. The report should include the withdrawn conclusion and the corrective actions subsequently undertaken.

***Major failure:** Failure of a Transformer which causes the cessation of one or more of it's fundamental functions.
A major failure will result in an immediate change in the system operating conditions,
e.g the backup protective equipment will be required to remove the fault, or will result in mandatory removal from service within 30 minutes for unscheduled maintenance.

4. 170 kV Voltage Transformer oil insulated RAM DATA

Bidder shall submit the following 170 kV Voltage Transformer oil /SF6 gas insulated RAM data:

Table 1: Voltage Transformer oil insulated components RAM parameters of similar construction of ratings

Component	MTBF (Yrs)	EOL (Yrs)	MTTR (Hrs)
1. Inductive Voltage Transformer			
1.1. Main internal insulation (e.g. oil)			
1.2. Core			
1.3. Insulator (e.g. porcelain / composite)			
1.4. Sealing (e.g. gasket, valve)			
1.5. Painting			

Where:

MTBF: Mean Time Between Failures, For *Major Failure
EOL: Expected Operating Life.
MTTR: Mean Time To Repair, for *Major Failures.

5. Field Data

The bidder will fill the following table:

Table 3: Field Demonstrated RAM data for similar construction and ratings voltage transformers

Field RAM Data		2014	2015	2016	2017	2018	2019	2020	2021	2022
Total number of installed VT's										
Major Failures										
Specific Part which undergo Major Failure	internal insulation									
	Core									
	Insulator									
	Sealing									
	Other									
Mean Time to Repair/Replace										

6. Unreliability Demonstration Procedure (UDP)/Reliability Test

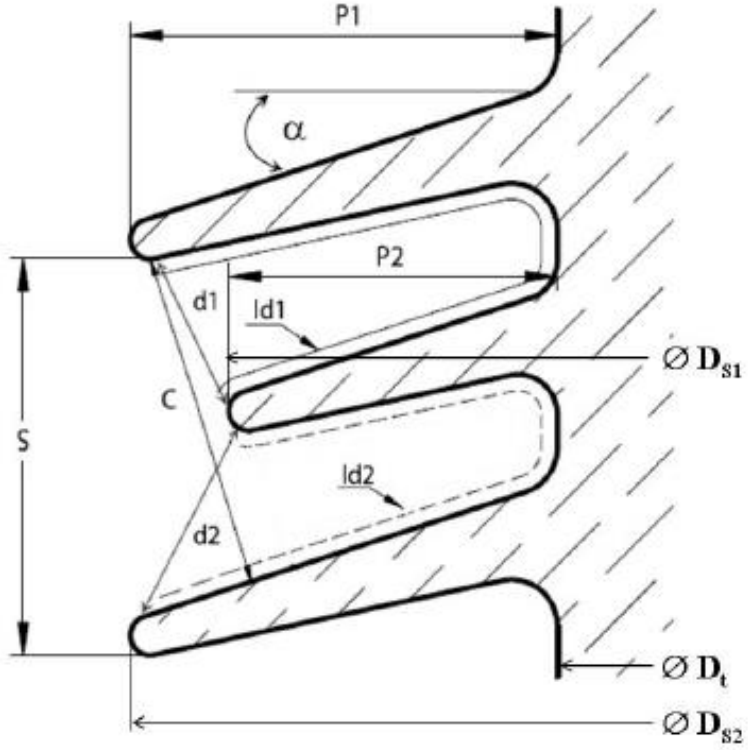
NOGA IISO could conduct an Unreliability Demonstration Procedure (UDP)/Reliability Test, according to NOGA IISO's Judgement. The manufacturer may request NOGA to see example for a UDP . The final UDP could be change according to each individual case and circumstances, as to be decided by NOGA IISO.

5.2. APPENDIX 2 - DESIGN AND CONSTRUCTION

COMPOSITE &PORCELAIN INSULATOR - ALTERNATE-SHEDS

Flat Alternating Sheds

The profile parameters shall be according to the following values



P_1-P_2	> 15 mm
S/P_1	> 0.75
C	> 40 mm
α	7° ≤ α ≤ 14°
D_a	< 300 mm
K_{ad}	1
USCD	53.7 mm/kV
A	> 1500 mm
CF = L/A	3.0 < CF < 4.5
l_1/d_1	2.5 ÷ 4.5
l_2/d_2	2.5 ÷ 4.5

P_1, P_2, S, C, α, ld_1, d_1, ld_2, d_2, D_{s1}, D_{s2}, D_t: see drawing.

K_{ad}: Correction factor for insulator diameter of the RUSCD.

USCD: Unified specific creepage distance phase to ground.

D_a: $(D_{s1} + D_{s2} + 2D_t)/4$.

L: Creepage Distance.

A: Arcing Distance.

5.3. APPENDIX 3 - NAMEPLATE EXAMPLE

In addition to clause 3.14, the rating plate shall carry the appropriate information in accordance with IEC 61869-3 :2011, clause 6.13.302 - see example below figures 311-312.

MANUFACTURER'S NAME		**VOLTAGE TRANSFORMER TYPE** _____	
YEAR		SERIAL	MASS kg
A - N ____/√3 kV	1a – 1n ____ V VA ____ Class	2a - 2n ____ V VA ____ Class	da - dn ____ V VA ____ Class
Frequency ____ Hz	U_m ____ kV	LI/SI/AC ____ kV/ ____ kV / ____ kV ____ sec	
Mech. ____ kN	Temp. - ___ /+ ___ °C	F_v ____ for ____	Ins. Class ____

Additional markings when required

Filling fluid ____	Filling pressure ___ kPa	Min pressure ___ kPa	Fluid volume ___ litre

IEC 1304/11

Figure 311 – Example of a typical rating plate

MANUFACTURER'S NAME		**VOLTAGE TRANSFORMER TYPE** Type designation	
YEAR 2007		SERIAL as required	MASS 500 kg
A - N 220/√3 kV	1a – 1n 63.5 V VA 25/50* Class 0.5/3P	2a - 2n - V VA - Class -	da - dn 110 V VA 25 Class 6P
Frequency 50 Hz	U_m 245 kV	LI/SI/AC 1050 kV / --- kV / 460 kV 60sec	
Mech. 1,25 kN	Temp. - 25/+ 40 °C	F_v 1.5 for 30 s	Ins. Class A
Filling fluid Oil Type (Grade)	Filling pressure 120 kPa	Min. pressure 100 kPa	Fluid volume 300 litre
Note* - Thermal limit burden 100 VA		**Sealed Unit – Do not tamper**	

IEC 1305/11

Figure 312 – Example of a rating plate with typical data

(In this case: 220 kV unit with two secondary windings)

5.4. APPENDIX 4 - INSULATION OIL REQUIREMENTS

1.	The VT oil shall meet the requirements indicated in:		IEC 60296
1.1.	The mixability between oils must be in accordance with:		• IEC 60296 • IEC 60422
1.2.	**Requirements for Insulation Oil:**		
	Property	**Test method**	**Limits**
1.2.1.	**Function**		
1.2.1.1.	Viscosity at 40 °C	ISO 3104	Max. 12 mm²/s
1.2.1.2.	Viscosity at -30 °C	ISO 3104	Max. 1 800 mm²/s
1.2.1.3.	Pour point	ISO 3016	Max. -40 °C
1.2.1.4.	Water content	IEC 60814	Max. 30 mg/kg [a]/40 mg/kg [b]
1.2.1.5.	Breakdown voltage	IEC 60156	Min. 30 kV/70 kV [c]
1.2.1.6.	Density at 20 °C	ISO 3675 or ISO 12185	Max. 0.895 g/ml
1.2.1.7.	DDF at 90 °C	IEC 60247 or IEC 61620	Max. 0.005
1.2.2.	**Refining/stability**		
1.2.2.1.	Appearance		Clear, free from sediment and suspended matter
1.2.2.2.	Acidity	IEC 62021-1	Max. 0.01 mg KOH/g
1.2.2.3.	Interfacial tension	EN 14210 or ASTM D971	Min. 40 mN/m
1.2.2.4.	Corrosive sulfur	DIN 51353	Not corrosive
1.2.2.5.	Anti-oxidant inhibitor	IEC 60666	0.08 - 0.40%
1.2.2.6.	Dibenzyl Disulfide (DBDS)	IEC 62697-1	Not detectable (<5 mg/kg)
1.2.2.7.	Metal passivators additives acc. to:	IEC 60666	Not detectable (<0.05 mg/kg)
1.2.2.8.	2-Furfural content	IEC 61198	Non-detectable (<0.05 mg/kg)
1.2.3.	**Performance**		
1.2.3.1.	Oxidation stability [f]	IEC 61125 (method C) Test duration: 500 h	
1.2.3.2.	Total acidity [f]	IEC 61125	Max. 1.2 mg KOH/g
1.2.3.3.	Sludge [f]	IEC 61125	Max. 0.8%
1.2.3.4.	DDF at 90 °C [f]	IEC 61125	Max. 0.5
1.2.4.	**Health, safety, and environment**		
1.2.4.1.	Flash point	ISO 2719	Min. 135 °C
1.2.4.2.	PCA content	BS 2000 Part 346	Max. 3%
1.2.4.3.	PCB content	IEC 61619	Not detectable (<2 mg/kg)

1.2.4.4	[a] For bulk supply, [b] For delivery in drums, [c] After laboratory treatment,	[d] Information must be provided [e] At the end of oxidation stability test [f] To be performed at the end of oxidation stability test.
1.3	**Requirements for Insulation Oil After Filling a New Electrical Equipment prior to Energization:**	
1.3.1.	Appearance	Clear, free from sediment and suspended matter
1.3.2.	Colour (on scale given in ISO 2049)	Max. 2.0
1.3.3.	Breakdown voltage [kV]	>60
1.3.4.	Water content [mg/kg] [g]	<10
1.3.5.	Acidity [mg KOH/g]	Max. 0.03
1.3.6.	DDF at 90°C and 40 to 60 Hz	Max. 0.015
1.3.7.	Resistivity at 90°C [GΩm]	Min. 60
1.3.8.	Interfacial tension [mN/m]	Min. 35
1.3.9.	Total PCB content [mg/kg] [h]	Not detectable (< 2 total)
1.3.10.	Particles (counting, sizing)	Should be made as baseline for future comparation
1.3.11.	Inhibitor content [h]	0.25-0.4%
1.3.12.	Total gas content according to IEC 61181 [i]	< 1%
1.3.13.	DGA according to IEC 61181	-
1.3.14.	[g] The values should be without temperature correction. [h] Shall be similar to the value before first filling. [i] By vacuum extraction.	
1.3.15.	The VT oil COT shall be approved by Purchaser before delivery acc. to:	IEC 60296

5.5. APPENDIX 5- COMMITMENT BY MANUFACTURER

5.5.1. DEVIATIONS FROM REQUIREMENTS:

Manufacturer is requested to describe or indicate deviations of the equipment and accessories from all requirements in this SYSTEM REQUIREMENTS document.

5.5.1.1. COMMENTS BY MANUFACTURER:

5.5.2. In case no deviations are mentioned it will be understood that Manufacturer's offer entirely complies with all requirements in this SYSTEM REQUIREMENTS document.

Manufacturer hereby certifies that he agrees to all provisions and conditions of this SYSTEM REQUIREMENTS document of NOGA IISO (Israel Independent System Operator), which including the accompanied Appendices documents unless exceptions are specifically and clearly listed (see cl. 5.5.1) and identified as Exceptions.

Manufacturer's Commitment:

Name	Company	Date	Signature of Manufacturer