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שם המפרט:

MINERAL INSULATING OIL SUPPLIED FOR/WITHIN ELECTRICAL EQUIPMENT

חתימה	תאריך	שם	
	05/08/2018	מזדאר תמירון גריסרו מריס	הוכן ע"י
	24/08/2018	ד"ר ויקטור מרקו	אושר ע"י

1. Scope

This specification covers *new* (unused) mineral insulating *inhibited* oil of *petroleum origin*, as delivered, for use in *Israel Electric Corporation* as an insulating and cooling medium in new and existing power and distribution electrical apparatus, such as transformers, regulators, circuit breakers, switchgear and similar equipment. It also applies to oil delivered to *Israel Electric Corporation* in new electric equipment and along with new electric equipment.

2. Reference Documents (last published revision)*

IEC 60296, *Unused mineral insulating oils for transformers and switchgear*
 IEC 60156, *Insulating liquids-Determination of the breakdown voltage at power frequency-Test method*
 IEC 60247, *Measurement of relative permittivity, dielectric dissipation factor and d.c. resistivity of insulating fluids*
 IEC 60422, *Supervision and maintenance guide for mineral insulating oils in electrical equipment*
 IEC 60475, *Method of sampling liquid dielectrics*
 IEC 60628, *Gassing of insulating liquids under electrical stress and ionization*
 IEC 60666, *Detection and determination of specified anti-oxidant additives in insulating oils*
 IEC 60814, *Insulating liquids – Oil-impregnated paper and pressboard – Determination of water by automatic coulometric Karl Fischer titration*
 IEC 61125, *Unused hydrocarbon based insulating liquids – Test methods for evaluating the oxidation stability*
 IEC 61198, *Mineral insulating oils – Methods for the determination of 2-furfural and related compounds*
 IEC 61619, *Insulating liquids – Contamination by polychlorinated biphenyls (PCBs) – Method of determination by capillary column gas chromatography*
 IEC 61620, *Insulating liquids-Determination of the dielectric dissipation factor by measurement of the conductance and capacitance – Test method*
 IEC 61868, *Mineral insulating oils – Determination of kinematic viscosity at very low temperatures*
 IEC 62021-1, *Insulating liquids-Determination of acidity – Part 1: Automatic potentiometric titration*
 ISO 2719, *Determination of flash point – Pensky-Martens closed cup method*
 ISO 3016, *Petroleum products – Determination of pour point*
 ISO 3104, *Petroleum products – Transparent and opaque liquids – Determination of kinematic viscosity and calculation of dynamic viscosity*
 ISO 3675, *Crude petroleum and liquid petroleum products – Laboratory determination of density – Hydrometer method*
 ISO 6295, *Petroleum products – Mineral oils – Determination of interfacial tension of oil against water – Ring method*
 ISO 12185, *Crude petroleum and petroleum products – Determination of density – Oscillating U-tube method*
 ISO 14596, *Petroleum products – Determination of sulfur content – Wavelength-dispersive X-ray fluorescence spectrometry*
 DIN 51353, *Detection of corrosive sulfur – Silver strip*
 BS 2000, Part 346, *Determination of polycyclic aromatics in lubricant base oil and asphaltene free petroleum fractions – Dimethylsulfoxide refractive method*
 ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

- If after issuing of the current Spec. some of the mentioned standards are updated, amended, withdrawn or superseded with other ones, the impact of these changes on the spec. and on the final product will be subjected to discussion between the manufacturer and purchaser.

3. Property Requirements for Insulating Oil (information shall be provided by the oil supplier)

3.1 Mineral insulating oil as delivered by the supplier shall meet all the requirements of **IEC60296** *Unused mineral insulating oils for transformers and switchgear for inhibited oils*.

3.2 Use of re-refined oil is allowed if it complies with all the properties listed in that standard.

TABLE A – Filled by accredited ISO 17025, independent laboratory and Pre-approved by IEC.

Name of oil manufacturer:				
Type of oil:				
	Property	Test method	Limits	Tested data
Unused Inhibited Mineral Insulating Oil Property Requirements				
Test No.	Function			
1	Viscosity at 40 °C	ISO 3104	Max. 12 mm ² /s	
2	Viscosity at -30 °C	ISO 3104	Max. 1 800 mm ² /s	
3	Pour point	ISO 3016	Max. -40 °C	
4	Water content	IEC 60814	Max. 30 mg/kg ^a /40 mg/kg ^b	
5	Breakdown voltage	IEC 60156	Min. 30 kV/70 kV ^c	
6	Density at 20 °C	ISO 3675 or ISO 12185	Max. 0.895 g/ml	
7	DDF at 90 °C	IEC 60247 or IEC 61620	Max. 0.005	
8	Particles (counting, sizing)	IEC 60970	See ^d	
Refining/stability				
9	Appearance	-	Clear, free from sediment and suspended matter	
10	Acidity	IEC 62021-1	Max. 0.01 mg KOH/g	
11	Interfacial tension	EN 14210 or ASTM D971	Min. 40 mN/m	
12	Total sulphur content	IP 373 or ISO 14596	See ^d	
13	Corrosive sulfur	DIN 51353	Not corrosive	
14	Potentially corrosive sulphur	IEC 62535	Not corrosive	
15	DBDS	IEC 62697-1	Non-detectable (<5 mg/kg)	
16	Anti-oxidant Inhibitors	IEC 60666	0.08-0.40%	
17	Metal passivator additives	IEC 60666	Non-detectable (<0.05 mg/kg)	
18	Other additives	-	See ^e	
19	2-Furfural content	IEC 61198	Non-detectable (<0.05 mg/kg)	
20	Stray gassing	6.22 of IEC 60296	See ^d	
21	FTIR – fingerprint or other method agreed between IEC and supplier.	-	See ^d (please add relevant documents)	
Performance				
22	Oxidation stability	IEC 61125 (method C) Test duration: 500 h		
23	Total acidity ^f	1.9.4 of IEC 61125	Max. 1.2 mg KOH/g	
24	Sludge ^f	1.9.1 of IEC 61125	Max. 0.8%	
25	DDF at 90 °C ^f	1.9.6 of IEC 61125	Max. 0.500	
26	Gassing tendency	IEC 60628, Method A	See ^d	

Test No.	Property	Test method	Limits	Tested data
	Health, safety and environment			
27	Flash point	ISO 2719	Min. 135 °C	
28	PCA content	IP 346	Max. 3%	
29	PCB content (mg/kg)	IEC 61619	Not detectable (< 2 total)	
	Requirements for Mineral Insulating Oils after Filling in New Electrical Equipment - The report shall filled by accredited ISO 17025 and Pre-approved by IECo. laboratory (Not independent is allowed)			
	Property	Highest voltage for equipment kV		
		<72.5	72.5 to 170	>170
30	Appearance	Clear, free from sediment and suspended matter		
31	Colour (on scale given in ISO 2049)	Max. 2.0	Max. 2.0	Max. 2.0
32	Breakdown voltage (kV)	>55	>60	>60
33	Water content (mg/kg) ^g	20 ^h	<10	<10
34	Acidity (mg KOH/g)	Max. 0.03	Max. 0.03	Max. 0.03
35	Dielectric dissipation factor at 90°C and 40 Hz to 60 Hz	Max.0.015	Max.0.015	Max.0.015
36	Resistivity at 90°C (GΩm)	Min.60	Min.60	Min.60
37	Oxidation stability ⁱ	As specified in IEC 60296		
38	Interfacial tension (mN/m)	Min.35	Min.35	Min.35
39	Total PCB content (mg/kg) ⁱ	Not detectable (< 2 total)		
40	Particles (counting, sizing)	-	Should be made as a baseline for future comparison	
41	Inhibitor content ⁱ	-		
42	Total gas content – according IEC 61181 ^j	-	<1%	<0.5%
43	DGA according to IEC 61181 ^j	-		
44	FTIR - fingerprint ⁱ	-		

^a For bulk supply.^b For delivery in drums.^c After laboratory treatment.^d Results must be provided.^e The supplier shall declare the generic type of all additives, and their concentrations in the case of antioxidant additives.^f To be performed at the end of oxidation stability test.^g The values should be without temperature correction.^h A different value could be agreed between supplier and user depending upon local circumstances.ⁱ Shall be similar to the value before first filling (Unused Inhibited Mineral Insulating Oil Property Requirements).^j By vacuum extraction only.

3.3 Tests required at various stages in complete process for power transformers commissioning (>72.5KV):

TABLE B			
	Stage description	TEST No.	Test certificate by
1 ⁱ	Bidder acceptance	1-29	Pre-approved laboratories (see clause 7.2)
2	C.O.T. from oil supplier after order confirmation ^a .	3-5,8,9,11,14-17,21,29	Pre-approved laboratories (see clause 7.2)
3	Incoming inspection.	4,11,21	Accredited/approved Lab ^h
4	After ^f first filling, before electrical testing at manufacturer site.	30-36,38-41,43,44	Accredited/approved Lab ^h
5	After ^f electrical testing at manufacturer site.	43,19	Accredited/approved Lab ^h
6	Testing of oil before transformer delivery to purchaser, according to one of the following scenarios:		
6.1	Filled with dry gas ^b and Partially assembled.	1-19,21,22 ^d	Pre-approved laboratories (see clause 7.2)
6.2	After ^f transformer was filled with oil and fully assembled ^c .	17,30-44 (for test No. 37 see ^d)	Pre-approved laboratories (see clause 7.2)
6.3	After ^f transformer was partially filled with oil and Partially assembled ^c :		
6.3.1	Tests for main Transformer.	17,30-41 (for test No. 37 see ^d), 44	Pre-approved laboratories (see clause 7.2)
6.3.2	Tests for separated oil.	44 (same as 6.3.1 oil)	Pre-approved laboratories (see clause 7.2)
7 ⁱ	Testing of oil according to the destination of the transformer according to one of the following scenarios ^e :		
7.1	Storage:		
7.1.1	With option 6.1 after ^f D.P. test, full assembly and full with oil according to manufacturer instructions.	32-35,38,40,43,44	Accredited/approved Lab ^h
7.1.2	With option 6.2	4,5,8,11,43 – After one year	Accredited/approved Lab ^h
7.1.3	With option 6.3 and after ^f full assembly and full with oil according to manufacturer instructions	32,33,35,38,41-44	Accredited/approved Lab ^h
7.2	Purchaser station:		
7.2.1 ^g	Before energizing and after ^f full assembly and full with oil according to manufacturer instructions.	30-36,38,40,41,43,44	Pre-approved laboratories (see clause 7.2)
7.2.2	Storage:		
7.2.2.1	With option 6.1 after ^f D.P. test, full assembly and full with oil according to manufacturer instructions.	32-35,38,40,43,44	Accredited/approved Lab ^h
7.2.2.2	With option 6.2	4,5,8,11,43 – After one year	Accredited/approved Lab ^h
7.2.2.3	With option 6.3 and after ^f fully assembled according to manufacturer instructions	32,33,35,38,41-44 –	Accredited/approved Lab ^h

^a For 20 ton batch for each order or as agreed between supplier and purchaser.

^b Dew point < -50°C

^c The oil will not be treated and/or circulated before energizing at purchaser site

^d The result should not postpone delivery.

^e According to commercial annexures (if it's include in manufacturer warranty/responsibility).

^f Sample shall be taken between 24 – 48 hours.

^g Each transformer have to perform 7.2.1 tests before energizing at purchaser station.

^h Labs that shall be agreed between purchaser and supplier.

ⁱ The oil tests reports provided for current stage shall include also the reports of the oil tests performed between the previous stage and the current stage.

Note: The oil will be tested in storage up to 5 years according to paragraph 6.2 and limits therein. The transformer oil will be tested also during operation within the warranty period once every 3 months according to routine tests specified by IEC60422. Any excess of trends and limits will be a clause to contact the transformer supplier and find out the cause for it.

3.4 Test at stages in complete process for distribution and small transformers (<72.5KV), one certificate is enough for a group of 20 supplied transformers.

TABLE C			
	Stage description	TEST No.	Test certificate by
1 ^d	Bidder acceptance	1-29	Pre-approved laboratories (see clause 7.2)
2	C.O.T. from oil supplier after order confirmation ^a .	3-5,8,9,11,14-17,21,29	Pre-approved laboratories (see clause 7.2)
3	Incoming inspection.	4,11,21	Accredited/approved Lab ^c
4 ^d	After ^b electrical testing at manufacturer site.	30-36,38-41,43,44	Pre-approved laboratories (see clause 7.2)

^a For 20 ton for each order or as agreed between supplier and purchaser.

^b Sample shall be taken between 24 – 48 hours.

^c Labs that shall be agreed between purchaser and supplier.

^d The oil tests reports provided for current stage shall include also the reports of the oil tests performed between the previous stage and the current stage.

4. Specific requirements for special applications

For transformers with higher operating temperatures or designed for extended service life, Israel Electric Corporation may require the oil (catalog N° 5236327) to comply with restricted limits after oxidation test according to IEC 61125 (Method C). Specific requirements oils are in generally more robust to aging and can prolong the transformer life.

- Total acidity: max. 0.3 mg KOH/g;
- Sludge: max. 0.05 %;
- DDF at 90 °C: max. 0.050;
- Total sulphur content: max. 0.05% (before oxidation test).

5. Identification and general delivery requirements for separate oil

- 5.1 Oil shall be delivered in bulk, tank containers or packed in steel drums. These shall be clean and suitable for this purpose to avoid any contamination. *Israel Electric Corporation* catalog numbers (for the oils that comply with General Specification): 847103 (drums), 3177771 (bulk).
- 5.2 The Oil in the bulk, tank containers or packed in steel drums must be filled at the oil manufacturer.
- 5.3 Oil drums shall be new and free of any internal coating.
- 5.4 Oil drums and sample containers shall carry at least the following markings:

- manufacturer's designation;
- classification;
- oil quantity.

5.5 Marking shall be accomplished by labeling or stenciling.

5.6 Paint type and/or sticker shall be water and oil proof.

5.7 Each oil delivery shall be accompanied by a document from the supplier specifying at least: manufacturer's designation, oil classification and **compliance certificate**.

5.8 *Israel Electric Corporation* is free to send at any time an oil sample to any of the pre-approved laboratories of 7.2, to check if the oil values of a specific delivery meet the initial specification. If any contradiction is found between the actual measurements and the certificate values, the oil can be returned to the supplier after further clarification.

6. Sampling

Sampling for any purpose, shall be carried out only in accordance with the procedure described in IEC 60475.

7. Testing and certification

7.1 Potential suppliers shall include in their proposals:

- **The table in sub-clause 3.2 including the type and concentration of any additive in the oil;**
- **The original manufacturer's technical specification of the oil;**
- **The list of the laboratories measuring each parameter in the table in sub-clause 3.2. must be acceptable to *Israel Electric Corporation*;**
- **Certification of the quality assurance system of the oil manufacturer's production line. The certifying organization must be known and accepted by *Israel Electric Corporation*;**
- **Safety Data Sheet (SDS) of the oil.**

7.2 All the laboratories shall be accredited by ISO 17025 and must be Pre-approved by IECo.

General Notes:

- 1 – *The approval of an oil type will be relevant only for the tender in which it was offered.*
- 2 – *Any transformer shall contain only one brand of oil. No mixing of oils is allowed.*