RELIABILITY & H.V. EQUIPMENT DEPARTMENT

Main Technical Requirements

For 170 kV

WALL BUSHINGS

July 2025

	Name	Signature	Date
Prepared by:	Carlos Lisman		22-07-2025
Checked by:	Adir Anidgar		24-07-2025
Approved by:	Chen Marchini		24-07-2025

Requirements for purchase, installation and connection to the Israeli grid

The purchase of equipment, its installation, or its integration into the electricity sector in Israel shall be permitted solely upon receipt of prior written approval from NOGA-ISO (for private customers, within the framework of the technical coordination process, and, with respect to the Israel Electric Corporation - written approval), confirming that the System Requirements Document - as published and updated from time to time on NOGA-ISO's official website - has been fully complied with by the purchaser, and further subject to the submission, in full, of all required technical materials, information, and accompanying documents, as detailed in the System Requirements Document, and upon completion of a formal, full, and final examination and approval, to the sole satisfaction of NOGA-ISO.

MAIN TECHNICAL REQUIREMENTS FOR 170 KV WALL BUSHINGS

Scope of work:

This document describes the System data and the main wall bushing components, focusing on the threshold requirements.

Its primary purpose is to serve as a technical compulsory guideline for parties involved in preparing a detailed specification for a Wall Bushing that complies with applicable local regulations and the Purchaser's requirements in the Israel grid.

Note:

1. *This document adopts the IEC 60137 as the primary international standard governing Wall bushings.*
2. *The technical data, procedures, and requirements specified herein shall be regarded as part of the System's Threshold Requirements.*
3. *The final Wall Bushing Specification shall be jointly reviewed by the Customer and the Manufacturer to define the detailed design of each component, in accordance with the Israel Grid Code requirements* https://www.noga-iso.co.il/pdt/grid-code/.
4. *In cases where certain components lack the required documentation or fail to meet NOGA-ISO's technical requirements, the equipment or the affected parts may be disqualified for use.*
5. ***This document must be approved and signed by:***
   - *5.1. End Customer or his representative*
   - *5.2. The entity responsible for preparing the wall bushing specification (if applicable)*
   - *5.3. Wall bushing manufacturer*

The Customer shall be responsible for providing all data and information requested in this document, and for ensuring that all technical requirements are fully met by the Manufacturer in the final supplied product.
The Customer is also responsible for verifying the accuracy and validity of all data submitted by the Manufacturer.

Project Name:				
Spec. No.				
No. of units:				
	Name	**Company & country**	**Date**	**Sign**
End-Customer or his representative				
Entity responsible for preparing the wall bushing spec.				
Manufacturer				

General:

- The applicable standards are included in the respective clauses of this document.
- **Required Information and Documentation:** Requirements about documentation are in Clause 9.
- All clauses must be addressed. Only a specific **data value**, confirmation of compliance with the requirement (**Complies**), or indication that the requirement is not applicable (**N/A**) will be accepted.

Table of content:

TECHNICAL REQUIREMENTS AND REQUIRED INFORMATION

	Description	Required Value or Applicable Standard	Manufacturer's Confirmation or Proposal
1.	**System data**		
1.1.	**System frequency,** according to definition in:	IEC 60050-421, 421-04-03, modified	
1.1.1.	Rated frequency [Hz]	50	
1.1.2.	Range of frequency variation [Hz]	According to ***Israel Grid code***	
1.2.	**System voltages,** according to definition in:	IEC 60050-421, 421-03-05	
1.2.1.	Rated system voltage [kV]	161	
1.2.2.	Highest system voltage [kV]	170	
1.3.	**Symmetrical short [kA rms]**	50	
1.4.	**Fault duration** [sec.]	1	
1.5.	**Earth fault factor (EFF)**	1.4	
1.6.	**Line auto reclosing policy [sec.]**.	0.6	
2.	**Environment Conditions**		
2.1.	Environment conditions according to:	IEC 60721/3-4	
2.1.1.	7 months a year without rain with more than 100 nights with dew and high humidity in the air as experienced in coastal or desert areas in this country.		
2.1.2.	Severe atmospheric and industrial air pollution, dust, salt spray and sandstorms		
2.1.3.	Altitude over the sea level up to [m]	1000	
2.1.4.	**Chemically active substances**: **corrosively category** according to:	ISO 9223, C5	
2.1.5.	**Classification of mechanically active substances** according to:	IEC 60721-3-4 Table 4 4S13	
2.1.6.	Bushings pollution levels: Desert and Coastal types of environments, according to:	IEC 60815-1/ Table 5, E6 E7	
2.1.7.	Type of Pollution: Desert-Coastal, high inert content	Mixed A+B, A prevalent IEC TS 60815-1	
2.1.8.	Site pollution severity (SPS) class	e (very heavy)	
2.1.9.	Non-Soluble Deposit Density (NSDD) [mg/cm^2]	2	

	Description	Required Value or Applicable Standard	Manufacturer's Confirmation or Proposal
2.1.10.	Equivalent Salt Deposit Density (ESDD) [mg/cm^2]	0.45	
2.1.11.	Annual number of dangerous wetting events	200	
2.2.	**Classification of Climatic Conditions** according to:	IEC 60721-3-4 Table 1 4K26	
2.2.1.	Air temperatures according to:	Clause 2.3	
2.2.2.	Water from sources other than rain [m/s]	15	
2.2.3.	Classification of special climatic conditions according to:	IEC 60721-3-4 Table 2 4Z5	
2.3.	**Ambient air temperatures**		
2.3.1.	The indicated temperatures will be considered as default. Other temperatures values must be justified by customer and approved by NOGA-ISO	Maximum: 50°C	
2.3.2.		Minimum: -5°C	
2.3.3.		Maximum daily mean (hottest month): 40 °C	
2.3.4.		Yearly average 30 °C	
3.	**Seismic Qualification Level**		
3.1.	Applicable standard:	IEC TS 61463	
3.2.	Seismicity of site:	Moderate level	
3.3.	Peak ground acceleration with an 85% probability not to be exceeded over a 50 years period:	0.5g	
4.	**Data sheet and Functional Specifications**		Enter all required information in Annex 1
5.	**Metal parts coating and application system**		
5.1.	The metal parts coating system shall supply protection against atmospheric erosion and corrosion according to environmental condition as described in:	clause 2	
6.	**Marking plate**		
6.1.	The Marking plate must include all the information requested in:	IEC 60137, clause 6.2	
6.2.	Data on the Marking plate must be laser engraved.	NOGA-ISO requirement	
7.	**Wall bushing tests**		
7.1.	**Type test** according to:	IEC 60137 clause 7.2.2	
7.1.1.	Wet power-frequency voltage withstand test	IEC 60137 clause 8.2	

	Description	Required Value or Applicable Standard	Manufacturer's Confirmation or Proposal
7.1.2.	Long duration power-frequency voltage withstand test (ACLD)	IEC 60137 clause 8.3	
7.1.3.	Dry lightning impulse voltage withstand test	IEC 60137 clause 8.4	
7.1.4.	Electromagnetic compatibility test	IEC 60137 clause 8.7	
7.1.5.	Temperature rise test	IEC 60137 clause 8.8	
7.1.6.	Verification of thermal short-time current withstand	IEC 60137 clause 8.9	
7.1.7.	Cantilever load withstand test	IEC 60137 clause 8.10	
7.1.8.	Tightness test	IEC 60137 clause 8.11	
7.1.9.	Verification of dimensions	IEC 60137 clause 8.14	
7.2.	**Routine tests** according to:	IEC 60137 clause 7.2.3	
7.2.1.	Measurement of dielectric dissipation factor (tan δ) and capacitance at ambient temperature	IEC 60137 clause 9.2	
7.2.2.	Dry lightning impulse voltage withstand test	IEC 60137 clause 9.3	
7.2.3.	Dry power-frequency voltage withstand test	IEC 60137 clause 9.4	
7.2.4.	Measurement of partial discharge	IEC 60137 clause 9.5	
7.2.5.	Tests of tap insulation	IEC 60137 clause 9.6	
7.2.6.	Tightness test	IEC 60137 clause 9.8	
7.2.7.	Visual inspection and dimensional check	IEC 60137 clause 9.11	
7.3.	**Special tests required by NOGA-ISO** according to:	IEC 60137 clause 7.2.4	
7.3.1.	Seismic qualification according to:	IEC TS 61463	
7.3.1.1.	Seismic qualification may by demonstrated by dynamic analysis when:	The manufacturer shall provide evidence that the bushing exhibits linear and elastic behavior under seismic loading, in accordance with IEC TS 61463.	
7.3.1.2.	Seismic qualification shall be demonstrated by means of a vibration test when (including time- history):	The behavior of the test specimen is non-linear as defined in IEC TS 61463.	
8.	**Housing insulators tests**		
8.1.	**Ceramic** according to:	IEC 62155	
8.1.1.	**Insulator type tests**	IEC 62155, clause 8	

	Description	Required Value or Applicable Standard	Manufacturer's Confirmation or Proposal
8.1.1.1.	Temperature cycle test	IEC 62155, clause 7.3	
8.1.1.2.	Pressure test	IEC 62155, clause 8.2	
8.1.1.3.	Bending test	IEC 62155, clause 8.3	
8.1.1.4.	Torsion, tension or compression tests	IEC 62155, clause 7.2.3-7.2.4-7.2.5	
8.1.1.5.	Mechanical failing load tests	IEC 62155, clause 7.2	
8.1.2.	**Insulator routine tests**	IEC 62155, clause 10	
8.1.2.1.	Visual examination	IEC 62155, clause 10.3	
8.1.2.2.	Electrical routine test	IEC 62155, clause 10.4	
8.1.2.3.	Mechanical routine test	IEC 62155, clause 10.5	
8.1.2.4.	Routine bending test	IEC 62155, clause 10.5.2	
8.1.2.5.	Routine thermal shock test	IEC 62155, clause 10.7	
8.1.3.	**Insulator sample test**	IEC 62155, clause 9	
8.1.3.1.	Verification of dimensions and roughness of ground surfaces	IEC 62155, clause 7.1	
8.1.3.2.	Porosity test	IEC 62155, clause 7.4	
8.1.3.3.	Temperature-cycle test	IEC 62155, clause 7.3	
8.1.3.4.	Galvanizing test (when applicable)	IEC 62155, clause 7.5	
8.1.3.5.	Pressure test	IEC 62155, clause 8.2.1	
8.1.3.6.	Bending test	IEC 62155, clause 8.3.1	
8.1.3.7.	Torsion, tension or compression tests	IEC 62155, clauses 7.2.3-7.2.4-7.2.5	
8.2.	**Composite** according to:	IEC 61462	
8.2.1.	**Insulator type tests**	IEC 61462, clause 8	
8.2.1.1.	Bending test	IEC 61462, clause 8.5	
8.2.2.	**Insulator sample tests**	IEC 61462, clause 9	
8.2.2.1.	Verification of dimensions	IEC 61462, clause 9.3	
8.2.2.2.	Mechanical tests	IEC 61462, clause 9.4	
8.2.2.3.	Galvanizing test (when applicable)	IEC 61462, clause 9.5	
8.2.3.	**Insulator routine tests**	IEC 61462, clause 10	
8.2.4.	Visual examination	IEC 61462, clause 10.2	
8.2.5.	Routine mechanical tests	IEC 61462, clause 10.3	
8.2.6.	Routine tightness test	IEC 61462, clause 10.5	

	Description	Required Value or Applicable Standard	Manufacturer's Confirmation or Proposal
9.	**Required Attachments**		
9.1.	Filled " Main Technical Requirements For 161 kV Wall bushings"		
9.2.	Valid manufacturer certifications according to:	• ISO 9001 • ISO/IEC 17025	
9.3.	Installation Instruction book		
9.4.	Bushing test reports, according to:	clause. 7	
9.5.	Housing test reports, according to:	clause. 8	
9.6.	Manufacturer catalog / data sheet	That includes the selected wall bushing	
9.7.	Wall bushing general dimensions drawings which also include the following information:	• Applicable standards, • Housing type / model / drawing No. and manufacturer, • Mechanical loads, • Creepage and arcing distances, • Conductor material, • Detailed shed profile according to Annex 2 • Grounding sleeve length, • Seismic qualification, • Type of insulation, • Detailed flange dimensions.	
9.8.	Housing general dimensions drawings including all parameters indicated in Annex 2		
9.9.	Seismic qualification test according to:	clause 7.3.1	
9.10.	Marking plate drawing according to:	clause 6	
9.11.	FAT and SAT programs and tests reports according to:	• Requirements in clauses 7, 8 and 10 • IEC 600137	
9.12.	Filled Annex 1 " Data sheet and Functional Specifications "		
9.13.	Filled "Threshold Requirement" on NOGA-ISO website		
9.14.	Filled "RAMS" on NOGA-ISO website"		

	Description	Required Value or Applicable Standard	Manufacturer's Confirmation or Proposal
10.	**FAT, Arrival test and SAT**		
10.1.	• NOGA-ISO must evaluate and approve the content of the FAT and SAT programs. The FAT program must be submitted to NOGA-ISO at least 1 month before the scheduled test date and SAT program at least 1 month before the scheduled installation date. • The FAT program must include the description of each test, the applicable standard, test voltage (where applicable), acceptance criteria, guaranteed values, and tolerances. The FAT report must include a wall bushing and rating plate drawing. • The results of the FAT and SAT must be sent to NOGA-ISO for evaluation. • **The wall bushings will not be shipped to its destination before obtaining the FAT approval by NOGA-ISO**.		
10.2.	**Arrival and SAT**: The manufacturer's recommendations in the instruction and installation book will be followed, according to:	IEC 60137, clause 11	
11.	**Operational experience**	See Threshold Requirements on NOGA-ISO website	
12.	**Reliability, Availability, Maintainability and Safety**	See RAMS document on NOGA-ISO website	

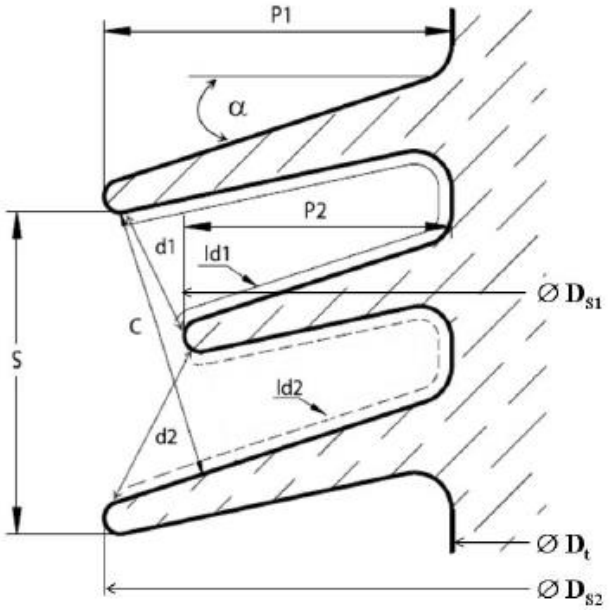
Annex 1: Data sheet and Functional Specifications

	Description	Required Value or Applicable Standard	Manufacturer's Confirmation or Proposal
1.	**Data sheet and Functional Specifications**		
Note 1	**The bushings shall be designed for the service conditions stated in clause 2 and 3 of this document.**		
1.1.	Manufacturer / Type / Model / Catalog No.		
1.2.	Wall bushing drawing No.		
1.3.	Applicable standard	IEC 60137	
1.4.	Housing material	Porcelain / composite	
1.5.	Housing color		
1.6.	Housing drawing No.		
1.7.	Insulation type:	OIP, RIP, RIS, other	
1.8.	Insulation class according to:	IEC 60137, Table 2	
1.9.	Overall dimensions [mm]		
1.10.	Length of earthed sleeve (considering the wall width) [mm]		
1.11.	Weight [kg]		
1.12.	Angle of mounting according to:	IEC 60137, clause 4.6	
1.13.	Conductor and terminals material		
1.14.	Installation altitude [m]		
1.15.	Type of installation:	1. External-external 2. External-internal 3. Internal-Internal	
1.16.	Pollution severity (SPS) class	e (very heavy)	
1.17.	Range of operating temperatures [^{0}C]	According to clause 2.3	
1.18.	Rated frequency [Hz]		
1.19.	Rated highest voltage for equipment (U_m) according to:	IEC 60137:2017, clause 4.1	
1.20.	Maximum phase–to-earth temporary over-voltages the bushings can withstand according to:	IEC 60137 clause 5.1	
1.21.	Rated current (I_r):		
1.21.1.	According to the Manufacturer spec. [A]	IEC 60137:2017, clause 4.2	

	Description	Required Value or Applicable Standard	Manufacturer's Confirmation or Proposal
1.21.2.	Corrected I_r value [A]	According to the temperature conditions in clause 2.3	
1.22.	Rated thermal short-time current (I_{th}) [kA] at least:	50 kA	
1.23.	Rated dynamic current (I_d) [kA] according to:	IEC 60137:2017, clause 4.4	
1.24.	Insulation level, at least:	IEC 60137:2017, Table 3	
1.24.1.	Lightning impulse withstand voltage, at least [kV peak]	750	
1.24.2.	Power frequency withstand voltage (dry and wet) at least [kV r.m.s]	325	
1.25.	Creepage distance [mm] according to SPS class e and RU SCD= 53.7 IEC 60815-3 / 60815-1. at least:	5270 IEC 60137, clause 3.36	
1.26.	Arcing distance, at least [mm]	1500 IEC 60137, clause 3.37	
1.27.	Required minimum values of cantilever withstand load applied on the bushings according to:	IEC 60137 clause 4.5 (level II)	
1.28.	Maximum value of test tap capacitance according to:	IEC 60137 clause 4.10	
1.29.	C1 typical dielectric dissipation factor [%], no more than values in:	IEC 60137, Table 8	
1.30.	C1 typical capacity [pf]		
1.31.	Maximum values of partial discharge according to:	IEC 60137, Table 9	
1.32.	The bushing profile shall include Alternating Sheds according to:	IEC 60815-3	
1.33.	Required profile parameters for bushings according to:	Annex 2	
1.34.	The temperature limits of metal parts in contact with insulating material must be according to:	IEC 60137, clause 4.8	
1.35.	Seismic qualification level according to:	Clause 3	

Annex 2: Bushings required profile parameters

	Required Data and Documentation	
	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.

$$D_a = \frac{D_{s1} + D_{s2} + 2D_t}{4}$$

L: creepage distance.

A: arcing distance.

Revision Control Table:

Rev	Date	Revision description	Performed by	Approved by
01	07-01-2026	Changes were made to clauses 3 and 7.3.1 Changes were made to Annexes 2 & 3	Carlos Lisman	Adir Anidgar
02	04-03-2026	Changes were made to the following clauses: • Annex 2 (Operational experience) has been removed from this document and uploaded into Threshold Requirements document on NOGA-ISO website. • Annex 3 (RAMS) – has been removed from this document and uploaded to NOGA-ISO site under "Threshold Requirements."	Carlos Lisman	Adir Anidgar
03				
04				