| Eskom | SPECIFICATION | NUCLEAR ENGINEERING |
|---|---|---|

Title: **Specification For Air Pressure Regulators**

| | |
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|---|---|---|
| X Booi | PN Clark | N Ryland |
| Engineering Technologist | Senior Technician | Manager |
| Specification Engineering Group | Specification Engineering Group | Specification Engineering Group |
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## ADDITIONAL CLASSIFICATION INFORMATION

| | |
|---|---|
| Business Level: | **3** |
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| Functional Control Area: | **Nuclear Engineering** |

# CONTENTS

# 1. INTRODUCTION

1.1 This specification lists the requirements for the procurement of Air pressure regulators.

1.2 If any conflict arises between this specification and other referenced documents, the Contractor/Vendor/Supplier shall not proceed, but shall request clarification, in writing, from the approved Eskom buyer.

# 2. SCOPE

The supply consists of the following equipment:

- Air pressure regulators.

The manufacturer shall be responsible for:

- Manufacture;
- Testing and qualification;
- Documentation;
- Packaging, storage and transport;
- Technical support;
- Customs formalities for export purposes.

## 2.1 PURPOSE

This specification lists the minimum requirements for the procurement of air pressure regulators, for use in both harsh and mild environments. These regulators supply control air to the solenoid valves and actuators. They are classified for environmental category 4 (i.e. they must be operable during and after a design basis accident) and must be seismically qualified since the regulator failure will affect the operability of the parent component. The solenoid valves and actuators (i.e. parent components) are safety class 1E.

## 2.2 APPLICABILITY

This specification is applicable to Eskom, Koeberg Nuclear Power Station.

# 3. REFERENCES

Parties using this specification shall apply the most recent edition of the documents listed in the following paragraphs.

## 3.1 NORMATIVE

[1] ANSI/ASME NQA-1: Quality Assurance Requirements for Nuclear Facility Applications

[2] IEEE 323: Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations

[3] IEEE 344: Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations

[4] RCC-E – Design and Construction Rules for Electrical Equipment of Nuclear Islands

### 3.2 INFORMATIVE

[5] ANSI N45.2.2: Level B Spare Parts Shelf Life

[6] KBA 12 22 E02 038: General Specification for Qualification to DBA Conditions

[7] KBA 12 22 E02 008: General Seismic Test Specification

[8] KBA 00 22 E00 077: Local Instrument Specification

[9] KBA 00 22 E01 005: Prescriptions Relative to Nuclear Cleanliness During Manufacture of Equipment used in the Nuclear Island

[10] KBA1216J10256: General Electric Installations

[11] KBA0022E00090: Post DBA Conditions

## 4. DEFINITIONS AND ABBREVIATIONS

### 4.1 DEFINITIONS

**4.1.1** **Class 1E** - The safety classification of electrical equipment and systems that are essential to emergency reactor shutdown, containment isolation, reactor core cooling, and containment and reactor heat removal, or are otherwise essential in preventing significant release of radioactive material to the environment.

Units of Radiation: 1 Gray (Gy) = 100 Rad

**4.1.2** **Environmental Qualification** - The primary objective of environmental qualification is to demonstrate with reasonable assurance that Class 1E equipment for which a qualified life or condition has been established can perform its safety function(s) without experiencing common-cause failures before, during, and after applicable design basis events. Class 1E equipment, with its interfaces, must meet or exceed the Environmental Qualification requirements. This continued capability is ensured through a program that includes, but is not limited to, design control, quality control, qualification, installation, maintenance, periodic testing, and surveillance.

**4.1.3** **Harsh Environment** - An environment expected as the result of the postulated service conditions appropriate for the design basis and beyond design basis accidents of the station. Harsh environments are the result of a loss of coolant accident (LOCA) or high energy line breaks (HELB) inside the containment and post-LOCA or HELB outside the containment.

**4.1.4** **Mild environment -** An environment that would at no time be significantly more severe than the environment that would occur during normal plant operation, including anticipated operational occurrences.

### 4.2 ABBREVIATIONS

| Abbreviation | Description |
|---|---|
| **ANSI** | American National Standards Institute |
| **ASME** | American Society of Mechanical Engineers |
| **COC** | Certificate of Conformance |
| **DBA** | Design Basis Accident |
| **EQ** | Environmental Qualification |
| **HELB** | High Energy Line Breaks |
| **IEEE** | The Institute of Electrical and Electronics Engineers, Inc. |
| **LOCA** | Loss of Coolant Accident |
| **MITP** | Manufacturing, Inspection and Test Plan |
| **NQA** | Nuclear Quality Assurance |
| **QADP** | Quality Assurance Data Package |
| **RRS** | Required Response Spectra |
| **SSE** | Safe Shutdown Earthquake |

## 5. REQUIREMENTS

The air pressure regulators must comply with all the requirements listed in Section 6.0 of this specification.

## 6. PROCUREMENT SPECIFICATION

### 6.1 DESIGN REQUIREMENTS

#### 6.1.1 Interfaces

| | | |
|---|---|---|
| Process connection | : | G 3/8 (Inlet & outlet) |
| Mounting | : | In-line |

#### 6.1.2 Dimensional Requirements

| | | |
|---|---|---|
| Overall width | : | 80 mm |
| Overall height | : | 159 mm |
| Weight | : | 2.2 kg |

#### 6.1.3 Service Conditions

##### 6.1.3.1 Normal Environmental Conditions:

| | | |
|---|---|---|
| Temperature | : | 15°C to 60°C |
| Pressure | : | 100 kPa ± 20 kPa |
| Relative Humidity | : | 50 to 100% |
| Radiation | : | 0.5 Gy/hr |

#### 6.1.3.2 Operating Conditions:

| | | |
|---|---|---|
| Operating temperature (max) | : | 60°C |
| Max supply pressure | : | 900 kPa |
| Regulated output pressure | : | 400 kPa (set point) |
| Humidity (max) | : | 100% |
| Radiation (max) | : | 3 Gy/hr |
| Process medium | : | Instrument air |

#### 6.1.3.3 Accident Conditions - Design Basis Accident (DBA):

| | | |
|---|---|---|
| Qualification | : | IEEE or RCC-E |
| Temperature (max) | : | 156°C |
| Pressure (max) | : | 0.55 MPa (absolute) |
| Humidity (max) | : | 100% |
| Radiation (max) | : | $6 \times 10^5$ Gy ($6 \times 10^7$ rad) (cumulative dose one year after accident) |
| Medium | : | Steam and water mixed with boric acid and trisodium phosphate |

Design basis accident conditions are discussed in more detail in Appendix A.

#### 6.1.3.4 Seismic Qualification:

The 1E qualified equipment shall withstand earthquakes according to the specifications given in Appendix B.

### 6.2 MANUFACTURING REQUIREMENTS

#### 6.2.1 Physical Requirements

- Body material : Leaded brass (or any qualified material)
- Diaphragm : EPDM
- Marking and Identification:
  - The manufacturer's name;
  - The type;
  - The serial number;
  - The operating pressure.

### 6.2.2 Verification and Tests

The supplier shall perform all inspections, tests, aging or other services necessary to guarantee the performance stated in this technical specification.

The manufacturer shall supply a production file, consisting of:

#### 6.2.2.1 The Manufacturing, Inspection and Test Plan (MITP)

These lists shall be prepared for each type of equipment. Each manufacturing operation or test shall be clearly specified in the MITP. Each operation mentioned shall be given a document reference which specifies the operation.

#### 6.2.2.2 The Manufacturing and Testing Procedures

These procedures shall correspond to the main operations mentioned in the MITPs.

These procedures shall indicate, in particular:

- The welding and weld inspection methods;
- The methods used to obtain and keep the required degree of cleanness;
- The acceptance criteria for testing.

#### 6.2.2.3 The Test Certificates or Test Reports

These documents correspond to the main manufacturing or testing operations and should be available for perusal:

- The weld examination certificates;
- Liquid penetrant testing (all the welds which cannot be checked by ultrasonic or radiographic testing);
- The compliance certificates for seals;
- The hydrotest certificates;
- The cleanness certificates.

Results of tests shall be submitted as part of the Quality Assurance Data Package (QADP).

## 6.3. ENGINEERING QUALITY REQUIREMENTS

### 6.3.1 Class 1E Requirements

The air pressure regulators supply control air to safety class 1E components and their failure will affect the operability of the parent components, for this reason they must pass or have passed tests proving their ability to perform specified functions under seismic loading and under accident and post-accident conditions.

### 6.3.2 Class of Nuclear Cleanness

Requirements associated with the cleanness of the air pressure regulators are specified in ANSI/ASME NQA-1.

**NOTE:** To facilitate manufacturing, the manufacturer may use a single class of cleanness, but it must comply with the requirements of the highest class.

### 6.3.3 Quality Assurance

- The air pressure regulators shall be qualified in accordance with IEEE-323-1974 (or latest standard) and IEEE-344-1975 (or alternative qualification standard, i.e. RCC-E code or KTA standard).
- The manufacturer or supplier is required to implement a quality assurance program which is consistent with, and meets those requirements of TITLE 10 CODE OF FEDERAL REGULATIONS 50 (10 CFR 50), Appendix B and ANSI or ASME NQA1 which are applicable to the scope of work performed under this specification. Eskom, Koeberg must be advised of any significant changes in the supplier's quality assurance programme.
- Eskom approval is required for the dispositioning of any non-conformances to procurement requirements or to Eskom-approved documents, except where the item can be re-worked to full compliance. Proposed dispositions for repair or "use-as-is" shall be identified on an APPLICATION FOR CONCESSION or PRODUCTION PERMIT FORMAT or equivalent, and submitted to Eskom, Koeberg Nuclear Power Station for approval.
- Eskom reserves the right of access to supplier or sub-supplier facilities and records for the purpose of inspection or audit.

## 6.4 TRAINING

Not applicable.

## 6.5 DOCUMENTATION

### 6.5.1 Documents to be submitted with the quote

6.5.1.1 For each type of instrument proposed:

- The technical sheet;
- The operating manual;
- The overall drawing.

6.5.1.2 Accreditation or Certification indicating independent acceptance of the supplier's quality assurance programme;

6.5.1.3 Manufacturers commitment to supporting the proposed air pressure regulators for the future, in terms of replacements and spares;

6.5.1.4 Manufacturers recommended maintenance requirements to ensure qualification.

### 6.5.2 Documents to be submitted on delivery of equipment

6.5.2.1 A complete and comprehensive QADP, which includes, as a minimum, the following documentation:

- The MITPs (Manufacturing, Inspection and Test Plans);
- Test certificates or reports as listed in sub-paragraph 6.2.2.3;
- Certificate of Conformance (C.O.C).

### 6.5.3 Documents to be submitted on initial purchase of equipment

6.5.3.1 In addition to the above, when the equipment is procured for the first time, or either the part number or component has changed, the supplier/manufacturer shall provide the following documentation:

- Environmental Qualification (EQ) test report (or summary of qualification);
- Seismic test report.

### 6.6 PACKAGING AND SHIPMENT

6.6.1 The supplier is responsible for packaging in accordance with ASME NQA-1 sub-part 2.2 for transportation to South Africa and for the transportation to a mutually agreed port of shipment.

6.6.2 Each package shall be identified with the following:

- Eskom Purchase Order Number;
- Equipment Part Number;
- This Specification Number.

### 6.7 RECORDS

6.7.1 All specifications, including superseded specifications, shall be retained as permanent records in accordance with 331-3.

## 7. DEVELOPMENT TEAM

The following people were involved in the development of this specification:

| Name | Designation or Business area |
|---|---|
| Xolelwa Booi | Engineering Technologist - Specification Engineering |

## 8. ACCEPTANCE AND AUTHORISATION

This specification has been seen and accepted by:

| Name | Designation or Business area |
|---|---|
| PN Clark | Senior Technician – Specification Engineering |
| K Moroka | Senior Engineer – Engineering Programmes |
| | |

## 9. APPENDICES

9.1 Appendix A: Ambient Containment Conditions After a DBA (Figures 1, 2 & 3)

9.2 Appendix B: Seismic Requirements (Figures 1 & 2)

## 10. REVISION INFORMATION

| Date | Rev. | Compiler | Remarks |
|---|---|---|---|
| 2015-06-03 | 0 | X Booi | Original |
| | | | |

## APPENDIX A

## AMBIENT CONTAINMENT CONDITIONS AFTER A DESIGN BASIS ACCIDENT

### 1. PRESSURE AND TEMPERATURE

The original design studies for Koeberg indicate that the maximum temperature and pressures obtained inside containment after a DBA are:

- Temperature : 156°C
- Absolute Pressure : 0.55 MPa

The simulation conditions are to be as per the graphs shown in Figure 1 and Figure 2.

### 2. RADIATION

The original design studies for Koeberg indicate the following:

- During the first hour following the accident, the instantaneous absorbed dose is $\geq 4.3 \times 10^4$ Gy/h ($4.3 \times 10^6$ rad/hr);
- The cumulative absorbed dose reaches $4.3 \times 10^4$ Gy ($4 \times 10^6$ rad) for the first hour;
- The cumulative absorbed dose reaches $6 \times 10^5$ Gy ($6 \times 10^7$ rad) after one year following a design basis accident.

### 3. RELATIVE HUMIDITY

100%

### 4. CONTAINMENT SPRAY

- Boric acid (H3BO3): 2 500 mg B/kg in PTR 001 BA prior to injection;
- Hydrated trisodium phosphate, $Na_3PO_4.12H_2O$ (TSP), in solid granular form during recirculation;
- The pH varies from between 4 and 6 at the beginning of direct spraying to 7.02 during the recirculation phase, when all the liquids released in the containment following a LOCA are mixed. The design requirement is to maintain the pH to between 7.02 and 7.49.

Must be assumed to occur during the pressure and temperature peak transient.

**FIGURE 1: DBA QUALIFICATION CONDITIONS - TEMPERATURE VS TIME**

**FIGURE 2: DBA QUALIFICATION CONDITIONS FOR 1E EQUIPMENT – CUMULATIVE DOSE VS TIME (GAMMA RADIATION)**

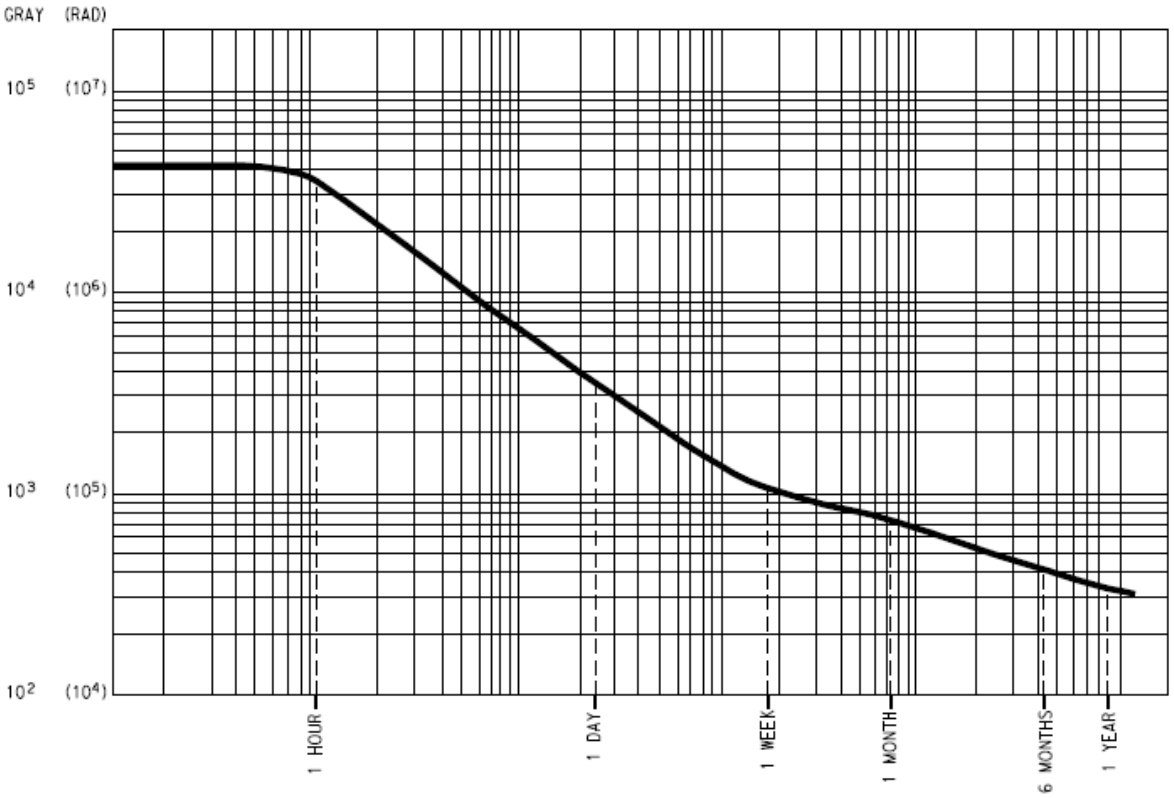


**FIGURE 3: DBA QUALIFICATION CONDITIONS FOR 1E EQUIPMENT – INSTANTANEOUS DOSE VS TIME (GAMMA RADIATION)**

# APPENDIX B

# SEISMIC REQUIREMENTS

## AIM

The aim of this appendix is to define the safe shutdown earthquake (SSE) applicable to allow testing according to the guidelines of IEEE 344, and not to define the test method.

## 1.0 SAFE SHUTDOWN EARTHQUAKE INTRODUCTION

### 1.1 Vibration Specifications

In the event of an earthquake, the floors upon which the various pieces of electrical equipment are installed are subjected to vibratory waves. These waves are transmitted by the structural elements of the buildings, which serve to filter out some of the waves. If time line history (actually recorded or theoretical) is available, the waveforms of these vibrations can be studied and understood.

The effects of the vibratory waves can be predicted from the behaviour of dummy oscillators anchored to the floors. This behaviour is transformed into floor oscillator response or floor response spectra. Such spectra are generally of the acceleration response type.

The spectrum for a given floor consists of a family of parametric curves, which vary from the oscillator reduced damping factor.

Seismic floor motion occurs simultaneously in all directions, but it can be broken down into three fundamental axes. Response spectra are generally established for one random horizontal axis and the vertical direction as well.

**Required Response Spectra (RRS)**

By joining together the response spectra for the various floors of the building, one horizontal envelope spectrum and one vertical envelope spectrum can be determined. Such spectra represent the sum of seismic phenomena that will take place at equipment anchoring points. This constitutes the required response spectra (RRS) for qualification purposes. In determining envelope spectra, it is preferable to select those curves which correspond to the assumed damping level for the piece of equipment to be qualified.

In most cases, however, this value can be assumed to be 5%.

### 1.2 Test Principle

These tests shall be run by subjecting the equipment to a vibratory motion that conservatively simulates the vibration expected to occur at the equipment anchoring point in the event of a SSE.

Consequently, motion observed on the shake table shall produce effects identical or superior to those specified by the reference spectra.

### 1.3 Mounting of Equipment on Shake Table

Equipment shall be mounted on the shake table so as to simulate actual intended on-site mounting. The orientation of the equipment shall be identical to its location on site, as the effect of gravity is of particular importance.

Connections shall be identical to those used in actual installation (bolting, welding, etc.). The effect of electrical connections, conduits and sensing lines shall be taken into account.

## 2.0 TEST REPORT

This document shall contain all data necessary to show that the equipment has been properly qualified.

The following items shall be included:

a) Equipment specification;
b) Test facility description;
c) Test method description;
d) Test data (including proof of performance);
e) Test results and conclusions (comparison of the test response spectrum and the RRS);
f) Date and approved signature.

## 3.0 REQUIRED RESPONSE SPECTRA (RRS)

### 3.1 Electrical Control and Instrumentation Assemblies

Two envelope spectra have been drawn up (one vertical and one horizontal), with 5% damping factor.

These spectra are representative of severity levels determined for the Koeberg Nuclear Power Station plant. They are represented in figures 1 and 2 respectively, **by solid lines.**

**Qualified Equipment shall meet seismic conditions defined by these spectra.**

**NOTE:**

There exists a critical point on the horizontal spectrum at 1 Hz (high acceleration). If this low frequency service cannot be simulated at the test facility (shake table travel and velocity are usually limited), **it must be shown that the equipment subjected to testing does not carry any natural frequency in the 1 Hz range.**

## KBA 1222 E02 008 – GENERAL SEISMIC TEST SPECIFICATION FOR 1E EQUIPMENT

## KBA 1222 E02 008 – GENERAL SEISMIC TEST SPECIFICATION FOR 1E EQUIPMENT

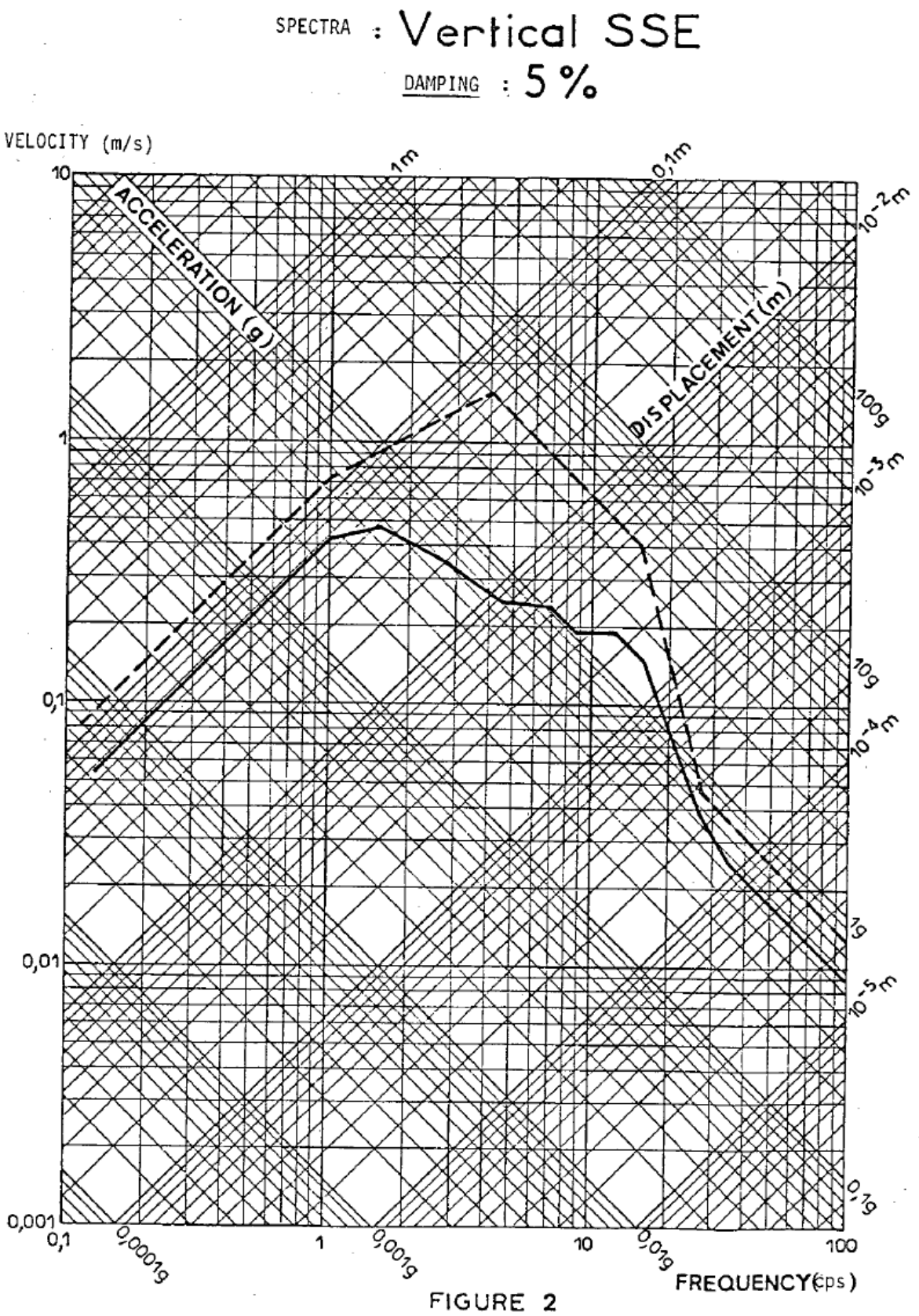


FIGURE 2