



Exploration & Production

GENERAL SPECIFICATION

ELECTRICAL

GS EP ELE 114

HV Synchronous Motors

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Contents

1. Scope	4
2. Reference documents.....	4
3. Abbreviations	6
4. Environment conditions	6
5. General.....	7
5.1 Materials, workmanship and suitability	7
5.2 Specification deviations.....	7
5.3 Motors for hazardous area	7
5.4 Rating and performance.....	7
6. Construction requirements	10
6.1 General.....	10
6.2 Machine cooling	10
6.3 Stator frame	11
6.4 Terminals and terminal boxes	13
6.5 General requirements related to EEx"p" design.....	13
6.6 Rotor	13
6.7 Rotating exciter	14
6.8 Maintenance access	14
6.9 Motor earthing	15
6.10 Bearings.....	15
6.11 Lubrication	15
6.12 Motor protection	16
6.13 Labels and rating plates	16
6.14 Noise levels	16
6.15 Special tools	16
7. Inspection and testing	16
7.1 Qualification tests.....	16
7.2 Test during production	16
7.3 Factory Acceptance Tests (FAT).....	17



7.4	Test reports.....	18
8.	Design Life & Obsolescence	18
9.	Documentation to be provided	19
10.	Other references	20
Appendix 1	Fixed speed motors protections.....	21
Appendix 2	Variable speed motors protections	22
Appendix 3	Data Sheet HV Synchronous Motor	23



1. Scope

The purpose of this specification is to set out the general requirements for the design, manufacture and performance of HV synchronous motors either fed by a grid (fixed speed motors) or fed by a Variable Speed Drive (variable speed motors), to be installed in Company sites located either onshore or offshore.

2. Reference documents

The reference documents listed below form an integral part of this General Specification. Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the EFFECTIVE DATE of the CONTRACT.

The following order of precedence applies specifically to electrical equipment:

- Applicable laws and regulations of the country in which the system will be operated. In cases where no "local" regulations exist, the French laws and regulations shall be used
- Company Particular Specifications and data sheet (if any)
- Company General Specifications
- Applicable International Electro-technical Commission (IEC) Standards
- Applicable CENELEC Standards
- Applicable recognised standards and codes (e.g. UTE-NFC, BSI, VDE, etc.) where IEC publications have not yet been issued.

Any conflict or inconsistency between the above set of documents (standards, specification, codes and local regulation or laws) shall be raised to Company attention for resolution.

Standards

Reference	Title
IEC 60034 (Parts 1; 5; 6; 9; 14)	Rotating Electrical Machines - (Parts 1; 5; 6; 9; 14)
IEC 60072	Dimensions and output ratings for rotating electrical machines
IEC 60085	Thermal evaluation and classification of electrical insulation
IEC 60146-1-2	Semiconductor convertors - General requirements and line commutated convertors. Part 1-2: Application guide
IEC 60529	Classification of Degree of Protection Provided by Enclosures
IEC 61000-2-4	Electromagnetic compatibility (EMC) - Part 2-4: Environment - Compatibility levels in industrial plants for low-frequency conducted disturbances
IEC 61800-4	Adjustable speed electrical power drive systems
IEC 62262	Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)
IEC 62402	Obsolescence management - Application guide



Reference	Title
IEEE 43	IEEE recommended practice for testing insulation resistance of rotating machinery (ANSI)
IEEE Std 115	Test procedures for synchronous machines Part I: Acceptance and performance testing Part II: Test procedures and parameter determination for dynamic analysis
IEEE Std 995	Recommended practice for efficiency determination of alternating-current adjustable speed drives Part I: Load commutated inverter synchronous motor drives
ISO 7919-1	Mechanical vibration of non-reciprocating machines. Measurements on rotating shafts and evaluation criteria. Part 1: general guidelines.
ISO 12944-2	Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 2: classification of environments
ISO 281	Rolling bearings - Dynamic load ratings and rating life
ISO 2954	Mechanical vibration of rotating and reciprocating machinery - Requirements for instruments for measuring vibration severity
ISO 4628-3	Paints and varnishes - Evaluation of degradation of coatings - Designation of quantity and size of defects, and intensity of uniform changes in appearance - Part 3: Assessment of degree of rusting
ISO 8821	Mechanical vibration - Balancing - Shaft and fitment key convention

Professional Documents

Reference	Title
Not applicable	

Regulations

Reference	Title
Not applicable	

**Codes**

Reference	Title
Not applicable	

Other documents

Reference	Title
Not applicable	

Total General Specifications

Reference	Title
GS EP COR 350	External protection of offshore and coastal structures and equipment by painting
GS EP COR 354	External protection of onshore structures and equipment by painting
GS EP ELE 079	Electrical apparatus for potentially explosive gas atmospheres
GS EP ELE 121	HV Variable Speed Drive Systems
GS EP TEC 007	Obsolescence and Lifetime Cycle Management

3. Abbreviations

EMA	Experimental Modal Analysis
FAT	Factory Acceptance Tests
LCI	Load Commutated Inverter
THD	Total Harmonic Distortion
VPI	Vacuum Pressure Impregnated
VSD	Variable Speed Drive

4. Environment conditions

The minimum degree of protection of enclosures shall comply with the following (according to [IEC 60529](#)):

- Indoor equipment IP 23
- Outdoor equipment IP 55
- Indoor or outdoor equipment IK 08



5. General

5.1 Materials, workmanship and suitability

All materials and parts included in the construction of the motors shall be new and unused, of current manufacture, of the highest grade, and free from all defects and imperfections likely to affect its performance.

5.2 Specification deviations

The Supplier shall advise Company of any deviations made in respect of this specification at the time of tendering.

Should this specification conflict with requirements of the listed standards, the Supplier shall request clarification from the Company.

5.3 Motors for hazardous area

Motors installed in hazardous areas shall be selected as per **GS EP ELE 079** requirements.

Motors and accessories shall bear their own marking, according to the mode of protection used.

5.4 Rating and performance

5.4.1 General

Unless otherwise specified in the data sheet, fixed speed motors shall be suitable for continuous duty type S1 and variable speed motors shall be suitable for duty type S9, at the rated power and specified ambient conditions without any harmful effects.

Motors, excitation systems and all accessories shall be designed and constructed in accordance with good engineering practices which shall result in an expected lifetime of at least 20 years. The machines shall be suitable for at least five years uninterrupted operation under the conditions specified.

5.4.2 Auxiliary supplies

Unless otherwise specified in the data sheet the voltages provided by Company for auxiliary equipment shall be:

- 400 V AC - 3 phase from normal supply (earthed through a 150 mA high impedance)
- 230 V AC - Phase / Neutral TT or TNS from normal supply
- 230 V AC UPS - 1 phase floating
- DC voltage - 24 or 48 V DC floating.

The auxiliary loads shall be included into the power balance.

5.4.3 Start-up

Unless otherwise specified, fixed speed motors shall be designed for direct-on-line asynchronous starts, in this case fixed speed motors shall be designed for heavy duty 1000 starts/year for the mechanical system and electrical system.

5.4.4 Sudden short circuit

The motors shall be designed to withstand without damage a short circuit of any kind (and at least 300% of the rated motor current) at the terminals, whilst operating at rated load and 105% of rated voltage, for a period of three seconds.

5.4.5 Pulsating stator current

The motors driving equipment which requires a variable torque during each revolution (e.g. reciprocating compressors) shall have sufficient inertia to limit the variations in motor stator current to a value not exceeding 20% of the rated current.

5.4.6 Form and symmetry of voltages and currents

The motors shall be able to operate on an unbalanced system as defined in [IEC 60034-1](#) paragraph 7.2.

For fixed speed motors, the performance of the equipment shall not be affected by Harmonic voltage THD up to 10% and each Individual Harmonic Distortion within the limits of class 3, tables 3 and 4 of [IEC 61000-2-4](#).

Should the limits of deformation and balance occur simultaneously in service at the rated load, this shall not lead to any deleterious temperature in the motor and the excess resulting temperature rise or temperature related to be limits specified in this standard shall be not more than approximately 10K.

5.4.7 Harmonics

For fixed speed motors, when tested in open circuit and at rated speed and voltage, the voltage THD shall not exceed 3% and individual harmonics voltage shall not exceed 2%. The Manufacturer shall specify the maximum acceptable harmonic rejection from consumers to motor to operate in satisfactory conditions.

For variable speed motors, the Manufacturer shall liaise with the VSD Supplier to take into account the effects of harmonics and inter harmonics of the VSD on the motor design.

For variable speed motors, when used with a Load Commutated Inverter (LCI), the losses shall be determined using the [IEEE Std 115](#) test procedure amended by [IEEE Std 995](#) for harmonic losses and auxiliary losses.

5.4.8 Windings insulation level (Stator and Rotor)

For fixed speed motors fed via vacuum circuit breaker, the Contractor shall indicate to the Manufacturer the maximum dV/dt expected on the motor terminals in order to assess the motor insulation levels.

Variable speed motors shall comply with the minimum motor insulation levels as per [IEC 61800-4](#) requirements. The Manufacturer shall liaise with the VSD Supplier to take into account the expected voltage stress on the motor winding insulation system as a result of transient peak voltage values, peak rise time and repetition rate.

5.4.9 Excitation system

For fixed speed motors, the excitation system shall be designed for a rated power factor of 0.8 leading (overexcited) at rated output, expressed in kilo-volt-amperes, and with the motor voltage between 90% and 110% of the rated value.

Excitation system shall be rated for at least 110% of the excitation current required during full load operation at rated voltage and rated power factor.

Excitation system shall have a thermal protection of the rotor based on excitation current measurement.

Fixed speed motors shall be supplied with a separate panel which contains the excitation system, regulation equipment, local control switches and/or pushbuttons, etc. Excitation system shall be equipped with an automatic power factor controller capable of maintaining the power factor within a margin of $\pm 2.5\%$.

For variable speed motors, the following shall apply:

- The excitation panel shall be included within the VSD panel
- The excitation system shall be controlled by the VSD
- The excitation current shall be cancelled as soon as a trip is triggered by the VSD.

5.4.10 Earth faults

The Manufacturer shall provide Company with the external earth fault withstand capability curve: $i_0 = f(t)$.

For fixed speed motors, unless otherwise specified in the data sheet, the minimum requirement current shall be 30A for three seconds, without exceeding the specified temperature rise limits.

For variable speed motors, the Manufacturer shall liaise with the VSD Supplier to define the earth fault current and the associated time.

5.4.11 Mechanical

5.4.11.1 Transient air-gap torque

The Manufacturer shall state the maximum transient air-gap torque during 2 or 3 phase short-circuit faults.

For fixed speed motors, the Manufacturer shall state the maximum transient air-gap torque during asynchronous start and reconnection after power interruption.

5.4.11.2 Critical speeds

Motor with a rigid and subcritical rotor bearing shall have the first critical speed not lower than 125% of the rated speed. For motor with a flexible, overcritical rotor bearing, the first critical speed shall not be above 80% of rated speed and the second not lower than 125% of rated speed.

The driven equipment Manufacturer shall perform a torsional analysis of the complete system. The motor Manufacturer shall provide all required data in a timely fashion to allow this work to proceed including dimensional data to prepare the torsional model as well as motor air-gap torque and dynamic torque characteristics during system fault conditions.

In addition for variable speed motors, the motor Manufacturer shall liaise with the VSD Supplier and driven equipment Supplier to take into account, as part of the torsional analysis, the torque pulsations produced as a result of VSD voltage and current harmonics.