

DEP SPECIFICATION

**ELECTRICAL MACHINES - CAGE-INDUCTION TYPES
(AMENDMENTS/SUPPLEMENTS TO
IEC 60034-1 AND IEC 60034-14)**

DEP 33.66.05.31-Gen.

February 2017

DESIGN AND ENGINEERING PRACTICE



© 2017 Shell Group of companies

All rights reserved. No part of this document may be reproduced, stored in a retrieval system, published or transmitted, in any form or by any means, without the prior written permission of the copyright owner or Shell Global Solutions International BV.

This document has been supplied under license by Shell to:
UOP Honeywell ted.fuger@honeywell.com 19/01/2018 09:20:08

AVA Documents
Document Sharing Hub

PREFACE

DEP (Design and Engineering Practice) publications reflect the views, at the time of publication, of Shell Global Solutions International B.V. (Shell GSI) and, in some cases, of other Shell Companies.

These views are based on the experience acquired during involvement with the design, construction, operation and maintenance of processing units and facilities. Where deemed appropriate DEPs are based on, or reference international, regional, national and industry standards.

The objective is to set the standard for good design and engineering practice to be applied by Shell companies in oil and gas production, oil refining, gas handling, gasification, chemical processing, or any other such facility, and thereby to help achieve maximum technical and economic benefit from standardization.

The information set forth in these publications is provided to Shell companies for their consideration and decision to implement. This is of particular importance where DEPs may not cover every requirement or diversity of condition at each locality. The system of DEPs is expected to be sufficiently flexible to allow individual Operating Units to adapt the information set forth in DEPs to their own environment and requirements.

When Contractors or Manufacturers/Suppliers use DEPs, they shall be solely responsible for such use, including the quality of their work and the attainment of the required design and engineering standards. In particular, for those requirements not specifically covered, the Principal will typically expect them to follow those design and engineering practices that will achieve at least the same level of integrity as reflected in the DEPs. If in doubt, the Contractor or Manufacturer/Supplier shall, without detracting from his own responsibility, consult the Principal.

The right to obtain and to use DEPs is restricted, and is typically granted by Shell GSI (and in some cases by other Shell Companies) under a Service Agreement or a License Agreement. This right is granted primarily to Shell companies and other companies receiving technical advice and services from Shell GSI or another Shell Company. Consequently, three categories of users of DEPs can be distinguished:

- 1) Operating Units having a Service Agreement with Shell GSI or another Shell Company. The use of DEPs by these Operating Units is subject in all respects to the terms and conditions of the relevant Service Agreement.
- 2) Other parties who are authorised to use DEPs subject to appropriate contractual arrangements (whether as part of a Service Agreement or otherwise).
- 3) Contractors/subcontractors and Manufacturers/Suppliers under a contract with users referred to under 1) or 2) which requires that tenders for projects, materials supplied or - generally - work performed on behalf of the said users comply with the relevant standards.

Subject to any particular terms and conditions as may be set forth in specific agreements with users, Shell GSI disclaims any liability of whatsoever nature for any damage (including injury or death) suffered by any company or person whomsoever as a result of or in connection with the use, application or implementation of any DEP, combination of DEPs or any part thereof, even if it is wholly or partly caused by negligence on the part of Shell GSI or other Shell Company. The benefit of this disclaimer shall inure in all respects to Shell GSI and/or any Shell Company, or companies affiliated to these companies, that may issue DEPs or advise or require the use of DEPs.

Without prejudice to any specific terms in respect of confidentiality under relevant contractual arrangements, DEPs shall not, without the prior written consent of Shell GSI, be disclosed by users to any company or person whomsoever and the DEPs shall be used exclusively for the purpose for which they have been provided to the user. They shall be returned after use, including any copies which shall only be made by users with the express prior written consent of Shell GSI. The copyright of DEPs vests in Shell Group of companies. Users shall arrange for DEPs to be held in safe custody and Shell GSI may at any time require information satisfactory to them in order to ascertain how users implement this requirement.

All administrative queries should be directed to the DEP Administrator in Shell GSI.

TABLE OF CONTENTS

PART I	INTRODUCTION	5
1.1	SCOPE	5
1.2	DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS	5
1.3	DEFINITIONS	6
1.4	CROSS-REFERENCES	9
1.5	SUMMARY OF MAIN CHANGES.....	9
1.6	COMMENTS ON THIS DEP	9
1.7	DUAL UNITS.....	10
1.8	NON NORMATIVE TEXT (COMMENTARY).....	10
PART II	GENERAL REQUIREMENTS	11
2	GENERAL	11
2.1	STATEMENT OF COMPLIANCE	11
2.2	LIFETIME AND RELIABILITY.....	11
2.3	STUDIES	11
2.4	EFFICIENCY AND LIFE-CYCLE COST	11
2.5	GENERAL DESIGN FEATURES.....	12
PART III	AMENDMENTS/SUPPLEMENTS TO IEC 60034-1.....	14
3	Terms and definitions	14
4	Duty	14
4.1	Declaration of duty.....	14
5	Rating	14
5.5	Rated output	14
6	Site operating conditions.....	15
6.1	General	15
6.4	Minimum ambient air temperature	15
6.5	Water coolant temperature	15
6.8	Additional design data for air-to-water cooled heat exchangers	16
7	Electrical operating conditions	16
7.1	Electrical supply.....	16
7.2	Form and symmetry of voltages and currents	17
7.3	Voltage and frequency variations during operation	17
7.4	Three-phase a.c. machines operating on unearthed systems	17
8	Thermal performance and tests	17
8.9	Measurement of bearing temperature	17
9	Other performance and tests.....	17
9.1	Routine tests	17
9.6	Safe operating speed of cage induction motors	17
9.7	Overspeed	18
9.12	Starting, re-starting and re-acceleration	18
9.13	Starting characteristics	19
9.14	Transient air-gap torques.....	21
9.15	Running-up time.....	21
9.16	Critical speeds	22
9.17	Noise	23
9.18	Pulsating stator current.....	23
10	Rating plates	24
10.1	General	24
10.2	Marking	24
10.3	Marking of machines in hazardous areas	25
11	Miscellaneous requirements	25

11.3	Machine housing	25
11.4	Windings	28
11.5	Terminal boxes	29
11.6	Bushings and terminations	30
11.7	Stator core of VSDS motors	31
11.8	Rotor, fans and coupling	31
11.9	Protective systems.....	33
11.10	Bearings	35
11.11	Special constructions	38
11.12	Mass	39
11.13	Surface finish	39
11.14	Unit transformer (HV motors).....	40
12	Tolerances	40
12.1	General	40
13	Electromagnetic compatibility (EMC)	41
13.1	General	41
13.2	Immunity	41
13.3	Emission	41
15	Additional requirements for machines in hazardous areas	41
15.1	General	41
15.2	Requirements for machines of type of protection 'eb'	42
15.3	Requirements for machines of type of protection 'd'	42
15.4	Requirements for machines of type of protection 'p'	42
15.5	Requirements for machines of type of protection 'ec'	42
15.6	Requirements for machines in areas with hazardous dust	42
16	Inspection and tests	43
16.1	General	43
16.2	Tests during production – HV machines.....	43
16.3	Special tests for VSDS motors	43
16.4	Final tests.....	43
16.5	Test specification	45
17	Documentation.....	48
Annex C	Insulation quality test.....	49
C.1	General	49
C.2	Assessment of insulation quality.....	50
Annex D	Minimum efficiency at full load of machines	51
Annex E	Minimum power factor at full load of HV machines	52
Annex F	Calculation of the total all-in cost (TAC)	52
PART IV	AMENDMENTS AND SUPPLEMENTS TO IEC 60034-14.....	55
8	Limits of bearing housing vibration.....	55
8.1	Limits of vibration magnitude	55
8.2	Limits of vibration velocity with twice-line frequency for a.c. machines.....	55
8.3	Axial vibration.....	55
9	Limits of relative shaft vibration	55
10	Vibration tests	56
PART V	REFERENCES	57

PART I INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for electrical machines of the cage-induction type. It applies to both induction motors and induction generators.

(Part III) of this DEP gives amendments and supplements to IEC 60034-1 (11th edition, 2010-10) considered necessary for the machine to be suitable for operation and maintenance in continuously operating plants. All clauses of IEC 60034-1 not modified by this DEP remain valid as written with application to all machines except where the heading identifies that they apply to low voltage machines only or to high voltage machines only.

(Part IV) gives amendments and supplements to IEC 60034-14 (edition 3.1, 2007-03). All clauses of IEC 60034-14 not modified by this DEP remain valid as written.

The minimum performance requirements specified in this DEP refer to constant speed operation and direct-on-line starting of the machines.

The specific requirements for the motors that form part of A.C. Variable Speed Drive Systems (VSDS) are included in this DEP. For the total VSDS specification reference is made to DEP 33.66.05.33-Gen.

This is a revision of the DEP of the same number dated February 2012; see (1.5) regarding the changes.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by Shell GSI, the distribution of this DEP is confined to Shell companies and, where necessary, to Contractors and Manufacturers/Suppliers nominated by them. Any authorized access to DEPs does not for that reason constitute an authorization to any documents, data or information to which the DEPs may refer.

This DEP is intended for use in oil refineries, gas plants, chemical plants, exploration and production facilities and supply/distribution installations. This DEP may also be applied in other similar facilities.

When DEPs are applied, a Management of Change (MOC) process shall be implemented; this is of particular importance when existing facilities are to be modified.

If national and/or local regulations exist in which some of the requirements could be more stringent than in this DEP, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable with regards to the safety, environmental, economic and legal aspects. In all cases, the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned, the objective being to obtain agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party that carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party that manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party that initiates the project and ultimately pays for it. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

The word **may** indicates a permitted option.

1.3.2 Specific definitions

Term	Definition
Air-to-air cooled machine	A closed machine with integral or machine mounted heat exchanger, using air as the primary and secondary coolant.
Air-to-water cooled machine	A closed machine with a heat exchanger using air as primary coolant and water as secondary coolant.
Allowable running-up time (ART)	The time for a machine to complete one start with rated voltage and frequency applied and coupled to a load with the actual running-up characteristics, but with the maximum moment of inertia so that when full speed is reached the most critical part of the machine has reached the highest permissible temperature. The initial machine temperature is the full load working temperature. The coolant temperature is the maximum specified.
Critical speed	A finite speed at which resonance exists, regardless of the cause of the resonance.
Declaration of compliance (IEC 60079-15)	Document issued by the Manufacturer/Supplier stating that the machine complies with the requirements of IEC 60079-15.
Electromagnetic compatibility (EMC)	The ability of equipment or a system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment.
Frame-surface cooled machine	A closed machine with its surface cooled by means of surrounding medium.
Fouling Resistance	A measure of the ultimate additional resistance to heat transfer caused by deposits on and corrosion of the heat transfer material surface.
High Voltage (HV)	A voltage exceeding 1000V.
Limiting temperature (IEC 60079-7)	The maximum permissible temperature for machines, or parts of machines, determined by: • The danger of ignition of the explosive atmosphere. • The thermal stability of the materials used.
Low voltage (LV)	A voltage not exceeding 1000 V.

Term	Definition
Requisition	The requisition from one of the following: • DEP 33.66.05.93-Gen., Data/requisition sheet for electrical machines, LV cage induction motors. • DEP 33.66.05.94-Gen., Data/requisition sheet for electrical machines, HV cage induction motors. NOTE: Requirements for additional equipment, e.g., power transformers, can be found on separate specific data/ requisition sheets.
Running-up time (RT)	The time needed by a machine to complete one start with rated voltage and frequency applied and coupled to the actual load.
Self-cooled machine	A machine where cooling is effected by means of its own rotation.
Separately-cooled machine	A machine where cooling is effected by means of other than its own rotation.
Stalling time	The time taken for any part of the machine, when it is energised at rated voltage and in the stalled condition, to be heated up from the temperature reached under full load and maximum coolant temperature conditions to the highest temperature which does not impair its subsequent performance.
Starting load torque	The torque required by the load over the starting period from zero speed to load speed. The starting load torque includes, if applicable, compression torque and bearing friction torque.
Time tE	The time tE is the lesser of the following defined times: • Time for the AC windings, when carrying the locked rotor current with the motor in the stalled condition, to be heated up from the temperature reached under full load and maximum coolant temperature conditions to the limiting temperature. • Time for any other part of the machine in stalled condition, and with the AC windings carrying the locked rotor current, to be heated up from the temperature reached under full load and maximum coolant temperature conditions to the limiting temperature.
Vibration severity	The vibration severity is the root-mean-square value of the vibration velocity.
Certificate of Conformity	Certificate stating that the electrical apparatus complies with the relevant standards for use in potentially explosive atmospheres.
Expected Lifetime	Time during which the system remains suitable for the application for which it was made, provided it is used, regularly inspected, examined and serviced in accordance with the Manufacturer's instructions and with replacement of parts subject to mechanical wear

Term	Definition
Offshore Installation	Installation located near open saliferous water, e.g., platforms, jetties, floating drilling/production facilities

1.3.3 Abbreviations

Term	Definition
IP	Ingress Protection
VSDS	Variable Speed Drive Systems
VA	Volt-ampere

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section or clause number is shown in brackets (). Other documents referenced by this DEP are listed in (Part V).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a revision of the DEP of the same number dated February 2012. The changes followed a requirements quality review and were not a full technical update. The following are the main, non-editorial changes.

Section/Clause	Change
All	Restructured and clarified requirements, enforced use of shall / should / may for normative statements.

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be submitted to the Administrator using one of the following options:

Shell DEPs Online (Users with access to Shell DEPs Online)	Enter the Shell DEPs Online system at https://www.shelldeps.com Select a DEP and then go to the details screen for that DEP. Click on the "Give feedback" link, fill in the online form and submit.
DEP Feedback System (Users with access to Shell Wide Web)	Enter comments directly in the DEP Feedback System which is accessible from the Technical Standards Portal http://swwww.shell.com/standards . Select "Submit DEP Feedback", fill in the online form and submit.
DEP Standard Form (other users)	Use DEP Standard Form 00.00.05.80-Gen. to record feedback and email the form to the Administrator at standards@shell.com .

Feedback that has been registered in the DEP Feedback System by using one of the above options will be reviewed by the DEP Custodian for potential improvements to the DEP.

1.7 DUAL UNITS

This DEP contains both the International System (SI) units, as well as the corresponding US Customary (USC) units, which are given following the SI units in brackets. When agreed by the Principal, the indicated USC values/units may be used.

1.8 NON NORMATIVE TEXT (COMMENTARY)

Text shown in italic style in this DEP indicates text that is non-normative and is provided as explanation or background information only.

Non-normative text is normally indented slightly to the right of the relevant DEP clause.

PART II GENERAL REQUIREMENTS

2 GENERAL

1. Electrical machines installed in hazardous areas shall comply with the relevant parts of the IEC 60079 series of publications.
2. Refer to (Part II), (Part III), (Part IV), and DEP 33.65.40.31-Gen. where a combination of a unit transformer is used with a motor

2.1 STATEMENT OF COMPLIANCE

1. All the equipment forming part of the order shall be tested individually and in combination at the Manufacturer/Supplier's work to prove their capability and compliance with the specification and the performance data.

2.2 LIFETIME AND RELIABILITY

1. The machine and all individual items forming part of it including, if applicable, the unit transformer shall have an expected lifetime of at least 20 years.

Rolling element bearings are exempted from the expected lifetime requirement.

2. The machine and all individual items forming part of it shall be designed for continuous uninterrupted operation for periods of at least 6 years.

Within the continuous uninterrupted operation six-year period, periods of running could alternate with idle periods of up to 6 months.

3. Re-greasing of bearings or replenishment of lube oil, if required, shall be possible with the machine in operation.

2.3 STUDIES

1. For HV machines starting studies or other reviews may be specified on the requisition sheet.

Detailed information will be given by the Principal in the specification.

2.4 EFFICIENCY AND LIFE-CYCLE COST

1. Refer to (Part III, Annex D) for the minimum values for efficiency and (Part III, Annex E) for the minimum values for power factor.
2. For machines which require separately driven auxiliary devices, e.g., ventilators, oil pumps, the Manufacturer/supplier shall list the power consumption of these devices in the quotation.

The Principal might decide to select the motor based on the total annual cost. This will be stated in the requisition. (Part III, Annex F) gives the calculation method and a calculation example.

2.5 GENERAL DESIGN FEATURES

2.5.1 Degree of protection (IP)

1. The minimum degree of ingress protection in accordance with IEC 60529 shall be as follows:

Table 2.6.1 Minimum degree of ingress protection

Machines	Motor type
Land installations	IP54 for the machine and auxiliaries IP55 for the terminal box and bearing housings
Offshore installations	IP56 for the machine, auxiliaries, terminal boxes and bearing housings
Submerged electric motors and electric drives of seal-less pumps	IP68 for the applicable parts

2. The enclosure of the machine shall be equipped with a normally-open drain hole in accordance with IEC 60034-5 to IP44.
 - a. The certification of explosion-protected machines (according to the relevant part of IEC 60079) shall not be invalidated by this normally-open drain hole.
 - b. A certified drain plug may be provided.

This clause is not applicable to Ex'd' machines.

2.5.2 Methods of cooling

1. Unless otherwise specified, machines shall be air cooled with the following methods of cooling, or in accordance with IEC 60034-6:
 - a. IC 4A1A1
 - b. IC 5A1A1
 - c. IC 6A1A1
2. If air-to-water self-cooled machines are specified in the requisition, the method of cooling IC 8A1W7 in accordance with IEC 60034-6 shall be supplied.
3. The use of separately cooled machines shall be subject to approval by the Principal.

2.5.3 Type of construction and mounting

1. Unless otherwise specified, the type of mounting for standard machines shall be one of the following, in accordance with IEC 60034-7:
 - a. IM B3 (IM 1001)
 - b. IM B5 (IM 3001)
 - c. IM V1 (IM 3011)
 - d. IM V6 (IM 1031)

2. Vertical machines with a downward drive-end shaft shall be provided with a canopy over any upward facing air inlets to prevent entry of water or any other contaminant.

3. Bearing housings shall be sealed to prevent water entry to the machine via the shaft.

This is important for vertical machines with upwards drive-end shaft, (mounting arrangement IM V3 [IM 3031] and IM V6 [IM 1031] to IEC 60034-7)

4. Frame sizes shall be in accordance with IEC 60072-1 and IEC 60072-2.
5. Dimensions of foot-mounted machines and mounting flange dimensions shall be in accordance with IEC 60072-1 and IEC 60072-2.

For special applications (e.g., reciprocating compressor drives) an alternative type of mounting might be preferred.

The mounting required will be indicated in the requisition.

PART III AMENDMENTS/SUPPLEMENTS TO IEC 60034-1

1. Part III is written as amendments and supplements to IEC 60034-1:2010. Wherever reference is made to IEC 60034-1, it shall be understood to mean IEC 60034-1:2010 as amended/supplemented by this DEP.
2. For ease of reference, the clause numbering of IEC 60034-1 has been used throughout Part III of this DEP.
3. Clauses in IEC 60034-1, which are not mentioned in the DEP, shall remain valid as written.

3 Terms and definitions

For additional definitions refer to (Part I, 1.3)

4 Duty

4.1 Declaration of duty

Add to this clause:

Periods of running could alternate with idle (standstill) periods of maximum six months.

6. The machine shall be designed to operate without requiring additional inspection after an idle period.

5 Rating

5.5 Rated output

5.5.2 AC generators

Add to this clause:

1. The required generator rating, expressed in Volt Amperes (VA), power factor and speed shall be stated in the requisition.
3. All insulation materials shall be Class F, as defined in IEC 60034-18.
4. The rating of the machine offered by the Manufacturer/Supplier shall be based on a Class B temperature rise for all parts of the machine windings.
5. The Manufacturer/Supplier shall provide advice regarding the optimum generator rating with respect to:
 - a. the prime mover capabilities,
 - b. the specified operating conditions, and
 - c. site conditions.

5.5.3 Motors

Add to this clause:

The required motor rating expressed in Watt (W) and speed will be stated in the requisition.

2. All insulation materials shall be Class F, as defined in IEC 60034-18.
3. The rating of the machine offered by the Manufacturer/Supplier shall be based on a Class B temperature rise for all parts of the machine windings.

6 Site operating conditions

6.1 General

Add to this clause:

2. Machines shall be designed for use in a saliferous, sulphurous and dusty atmosphere.
3. Condensation, solar radiation and wind loading should be used in the design of the machine, shall be taken into account.

The machines are normally installed outdoors without shelter with a common base plate on the foundation.

The area classification according to IEC 60079-10 will be stated in the requisition or appertaining documentation.

5. The Manufacturer/Supplier shall assume a background vibration severity level of 0.4 mm/s (0.033 in/s) (RMS) at the bearings of the machines.
6. Machines and auxiliary equipment (e.g., unit transformers) installed on mobile and fixed offshore installations shall be capable of absorbing shocks of twice the acceleration of free fall (2 x gn) when running or standing idle.
7. Refer to IEC 61892-3 for the requirements for testing of electrical equipment for mobile fixed offshore installations.

If a transformer forms part of the supply package then it is normally be located outside the substation building in a non- hazardous area according to IEC 60079-10.

8. Unless specified in the requisition, the operating conditions shall be as stated in IEC 60034-1 and supplemented as follows:

Table 6.1 Operating conditions

Condition	Amount
mean ambient air temperature (over 24 h period)	35°C (95 F)
maximum relative humidity	100 %

6.4 Minimum ambient air temperature

Replace the second clause with:

2. The minimum ambient temperature of machines shall be specified in the requisition and not be limited to 0°C.

Special measures (e.g., heating) could be required.

6.5 Water coolant temperature

Replace this clause with:

1. If the water coolant temperature is not stated on the requisition the temperature of the water at the inlet to the heat exchanger shall be assumed to be between 5°C and 30°C (41F and 86 F).

Add new clause:

6.8 Additional design data for air-to-water cooled heat exchangers

In the quotation stage, the Principal will provide the Manufacturer/Supplier with information about the cooling water available and the treatment the water receives to make it suitable for cooling water purpose.

1. The design data provided in Table 6.8 shall apply:

Table 6.8 Design data

Condition	Amount
maximum cooling water outlet temperature	37°C (99 F)
maximum temperature rise for cooling water	7 K
maximum static water pressure	8 x 10 ⁵ Pa
minimum static water pressure	3 x 10 ⁵ Pa
minimum cooling water velocity in tubes	1 m/s
fouling resistance	0.52 x 10 ⁻³ m ² .K/W

For further guidance on fouling resistance reference is made to DEP 31.21.01.30-Gen.

7 Electrical operating conditions

7.1 Electrical supply

Add to this clause:

The nominal system voltage and frequency will be indicated in the requisition.

During normal system operation and under steady-state conditions, the voltage at the machine terminals will not deviate from nominal voltage by more than 5 % and the system frequency will not deviate from the nominal frequency by more than 2 %.

The AC power supply will be symmetrical and sinusoidal, although the input voltage can be subject to transients resulting in short term voltage excursions between 80 % and 110 % of nominal, and to voltage interruptions during system short circuits.

Transient high frequency voltages of up to 2 kV can be superimposed on the input voltage as a consequence of system switching operations.

3. If the voltage and frequency values differ from (7.1), e.g., for offshore facilities, this shall be stated in the requisition.

Where a unit transformer is installed (7.1, Item 3) applies to the supply characteristics at the primary terminals of the transformer.

The requisition will state the maximum and minimum prospective short circuit current at the incoming terminals of the machine.

4. LV motors shall be protected by short circuit limiting devices, e.g., fuses.
 - a. A fuse or protection device rating of 3 times the motor full load current shall be used for the design of the LV motor and its terminal box.

7.2 Form and symmetry of voltages and currents

Add to this clause:

For specific installations, e.g., offshore facilities, the expected harmonic distortion can be more severe than stated in IEC 60034-1.

7.3 Voltage and frequency variations during operation

Add new clause:

7.3.1 LV machines

1. LV machines shall be designed for operating on a supply voltage within the limits as specified in IEC 60038.

7.4 Three-phase a.c. machines operating on unearthed systems

Add to this clause:

3. Three-phase a.c. machines shall be designed to operate for periods of up to 8 hours on an unearthed system with an earth fault on one phase.

The total operating time in this condition will not exceed 125 hours per year.

8 Thermal performance and tests

8.9 Measurement of bearing temperature

Add to this clause:

4. For both rolling element and sleeve bearings, the bearing temperature rise as measured by ETD fitted in the bearing housing, shall not exceed 55 K at the end of the heat run.
5. For sleeve bearings with forced lubrication the lubricating oil temperature rise with the minimum allowable oil flow shall not exceed 28 K at the end of the heat run.
6. The oil temperature shall not exceed 82°C (180 F).
7. For oil ring lubricated bearings the sump temperature shall not exceed 82°C (180F).

9 Other performance and tests

9.1 Routine tests

Add to this clause:

4. Refer to the routine test requirements stated in (16.4.3) and (16.5.3).

9.6 Safe operating speed of cage induction motors

Add to this clause:

2. Motors forming part of an AC Variable Speed Drive System (VSDS) shall comply with DEP 33.66.05.33-Gen.

9.7 Overspeed

Replace the second paragraph of this clause with the following:

2. Generators above 1000 kW shall be subjected to an overspeed test at 1.2 times rated speed for a duration of 2 minutes.
3. After the overspeed test the rotor balance condition shall be verified to be within the G2,5 limits as specified in ISO 1940-1.
4. If the rotor fails to comply with the ISO 1940-1 requirement the overspeed test may be repeated once after re-balancing, subject to the approval of the Principal.

Add new section:

9.12 Starting, re-starting and re-acceleration

9.12.1 General

1. Machines shall be designed for direct-on-line starting or re-acceleration with any voltage between 80 % and 100 % of the rated voltage applied at the machine terminals.
2. Motors shall be capable of re-acceleration under full load conditions following a power interruption not exceeding 0.2 s.

A quadratic torque-speed characteristic for the driven equipment can be assumed.

3. If the requirement in (9.12.1, item 2) cannot be met, and for other driven equipment torque-speed characteristics, the Manufacturer/Supplier shall provide detailed information regarding the re-acceleration ability of the motor.
4. For HV machines supplied via a dedicated unit transformer, the design of the machine-transformer combination shall be optimised with respect to the maximum allowable voltage drop at the busbar and the start and restart performance of the machine.

9.12.2 Number of sequential starts

1. At any voltage between 80 % and 100 % rated voltage, machines (including their unit transformers if applicable) shall be capable of:
 - a. three successive starts with the machine initially at maximum ambient temperature
 - b. two successive starts with the machine initially at full load operating temperature.

Between successive starts the machine can be assumed to decelerate under operating conditions to standstill.

2. After a cooling period of 30 minutes at standstill, another starting sequence of at least two successive starts shall be possible.