

GP 16-14-02	Engineered Variable Frequency Drive Systems	March 2002
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Engineered Variable Frequency Drive Systems

GP 16-14-02

Scope

- 1) [I] This Global Practice (GP) covers Engineered Variable Frequency Drive Systems (EVFD systems) for the speed control of AC induction and synchronous three phase machines. These EVFDs are not available as standard packaged designs from Manufacturers. They are typically 500 kW and greater, and can be rated to operate on medium or low voltage. This GP shall be used for applying EVFDs to new or existing electrical machines and covers all including: control and protective switchgear, supply transformers, variable frequency drive converters, reactors, harmonic filters, cabling, and cooling systems for the drive or the rotating electrical machine.
- 2) [I] This GP may also be applied to frequency converters for electrical generators driven by expanders or by variable speed gas turbines, where the energy produced will be delivered to a constant frequency power system.
- 3) [I] An asterisk (*) indicates that a decision or approval by Purchaser is required, or that additional information will be furnished by Purchaser.

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1. Required References

[I] This Section lists Practices and Standards that are generically referenced and assumed to be a part of this document. Unless otherwise specified herein, use the latest edition.

1.1. Global Practices–ExxonMobil Engineering Practices

GP 15-06-03	Programmable Logic Controllers
GP 15-07-02	Protective Systems
GP 16-09-02	AC Motors: Medium Voltage and Low Voltage Over 200 HP (150 kW)
GP 16-10-01	Power Transformers
GP 16-12-01	Switchgear, Control Centers, and Bus Duct

1.2. ExxonMobil Data Sheets

ExxonMobil Data Sheets	ExxonMobil Data Sheet Home Page
T161402C01	Electrical - MV Adjust. Freq. Drives for Induction Motors - AFD Design Data - Customary Units
T161402C02	Electrical - MV Adjust. Freq. Drives for Induction Motors - Vendor Supplied Data - Customary Units

2. Additional Requirements

[I] The following Standards shall be used with this GP as specified by the Owner's Engineer.

2.1. API–American Petroleum Institute

API STD 541	Form-Wound Squirrel Cage Induction Motors - 250 Horsepower and Larger
API STD 546	Brushless Synchronous Machines - 500 kVA and Larger

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2.2. IEC–International Electrotechnical Commission

IEC 60034-1	Rotating Electrical Machines - Part 1: Rating and Performance
IEC 60034-5	Rotating Electrical Machines - Part 5: Degrees of Protection Provided by the Integral Design of Rotating Electrical Machines (IP Code) - Classification
IEC 60034-12	Rotating Electrical Machines - Part 12: Starting Performance of Single-Speed Three-Phase Cage Induction Motors for Voltages up to and Including 660 V
IEC 60034-15	Rotating Electrical Machines Part 15: Impulse Voltage Withstand Levels of Rotating A.C. Machines with Form-Wound Stator Coils
IEC TR 60034-17	Rotating Electrical Machines - Part 17: Cage Induction Motors When Fed from Converters - Application Guide
IEC 60079-0	Electrical Apparatus for Explosive Gas Atmospheres - Part 0: General Requirements
IEC 60079-2	Electrical Apparatus for Explosive Gas Atmospheres - Part 2: Pressurized Enclosures P
IEC 60079-7	Electrical Apparatus for Explosive Gas Atmospheres Part 7: Increased Safety E
IEC 60079-14	Electrical Apparatus for Explosive Gas Atmospheres - Part 14: Electrical Installations in Hazardous Areas (Other Than Mines)
IEC 60079-15	Electrical Apparatus for Explosive Gas Atmospheres - Part 15: Type of Protection N
IEC 60146-1-1	Semiconductor Convertors - General Requirements and Line Commutated Convertors Part 1-1: Specifications of Basic Requirements
IEC 60146-1-3	Semiconductor Convertors General Requirements and Line Commutated Convertors Part 1-3: Transformers and Reactors
IEC 60146-2	Semiconductor Converters - Part 2: Self-Commutated Semiconductor Converters Including Direct d.c. Converters
IEC 60289	Reactors
IEC 60529	Degrees of Protection Provided by Enclosures (IP Code)
IEC 61000-4-3	Electromagnetic Compatibility (EMC) - Part 4-3: Testing and Measurement Techniques - Radiated, Radio-Frequency, Electromagnetic Field Immunity Test
IEC 61000-4-7	Electromagnetic Compatibility (EMC) Pt 4: Testing and Msmt Techniques Sec. 7: Gen. Guide on Harmonics and Interharmonics Msmts & Instrumentation, for Power Supply Systems
IEC 61800-3	Adjustable Speed Electrical Power Drive Systems - Part 3: EMC Product Standard Including Specific Test Methods

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2.3. IEEE–Institute of Electrical and Electronic Engineering

IEEE 519	Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems
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3. Definitions

Term	[I] Description
Air-cooled	This refers to the use of air as the cooling medium used to directly remove the heat from heat producing parts of the system. The air can be moved convectively or forced with fans or blowers.
Converter	The converter is defined as the section of the EVFD, which converts AC power to DC power.
EVFD System	The EVFD system is defined as the entire group of components and accessories needed to absorb power at a fixed voltage and frequency from the point of common coupling, and to provide power with a selected voltage and frequency to an electric machine. In the case of a power recovery system, it refers to that which is needed to deliver power at a fixed frequency and voltage to the point of common coupling, having absorbed power at a variable frequency and voltage.
EVFD System Efficiency	This refers to the efficiency as measured across the entire EVFD system, including all accessories, the cooling system, input and output filters, power factor correcting capacitors, and inductors.
Line filter	A line filter is a filter in the input power circuit used to prevent or reduce harmonic currents from being introduced into the power system at the point of common coupling.
Liquid-cooled	This term refers to a means of cooling the heat producing parts of the EVFD by circulating a liquid through the parts to remove the heat, and rejecting the heat via an air or water-cooled exchanger.
Load filter	A load filter is a filter located between the converter output and the motor cable used to reduce the harmonic current or harmonic voltage being supplied to the motor.

Term	[I] Description
Machine base frequency	This refers to the frequency for which the machine (motor or generator) was designed to operate—usually 50 Hz or 60 Hz.
Point of common coupling	This is the first upstream bus that supplies other loads.
Super-synchronous operation	This term refers to the operation at a frequency above the machine base frequency.
UPS	Uninterruptable power supply.

4. Vendor Qualification

- [I] Proposals shall be accepted only from Vendors who have manufactured and tested (at the proposed manufacturing location) at least three EVFDs that have been in continuous operation for at least two years, driving loads having similar characteristics. Vendor shall have also supplied systems which are similar in design, construction, voltage rating, power rating, speed range, and torque range. The system shall have power factor correction, harmonic filtering, and (if specified) automatic EVFD bypass. Vendor shall be able to perform and analyze torsional vibration analysis of complete train systems, including the driven machinery.
- [I] The equipment and installation shall be in compliance with any code or standard specified by an authority having jurisdiction.

5. Documentation

* [I] Vendor shall provide all data specified in [T161402C02](#) and any addenda. Quotations lacking data shall not be accepted. In addition, the following documentation shall be provided with the proposal.

5.1. Diagrams, Layouts, and Specifications

The following shall be provided:

- A one-line electrical diagram showing the power circuits and auxiliary/control loops of all major equipment from the supply busbars to the motor. The diagram shall include points of power isolation and main power conductor maintenance grounding provisions.
- Physical layouts and specifications of all major equipment.
- Physical requirements of the reactors or filters relative to the converter panel and the specification of any preferred type of interconnecting cable.
- A flow diagram of any external cooling system showing all components, control loops, and type of cooling.

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