INTER PLANT STANDARD – STEEL INDUSTRY		
IPSS	**VARIABLE VOLTAGE VARIABLE FREQUENCY SYSTEM (V.V.V.F.) V/F, VECTOR CONTROL / TORQUE CONTROL** Corresponding IS does not exist	**IPSS: 1-10-035-06**

0. FOREWORD

0.1 This interplant standard has been prepared by the Standard Committee on Electrical Components and equipment, 1:10 with the active participation of the representatives of the Steel Plants, major consultancy organizations and established manufacturers of VVVF (variable voltage and variable frequency) system and was adopted in November 2006.

0.2 Inter plant Standard for steel industry primarily aim at achieving rationalization and unification of parts and assemblies used in steel plant equipment and accessories, and provide guidance in indenting stores or equipment (or while placing orders for additional requirement) by individual steel plants. For experience effective control on inventories, it is advisable to select a fewer number of sizes/types from those mentioned in this standard, for the purpose of company standard of individual steel plants. It is not desirable to make deviations in technical requirements.

0.3 While formulating this standard, assistance has been drawn from the following publications.
i) IEC/146-1-1 (1991-04) ii) IEE Standard 444(Part-I):1973 iii) EN 61800-3(2nd environment) / IEC 1800-3 industrial environment.

1. SCOPE

1.1 This interplant standard covers the requirements of Variable Voltage Variable Frequency (VVVF) system used for low voltage A.C drives.

2. TERMINOLOGY

For the purpose of this standard, the definitions in IS: 1885 (part 17): 1979 “Electro technical Vocabulary” shall apply.

3. SITE CONDITIONS.

3.1 The following shall constitute the normal site conditions for the purpose of this standard:

3.1.1 Ambient temperature - The reference ambient temperature shall be 50^{o}C. Derating factors for the temperature is to be specified by the supplier.

3.1.2 Altitude - The altitude shall not exceed 1000m above sea level.

3.1.3 Relative humidity - The maximum relative humidity shall be 95%.

Note: However, maximum temperature and maximum relative humidity may not occur simultaneously.

3.1.4 Ambient air - The ambient air may contain a fair amount of conductive & heavy dust laden steel plant environment.

3.1.5 Noise – Noise shall conform to IEC 61000.

3.1.6 Vibration – Vibration shall conform to IEC 60068-2-34.

4. ENCLOSURE

4.1 The VVVF drive shall conform to IP20 and above degree of protection as per the requirement of the purchaser.

5. POWER SUPPLY SYSTEM.

5.1 The VVVF equipment shall be suitable for operation from the following power supply system.

a) *Rated Voltage*:

- 3 Phase 690V ac, 50 Hz

OR

- 3 Phase 415Vac, 50 Hz

OR

- 1 Phase 240Vac, 50 Hz

b) *Voltage variation*: +10%, -15%

c) *Frequency variation*: 50Hz+6%, -6%

5.2 AC input choke of suitable rating is required.
In case of grounded neutral system, additional filter is to be provided.

6. EQUIPMENT DETAILS

6.1 RATING

6.1.1 Rating is based on current and shall be rounded off to the higher integer value.

6.1.2 VVVF system shall always be rated for continuous duty as per IEC 146 (clause II).

6.1.3 Output frequency range shall be minimum 0 to 50 Hz at constant torque and 0 to 100 Hz at constant power.

6.1.4 Efficiency of VVVF shall be minimum 97%.

6.1.5 Rating of inverters shall be based on full load current at rated voltage of the drive and considering following overloads:

- 100% load continuous
- 150% for one minute (constant torque) or 110% for one-minute variable torque.
- 200% for 10 seconds.

6.1.6 Range of switching frequency shall be 3-12kHz.

6.2 VVVF system for A.C drives shall mainly comprise of the following.

- A.C power circuit with converter transformer filters etc.
- Converter bridge
- iii) Inverter
- iv) Control & regulation equipment including protection, indication & annunciation

6.3 Basic Features required in VVVF drive: -

6.3.1 Converters & inverters for VVVF shall be with microprocessor based digital regulation & control. VVVF system regulation & control shall be compatible to PLC/ICS/DDC etc. through standard communication protocol.

6.3.2 Inverter shall be fully microprocessor based, in design having 3 phase uncontrolled (for small driver)/ controlled rectification and IGBT based inverter with pulse width modulation (PWM) power section, suitable for constant /variable torque application. It shall be complete with programming unit.

6.3.3 The control section of the drive (controller, pulse/gate drive, power supply etc.) shall be inter phased to the power section (rectifier and inverter) with the help of screws, bus bars or flexible cables/wires and isolation of control & power section shall not require any desoldering /soldering of the components/ wires.

6.3.4 A suitable choke or terminator shall be provided at the output side of the drive to take care of capacitive surges and cable length limitations.

6.3.5 *Drive* - shall have following provisions to be operated from key pads :

i) Forward inching
ii) Reverse inching
iii) Forward run
iv) Reverse run
v) Stop
vi) Speed increase
vii) Speed decrease
viii) Provision to stop the motor quickly from running condition and quick reversal of the drive shall be provided.

6.3.6 Auto tuning feature:

i) Speed ratio of the motor shall be adjustable from 0 Hz to 50 Hz in continuous mode.
ii) Slip compensation shall be provided to 1% speed regulation from no load to full load.
iv) Adjustable electronic motor over load protection.
v) Ramp stoppage/coast to stop features.
vi) Minimum breaking torque of 30% shall be available. However, with breaking resistor (Optional) it shall be possible to achieve 150% for all the drives except V/F drives.
vii) Normal jogging and threading facilities (as per requirement)
viii) System shall accept digital and analog signal from other drives wherever required
ix) System shall give digital and analog signal to other drives wherever required.
x) Provision for checking system in manual regime.
xi) Current and speed feed back facility.

6.3.7 Minimum Control-function modules to be provided in digital regulation system.

- Reference speed setter.
- Ramp generator.
- Current feed back controller.
- Pulse transformer trigger module.
- Logic control and sequence module.
- V/F control module.

- Slip compensation control.
- Current limiter.
- Counter current braking.

6.3.8 *System shall have:*

- Digital inputs: 3 Nos.
- Digital outputs 3 Nos.
- Relay O/P 2 Nos. (programmable)

- Analogue inputs: 2 Nos.
- Analogue outputs 1 No.

6.3.9 *Communication* - Drive shall have following minimum features:

- RS 232
- RS 485 Modbus

a) Ethernet | Optional,
b) Profibus | 25 m cable and suitable
c) Device net | connectivity

6.4 Control supply and power components shall be so arranged that they do not cause any heating to the controller and allied section of the inverter.

6.4.1 Shall have panel mounted or integrated type backlit LCD display unit. The same unit shall be used for programming, fault messaging and running status. Display of the fault message will in English text form.

6.4.2 Acceleration and de-acceleration time with adjustable setting shall be provided which will be independently programmable.

6.4.3 Adjustable Torque boost facility shall be provided.

6.4.4 Selectable V/F pattern/ratio shall be provided.

6.4.5 In order to prevent resonance between motor and coupled machines multiple point skip frequency settings shall be provided.

6.4.6 Programmable automatic restart/flying re-start (start on fly) in case of momentary power failure during operation shall be provided.

6.4.7 Programmable power ride-through feature shall be provided. Suitable bypass provision on VVVF system failure shall be provided if required by the purchaser.

6.4.8 Adjustable current limit setting shall be provided.

6.4.9 Over loaded capacity shall be 150% for 1 minute (Constant Torque) or 110% for 1 minute (Variable Torque) repeated every 10 minutes. These overload capacities shall such that unit is shutdown safely at the end of the envisaged overload period without causing any failure to control and power section of the inverter.

6.5 Forced cooling arrangement shall be provided.

6.5.1 Self-diagnostic facility shall be provided.

6.5.2 Isolation arrangement for input and out put along with status monitoring device and shunt trip coil (240 VAC) shall be provided. Suitable inbuilt dc choke shall be provided.

6.5.3 The device shall be protected by semiconductor fuse at AC side.

6.5.4 Suitable choke at DC link shall be provided

6.5.5 Suitable choke (with mH rating, 3 phase) at input side shall be provided to meet the following In case of choke the same shall have following minimum requirement.

i) Nominal operating voltage = Rated voltage of the drive.
ii) Maximum current Imax= 2x I rated for 1 minute.
iii) Grade of core material CRGO.
iv) Temperature rise at Irated=95 deg C.
v) Insulation class F
Vi) Insulation resistance at 1100 V DC, between winding to core more than 100 M Ohms.

6.5.6 In case of power failure, drive shall be able to store and memorize set parameters and software blocks.

6.5.7 It shall have electromagnetic compatibility with EMC filter EN-61800-3/ IEC-1800-3.

6.6 Protection

The unit shall be capable of protecting the device (itself) and the motor both in case of faults. Following minimum protections are required.
i) Protection against input & output phase loss/phase short circuit.
ii) Under voltage and over voltage protection.
iii) Over voltage and under voltage in D.C bus.
iv Over current in D.C. bus.
v) D.C. Short circuit
vi) D.C earth leakage /earth fault.
vii) Wrong phase sequence.
viii) Transients and surges over voltage.

ix) Over current and short circuit at any point of the system
x) Under load.
xi) Control power supply failure.
xiii) Inversion fault
xiv) di/dt. Protection
xv) Fan failure
xvi) Stalling of motor.
xvii) Over speed
xviii) Display and data logging as per requirement
xix) Any other protection as per purchaser's requirement.

6.7 Alarm and Annunciation – Minimum 5 alarms for faults shall be stored preferably with the time stamping.

7. PANEL FOR DRIVES, SWITCHGEAR COMPONENTS AND ACCESSORIES

7.1 IP 41 and above with test certificate.

7.2 Sheet steel used for fabrication of metal cabinet for control panel shall be of cold rolled type and of thickness not less than 2 mm. Non-load bearing side may be of 1.6 mm thick sheet.

7.3 The cabinet shall be floor-mounting type and shall be provided with lockable-hinged door at front and back with handle.

7.4 The panel shall be accessible both from front and back.

7.5 Durable gasket shall be provided for all doors and covers and for all partitions between adjacent units. The gasket shall be of sponge rubber synthetic rubber and shall be adequately secured. Barrier shall be provided/between power equipment and control equipment.

7.6 Internal control & power wiring shall be routed separately to have better noise immunity.

7.7 The control and power terminals shall be such that each and individual terminal shall be accessible for maintenance without effecting the wiring at any other terminal

8. INFORMATION TO BE FURNISHED

8.1 The provision of clause 10 of IPSS: 1-04-041-03 shall apply.

APPENDIX – A

STANDARD INFORMATION TO BE FURNISHED BY SUPPLIER

SL. NO.	VENDOR'S NAME	CUSTOMER DATA	SUPPLIER DATA OR CONFIRMATION	REFERENCE
1	Drive type			
1.1	AC Drive specification for			
1.2	Make			
1.3	Model no.			
1.4	Control technology – VFD vector control / torque control			
2	Application requirement			
2.1	Application			
2.2	Normal duty/Light overload/High overload			
2.3	Speed range			
2.4	Cable length			
2.5	Small write up about application			
3	Motor data			
3.1	Motor voltage			
3.2	Full load current			
3.3	Frequency			
3.4	Nominal speed			
4	Ambient data			
4.1	Ambient temperature			
4.2	Humidity level			
4.3	Environment			
5.1	Drive data			
5.2	Temperature range for derating			
5.3	Offered drive continuous current for mentioned duty at $50^{o}C$			

5.4	Over load time			
5.5	Overload repeatability			
5.6	Drive over temperature limit			
6	Supply voltage			
6.1	Supply voltage limit			
6.2	Efficiency			
6.3	DC over voltage tripping limit			
6.4	DC under voltage tripping limit			
7	Switching frequency			
7.1	Switching frequency			
7.2	Available maximum limit			
7.3	Derating factor for quoted module on maximum switching frequency			
7.4	You have quoted considering			
8	Cable length			
8.1	Cable length allowed for Switching frequency considered			
8.2	Cable length between motor and drive output terminal			
8.3	Maximum permissible cable length			
8.3A	With output choke			
8.3B	Without output choke			
9	Communication requirement			
9.1	Communication protocol			
10	EMC Filter			
10.1	EMC Filter required			
10.2	Permissible cable length with offered EMC Filter			
10.3	Input choke			
10.4	Output choke			
11	Human Interface module			
11.1	HMI name			

11.2	Text line display (Back lid LCD display in full plane English text message for grouping, parameter description, programming and fault message display. It shall display the description of parameter/fault etc.			
11.3	Fault history			
11.4	Maximum parameters available on 1 screen			
12	I/O			
12.1	Digital Input			
12.2	Digital output/Relay output			
12.3	Analog input (0-10 V or 4-20 ma and number)			
12.4	Analog output (0-10 V or 4-20 ma and number)			
13	Protection			
13.1	Over voltage			
13.2	Under voltage			
13.3	I^2R protection (over temperature protection of motor)			
13.4	Short circuit			
13.5	Output earth fault			
13.6	Drive over temperature			
13.7	Drive under load			
13.8	Adjustable overload)			
13.9	Single phasing			
13.10	Under load			
13.11	Stall			
14	Protection of module			
15	Built in chopper (W/O resistance) for dynamic braking			

Note:

1. Please give the specific detail and page number of supporting documents/catalogue
2. For all the fields' supplier is supposed to confirm or give the data as applicable
3. Please use extra paper for clarification of specific points, if any.
4. The supplier shall fill this document with exception listed out clearly.