TATA STEEL

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Tata Steel Technical Directive

R2640101 Variable Speed Drives > 150 kW

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Information and changes

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1 INTRODUCTION

This document defines the technical requirements to design, material selection, construction features, manufacture, inspection & testing, delivery to site and performance testing of Variable Speed Drives (VSD) AC drives > 150 kW, in general for the Tata Steel site in IJmuiden.

Scope is single drive systems > 150 kW and common DC rail systems containing also smaller drives but with a combined power > 150 kW.

Being an integrated steel plant, all facilities for producing high quality steel are located at Tata Steel site IJmuiden. It starts at the beginning of the process by collecting raw material like coal and iron ores, followed by sinter plant, pellet plant, blast furnaces, basic oxygen furnace, continuous casting machines, hot rolling mills, cold rolling mills, galvanization lines and painting lines. For these process plants there is wide application of various motors, which in turn places high demands on the electrical drives. Typical environmental challenges are high temperature conditions, high concentrations of dust, high concentrations of salt from the sea shore, high concentrations of water or other fluids and in some cases high concentrations of chemical by-products.

A separate “Data Sheet” enclosed in chapter 8, ANNEX, this needs to be filled up by respective CONTRACTOR/MANUFACTURER during submission of technical bid.

2 STANDARDS AND REGULATIONS

Variable speed drives and accessories shall be in accordance with the most recent edition of international standards and directives, international regulations and Dutch directives. Most important standards, regulations and directives are listed below:

Code of Relevant Standards	Description
IEC 60146-1-1	Semiconductor converters - General requirements and line commutated converters - Part 1-1: Specification of basic requirements
IEC 60747	Semiconductor devices
IEC 60191	Mechanical standardization of semiconductor devices
IEC 60748	Semiconductor Devices - Integrated Circuits
IEC 61000	Radiated Electromagnetic Field Requirements
IEC 60529	Degrees of protection provided by enclosures (IP code)
IEC 61508-1	Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 1: General requirements
IEC 61800-3	Adjustable speed electrical power drive systems - Part 3: EMC requirements and specific test methods
IEC 61800-4	Adjustable speed electrical power drive systems - Part 4: General requirements - Rating specifications for A.C. power drive systems above 1kV A.C. but not exceeding 35 kV
IEC 61800-5-1	Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy
IEC 61800-5-2	Adjustable speed electrical power drive systems - Part 5-2: Safety requirements - Functional
ISO 13849-1	Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design
IEEE 519	Recommended practices and requirements for harmonic control in electrical power system
IEC 60204-11	Safety of machinery - Electrical equipment of machines - Part 11: Requirements for HV equipment for voltages above 1kV A.C. but not exceeding 36 kV
IEC 60721-3-1	Classification of environmental conditions - Part 3-1: Classification of groups of environmental parameters and their severities - Storage
IEC 60721-3-2	Classification of environmental conditions - Part 3-2: Classification of groups of environmental parameters and their severities - Transportation and Handling
IEC 60721-3-3	Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities - Section 3: Stationary use at weather protected locations
NEN EN 50160:2010.	Voltage characteristics of electricity supplied by public electricity networks

3 GENERAL REQUIREMENTS

3.1 Environmental conditions

All VSD shall be designed considering the following environmental conditions:

Ambient (Indoor) Temperature	Minimum (-) 5°C and maximum (+) 40°C
Relative Humidity	48 to 100 %
Altitude	8 m (sea level)
Location	Indoor

VSD normally is located inside an electrical room.

3.2 Design Life Time

The design life time of drives shall be minimum 20 years in the prevailing of industrial environment. CONTRACTOR/MANUFACTURER shall ensure for availability of spare parts and maintenance support service for the offered equipment for at least 20 years from the date of supply.

CONTRACTOR/MANUFACTURER shall give a notice of at least 5 years to the end user of the equipment before phasing out the product / spares to enable the end user to place the order for spare and services.

4 GENERAL ELECTRICAL REQUIREMENTS

4.1 Selection of VSD

Adoption of operating voltages:
420V/725V/3150V/6300V/10500V, 3 - Phase, 50 Hz supply voltages shall be considered for VSD. The drives shall be capable of delivering rated output considering the following:

Parameters	Values
System Voltage	420/725/3150 / 6300 / 10500V, 3-Phase
Voltage variation	(+) 5 % to (-) 15 %
Supply voltage for auxiliary system	420V, 3-Phase
Voltage variation for auxiliary system	(+) 10 % to (-) 15 %
Frequency & its variation	50 Hz (±) 0.5%
Maximum short circuit current	As specified in project specific technical specification
System earthing for medium voltage/LV:	IT/TN-S

4.2 Basic Features:

a) Type, configuration (converter transformer, rectifier & inverter circuit, output reactors, number of pulse etc.) & selection of voltage level for medium voltage AC drives shall be based on process/application, type & rating of motors.

b) The drive shall be energy efficient, provide very high reliability, high power factor, low harmonic distortion, wear and noise. It shall be easy to install with minimum time and expense, special tools (if required) to take out inverter & rectifier modules shall be provided for routine maintenance.

c) Selection of suitable speed control technique & semiconductor device of inverter circuit will be decided by CONTRACTOR/ MANUFACTURER based on process/application requirement or as specified either in project specific specification or data sheet.

d) Integrated safety functions including Safety Torque Off (STO) feature need to be considered as per applicability of the process/application.

e) The inverter shall have fully digital microprocessor based regulation and control system with suitable interfaces for communication with plant automation system. The microprocessor based control shall carry out all the functions required from the unit including triggering, protections, self-diagnostics and operator interface. Display of faults, fault register, alarms, as well as diagnostic messages will be available in plain text on the operator panel (LCD/HMI) mounted in the drive cubicle. All metering features viz voltage, current, frequency for incoming and outgoing side shall be included in the drive panel. It shall also be possible to do drive parameterization through the display unit.

f) Converter transformers shall have minimum following features: For indoor use only dry type cast resin transformers are allowed. These transformers should meet Tata technical directive R2650401

g) Drive shall have electromagnetic compatibility (EMC) with EMC filter capable of meeting the Second Environment levels for the EMC directive EN 61800-3/4.

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

i) Drive composer/Drive window tool with all necessary hardware & software shall be considered for parameterization, diagnosis, monitoring & programming by laptop/ desktop from remote location without disturbing the drive panel.

j) Maximum noise level from the drive at 1 meter distance, under rated load with all normal cooling fans operating shall be ≤85 dB (A) unless otherwise stated either in project specific technical specification or data sheet.

4.3 Control Requirement

The communication interface of drives shall be compatible with plant automation system (i.e. RS 232 / RS 485 Modbus / Ethernet / Profibus / Device net / Control net / Profinet), the same shall be considered as per project specific technical specification or data sheet. In case the CONTRACTOR/MANUFACTURER is using their proprietary communication interface module, the necessary interface hardware & software for use with owner's automation system shall be considered.

The starting, running, stopping logic, etc of the drive system can be provided with potential free contacts wired to the terminals for connection to other systems. Hardwired I/O (input/output) can be considered via separate I/O cards. Required I/O cards in drive can be consisting of both digital and analogue I/Os can be provided. The following programmable I/Os can be considered according to the requirement or as specified in the data sheet:

- **Digital Inputs**: DI (potential free contacts).
- **Digital Outputs**: DO (potential free contacts).
- **Analog Inputs**: AI (0-10V or 0/4 – 20mA).
- **Analog Outputs**: AO (0-10V or 0/4-20mA).
- Interface card for RTD/BTD connection.
- Interface card for Pulse encoder connection.
- Spare slots for I/O extension as per process/application requirement.

Required interposing relays & Inputs/Outputs in drive panel can be considered for interlocking & status purpose with MV isolating device & converter transformer such as:

- MV breaker ON & OFF command,
- Breaker trip, close & ON status
- Winding temperature high (trip) & alarm of converter transformer, etc.
- Interface provision in drive panel shall also be considered for vibration of motor & driven equipment.

4.4 Fault Diagnostic

Fault self-diagnostic feature having local digital display system shall be built into the drive to supervise the operation and failure of the drive system. The information regarding failure of the major components including shut down of the drive system shall be available even in

absence of power supply to the drive system. The drive system may be de-energized for maintenance or otherwise, it shall be possible to retrieve the record of prior to tripping of the drive system or de-energisation

.

Auxiliary supply to the system components or to the electronics (firmware) for the diagnostics display shall be taken care by the MANUFACTURER. display shall be suitable to utilize for parameters indication such as:

- The current in each phase of the outgoing AC supply to the motor.
- The phase-to-phase voltage of the outgoing AC supply to the motor.
- The frequency of the outgoing AC supply to the motor.
- RPM, etc.

4.5 Control Circuit

PURCHASER shall provide 3-phase, 420V auxiliary power supply at single point and further distribution of auxiliary control power supply via suitable control transformers shall be considered by CONTRACTOR/MANUFACTURER. Any external UPS control power requirement for drive to be informed by CONTRACTOR/MANUFACTURER during bid stage. Control power supply for devices external to VSD module i.e. cooling circuit, contactors control, space heater supply for Motor & VSD, including indication lamps, etc. shall operate on control power which will be derived from control transformers with protection device provided in primary and secondary located inside the drive cabinet. The control voltage shall be as per project specific technical specification or data sheet.

4.6 Cooling

Cooling arrangement as per manufacturer standard shall be considered. There may be two types of cooling arrangement which shall be selected / adopted based on rating of drives & site environmental conditions. However, air cooled type arrangement shall get first preference.

a) Air Cooled
b) Water Cooled

Air Cooled:

Cooling system shall include well-dimensioned panel comprise of adequate cooling air-flow path, drive module cooling fans and panel cooling fans for forced air cooling. CONRACTOR/MANUFACTURER shall ensure that the panel dimensions and flow paths have been designed for continuous operation at specified ambient without overheating. VSD panel shall include air-flow pressure switch and temperature detectors to monitor proper operation of the air cooling system. If fan fails, the system must generate alarm and VSD shall trip after reaching beyond the set temperature limit of air cooling system. A provision shall also be made for ducting so that hot air can easily be exhausted outside the VSD panel.

CONRACTOR/MANUFACTURER shall ensure that cooling air intake louvers with filter elements are located on front (top/bottom) of the panel. No louvers shall be located on rear or side surface.

Water Cooled:
For higher rated drives, water based cooling arrangement shall be adopted, input water shall be received from plant water circuit. Type of input water & its quantity shall be mentioned by the CONTRACTOR/MANUFACTURER during bidding stage to arrange the same by PURCHASER.

4.7 Harmonics

The voltage characteristics of the MV/LV networks at Tata Steel IJmuiden site shall comply with the NEN EN 50160:2010.
In addition to table 1 or 4 of this standard:

- The harmonic voltages above the 25th up to the 40th harmonic, shall be less than 1,0 % each.
- The maximum values of the individual harmonics and also the THD shall be reduced with a load, and a safety factor:

THDTata network = THD50160 x Csafety x Cload
Csafety = 0,75 and Cload is the quotient of maximum total new load of the network and the rated power of the feeding transformer, see data sheet
Network calculations on harmonic distortion shall be made by CONTRACTOR for loads > 500kW.

4.8 Converter configuration / AFE / DC Link / AC Line Reactors

AFE (active front end line converter), smoothing reactor and capacitor for the DC link shall be designed to meet harmonics specifications. AC line reactors (input chokes), if required as per standard MANUFACTURER design shall be suitable for harmonic suppression and fault current limitation.
The reactor shall be dry type, air-cooled, and located within the panel. The smoothing reactor shall be suitable for operation with the non-sinusoidal current wave shapes and DC components under all operating condition of the system without exceeding its temperature. If necessary, drive shall be 6/12/18/24/36 pulse based on process/application requirement as stated either in project specific technical specification or data sheet. Vector group of the input converter transformer (step down/isolation) shall be selected to meet the above configuration (i.e. 6/12/18/24/36 pulse).

4.9 Bearing currents and motor shaft voltages

To achieve minimal bearing currents in VSD controlled motors PURCHASER intends prevent bearing currents and limit the overall shaft to ground voltage (over the bearing) max 5 V(peak/peak). To meet these specifications we ask CONTRACTOR to propose measures to include in:
Motor specifications such as

- EMC cable glands
- Isolated bearings DE/NDE
- Brushes at shaft, DE/NDE
- Max voltage peak to be expected
- Max dU/dt to be expected

Motor cables specifications such as

- Max length
- Shielding, type or specification

Output reactors or filtering such as

- dU/dt filters
- output reactors
- sine filters

The CONTRACTOR should measure the max THD and bearing currents/voltages as part of the scope in order to show the specifications are met

4.10 Construction Features

The AC drive module shall be suitably housed in/on panels. The panel shall be suitable for indoor installation.
The panel can be free standing / wall mounting as specified either in project specific technical specification or data sheet.

In case of free standing floor mounted panels, equipment which needs manual operation shall not be located less than 350 mm & more than 1800 mm above ground level. Also all indicating meters / display units shall be mounted within 450 mm to 1800 mm from ground level. Free standing panels shall be considered with base frame.

Unless otherwise specified the panel shall be front access only. The panel should also have a suitable canopy at the top to prevent water entry into the panel and shall be suitable for air flow for cooling. Minimum ingress protection of drive panels shall be IP 42 unless otherwise stated either in project specific specification or data sheet.

The drive panel shall undergo pre-treatment including degreasing, rinsing, derusting, rinsing, phosphating, & passivation. Painting procedure shall follow as per manufacturer's standard practice.

Partition plate shall be considered to prevent accidental contact of the live parts. Sufficient maintenance space shall be considered to take out the VSD module.

All the live parts shall be shrouded to ensure complete personnel safety intending to carry out routine inspection by opening the panel doors. Minimal protection grade IP2x. All the equipment inside the panel and on the doors shall be with suitable nameplate. All cables shall be ferruled and terminals shall be properly numbered. Minimum 20% spare terminal shall be considered.

Drive panels shall have illuminating lamps with door switch & protection device, 5/15A Power socket with switch & MCB. Drive panel shall have space heater with switch, temperature settable thermostat & MCB.

All the metallic components / parts shall be connected to the main earth bus bar (PE bus bar) running at the bottom of the drive panel. Earth Bus bar shall be considered with extension on both sides outside the panel and provision for connection to plant earth grid. Material of construction of the earth bar shall be copper. Drive panels shall be provided with separate insulated instrument/electronic earthing bus bar for connection of screens of instrument cables. Material of construction of the earthing bus bar shall be copper. All panels shall be of same height for good aesthetic appearance.

All electronic modules and components shall be accessible from front of panel only. Modular plug-in / draw-out assemblies for both the system control electronics equipment shall be used. All copper bus bars used in drive panel shall be insulated. Protection grade min. IP2X

Suitable removable type hooks shall be provided for lifting the panel.

5 SPECIAL REQUIREMENTS

5.1 Lightning protection

Climatic and environmental problems, especially severe lightning surges, are prevalent in many
areas, and therefore an extremely important aspect of automatic frequency control (AFC) design must be thorough voltage surge protection of all semiconductor devices and control circuitry.

5.2 Interchangeability of Components

Wherever possible, with a view to minimise inventory, all control cards of similar functionality should be identical irrespective of the size of the various drives and other components (like power semiconductors, pulse transformers, firing circuits, etc) shall be electrically and mechanically interchangeable.

6 INSPECTION AND ACCEPTANCE TESTS

Drive shall be subjected to all the routine tests as per applicable IEC standard in the presence of the PURCHASER's representative unless otherwise stated in project specific technical specification or data sheet. Type test and optional tests shall be carried out if stated in Data Sheet. Otherwise MANUFACTURER shall submit all the type test and optional tests report carried out on identical motor during last five (5) years, for PURCHASER's review and record. Required optional tests should be as per agreement between MANUFACTURER & PURCHASER.

6.1 Acceptance Tests

The drive shall be tested in accordance with the most recent standards and regulations. Following tests shall be carried out in addition to the routine, type, additional & optional tests according to IEC 60146/61800/60204 other relevant international/European standards:

SL. No.	**Description of Routine tests**
1.	Visual inspection & dimensional checks
2.	Light load test & Functional Tests
3.	Insulation Test
4.	Checking of Cooling circuit
5.	Measurement of output voltage
6.	Combined testing for motor and VSD (if applicable)
SL. No.	**Description of Type tests**
1.	Temp. rise Test (at full load)
2.	Measurement of Efficiency at 50 % & full load
3.	Noise level Test
4.	Power loss determination (By Calculation Method)
5.	Degree of Protection for Cabinet
6.	Rated Output test
7.	Over current Test

7 DOCUMENTATION AND TECHNICAL DATA

MANUFACTURER shall submit the drawing & documents as mentioned below.
Before starting manufacture of motor, the MANUFACTURER shall have to take approval of relevant drawings and data from Owner in writing.

7.1 With quotation

Manufacturer/Contractor has to submit the following documents along with quotation.

a) Filled up guaranteed technical particulars as per Data Sheet-B attached with this technical directive.
b) Technical catalogue and brochures.
c) General Arrangement Drawing (with dimension, weight & Heat Loss Data).
d) Single Line Diagram.

7.2 Price and delivery time after award of order

Data/drawings/documents as listed below:

a) Final dimensional/arrangement drawings indicating heat loss & weights in AutoCAD.

b) Technical Data Sheet (drive & converter transformer) of Manufacturer.
c) Single line diagram.
d) BOM & Control schematic drawings.
e) Type and optional test certificates not older than five (5) years.
f) Price list of recommended spare parts.
g) Parts list.
h) Quality assurance plan and inspection test procedure.
i) Manufacturing- inspection- and test plan.
j) Operation- and maintenance manuals.
k) Commissioning procedures.

7.3 Before FAT

The supplier shall issue the procedures not later than four weeks before the beginning of the factory acceptance tests.

7.4 After FAT

Within 1 month after FAT:
a) Drive conservation instructions
b) Technical construction document
c) Signed routine test certificates of drive, drive panel & converter transformer.

7.5 After SAT

Site acceptance test either to be carried out or to be supervised according to the requirement mentioned in project specific technical specification and all reports to be signed.
List of SAT:

- Functional Tests
- Load test with actual load

- Harmonic measurement
  - THD (I) at input and output
  - THD (V) at input

8 Annex (Data Sheet)

No.	ITEM	FEATURES
1	**GENERAL DATA**	
2	Codes and standard to be applied	
3	Tests performed according	
4	Installation location in plant	
5	Particular prescriptions for installation environment. (if none, inside electrical room is assumed)	
6	Min/Max Electrical room temperature	
7	Mechanical conditions (operation in E.R.) according to EN 60721-3-3	
8	Operating schedule	
	TECHNICAL DATA	
9	Drive system configuration/type code	
10	Cabinet cooling type	
11	Semiconductor type (IGCT, IECT, IGBT)	
12	Motor type	
13	Output filtering (reactor dU/dt filter..)	
14	Output isolator	
15	Cabinet protection degree	
16	Cabinet voltage class	
17	Main disconnecting mean	
18	Incoming section rated voltage/type	
19	Drive cabinet short circuit certified withstanding according to EN 62271-200	
20	Drive cabinet internal arcing certified withstanding according to EN 62271-200	
21	Auxiliary voltage needed/expected consumption (A)	
22	Overall dimensions	
23	Weight of the cabinet	
24	Expected power losses to air	
25	Expected power losses to cooling water (at driven motor rated power)	
26	Cabinet painting color	
27	Power and control let cable inlet position	
28	Rated continuous current	
29	Base current for 240 sec, load cycle 300 sec	
30	Base current 60 sec, load cycle 300 sec	
31	DC link operational voltage	
32	Output frequency range	
33	Typical average switching frequency	
34	Cooling medium	
35	Typical operating pressure drop	
36	Required nominal water flow	
37	Maximum water operating temperature (inlet)	
38	Recommended maximum water conductivity	