General Data

Equipment Specification

System Description

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Project: 2GW-C

2GW-C

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Export Control Classification:

ECCN: N	AL: N

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Index of Revisions

Rev.	Date	Remark	Originator	Reviewer	Approver
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1 Introduction

1.1 Scope

This specification contains the general information for the equipment and systems to be supplied for 2GW-C grid connection system.

1.2 Locations

The stations of the grid connection system are located at:

- Offshore converter station at the North Sea
- Onshore converter station

The HVDC cable connecting the 2 stations shall extent from the Offshore converter station to Onshore converter station.

1.3 Expressions and Definitions

The following words and expressions shall have the meanings assigned hereby to them.

- “CV10” means both stations
- “CV11” means Offshore converter station
- “CV12” means Onshore converter station
- “Employer” means End customer
- “Contractor” means Siemens Energy and Consortium Partner
- “Manufacturer” means the person or persons, firm or company assigned to execute the works as defined by the scope of supply, described hereunder
- “Equipment Specification” refers to an additional specification written for each component
- “Standards” means international, regional and national standards. Further details are supplied in chapter 3.

1.4 Abbreviations

AC	Alternating Current
C&P	Control & Protection
CWC	Converter Water Cooling
DC	Direct Current
DNV GL	Det Norske Veritas Germanischer Lloyd

EHS	Environment, Health and Safety
HPE	Bundesverband Holzpackmittel, Paletten, Exportverpackung e.V.
HV	High Voltage
HVDC	High Voltage Direct Current
ISPM	Internationaler Standard für Pflanzenschutzmaßnahmen
ITP	Inspection and Test Plan
RIV	Radio Interference Voltage
QA	Quality Assurance
QM	Quality Management

2 Lifetime

All supplied equipment shall be designed and manufactured for safe operation and maintenance for a minimum expected life of 40 years in the prevailing ambient and physical/electrical environment. Where individual components have an expected life of less than 40 years, their replacement strategy and design life must be declared by the Manufacturer in the Manufacturer's proposal and arrangements satisfactory to the Contractor put in place to ensure the availability of replacement parts.

The Manufacturer delivers a spare part list for the maintenance and fault clearance of the components.

The equipment for outdoor application shall be capable of withstanding the effects of weather according to clause 4.

The equipment for indoor application shall be capable of withstanding the effects of indoor environmental conditions according to clause 4.

3 Standards and Precedence of Standards

Equipment and services offered are to fully comply with any included specifications and be in accordance with the relevant international standards and referenced national standards.
Where deviations are unavoidable, the deviations are to be fully detailed.

Where a standard is quoted in the text of the Equipment Specification, the Manufacturer shall make use of the version of the quoted standard current at the time of offer and shall not substitute another standard unless approval to substitute the other standard is obtained from the Contractor.

If an inappropriate standard has been referenced, or a suitable standard has not been referenced, the Manufacturer shall inform the Contractor in writing.
Where no applicable standard is published the Manufacturer shall propose a code of practice or regulation and seek the Contractor approval prior design, manufacture, testing, erection and commissioning of this item.

The equipment shall be designed, manufactured, tested, supplied, installed and commissioned considering to the following standards in the precedence as listed below:

- Standards as specifically noted in the text of the respective specification
- IEC standards
- CIGRE recommendations and guidelines as well as those published in Electra
- EN ISO standards
- DIN standards
- GL / DNV guidelines

The use of units and symbols shall be based upon the International System of Units (SI) in all documents, correspondence, technical schedules, and drawings. On drawings where other units have been used, the metric equivalent shall be marked in addition.

4 Environmental Conditions

4.1 General Conditions

		CV11	CV12
		Platform	Substation
Description	**Unit**		
Altitude			
Mean height above sea level	[m]	< 1000	< 1000
Ambient temperatures for equipment design			
Outdoor			
Minimum *at any time*	°C	-10	-30
Maximum *at any time*	°C	+28	+40
Converter hall,			
Minimum *at any time*	°C	+5	+5
Maximum *at any time*	°C	+40	+50
DC hall,			
Minimum *at any time*	°C	+5	-25[1]
Maximum *at any time*	°C	+40	+50
GIS room,			
Minimum *at any time*	°C	+5	N/A
Maximum *at any time*	°C	+30	N/A
Transformer room,			
Minimum *at any time*	°C	-10	N/A
Maximum *at any time*	°C	+28	N/A
Humidity *(indoor) max*	%	60	60
Site pollution severity IEC 60815-1 chapter 8.3 creepage distances are defined in chapter 7			
Outdoor	a to e	e	e
Converter hall	a to e	a	a
DC hall	a to e	b	b
GIS room	a to e	b	N/A

[1] -25°C during startup only; continuous temperature at minimum 5°C only

		CV11	CV12
		Platform	Substation
Description	**Unit**		
Transformer open room	a to e	e	N/A
Reference wind speed			
Maximum wind speed (for equipment design) acc. to IEC 60826 chapter 6.2.4	m/s	N/A	34 (1hr)
Basic wind velocity $v_{b,0}$ (for building design)	m/s	N/A	30
Ice data			
Radial ice thickness (for conductors) acc. to IEC 60826 chapter 6.3.2	mm	N/A	10
Maximum snow height	mm	N/A	200
Maximum frost penetration	mm	N/A	<600
Frequency of lightning (average)			
thunderstorm days per year	days/year	N/A	30
Precipitation			
Annual average	mm	N/A	603
Maximum hourly rate	mm/h	N/A	28
Solar radiation	W/m²	N/A	324
Corrosion Protection ISO 12944			
Outdoor	C1 to CX	CX	C5 VH
Indoor	C1 to CX	C2 VH	C2 VH
Seismic		As per clause 9	

Table 4-1: Environmental conditions

4.2 Air Quality

Air temperature will be controlled in such a way so that no moisture condensation at the equipment surface will occur. Air will be filtered; the rooms in the platform will be kept under slight overpressure.

5 AC System Data

5.1 AC System Voltages

		CV11	CV12
		Platform	Substation
Description	**Unit**		
Nominal	kV_{RMS}	66	400
Minimum continuous	kV_{RMS}	59.4	340
Maximum continuous	kV_{RMS}	72.5	420
Extreme Minimum short duration	kV_{RMS}	56.1 for 60 min	-
Extreme Maximum short duration	kV_{RMS}	75.9 for 30 min	440 for 60 min

Table 5-1: AC System Voltages

5.2 AC System Frequency

		CV11	CV12
		Platform	Substation
Description	**Unit**		
Nominal	Hz	50	50
Minimum continuous for rating	Hz	49	49
Maximum continuous for rating	Hz	51	51
Minimum short duration	Hz	47.5 – 49.0 for 90 min 47.0 – 47.5 for 60 sec	47.5 – 49.0 for 90 min 47.0 – 47.5 for 60 sec
Maximum short duration	Hz	51.0 – 51.5 for 90 min 51.5 – 52.0 for 15 min	51.0 – 51.5 for 90 min 51.5 – 52.0 for 15 min

Table 5-2: AC System Frequency

5.3 Short-Circuit Levels

		CV11	CV12
		Platform	Substation
Description	**Unit**		
Maximum short-circuit current for HV AC switchgear	kA	31.5 kA	80 kA
Duration of short circuit	s	2	1

Table 5-3: AC System Short Circuit Levels

6 Specific Creepage Distances, Shed Profiles and Clearances

6.1 Material

The insulators shall be either of the porcelain, glass or composite type and comply with the applicable standards (special requirements can be listed in the equipment specification of a component).

6.2 Specific Creepage Distances

Specific indoor and outdoor creepage distances for all components are specified according to the site pollution severity.

The AC Unified Specific Creepage Distances are determined in accordance with IEC 60071-2, IEC TS 60815-2 and IEC TS 60815-3.

The DC Specific Creepage Distances are defined according to extensive experience with DC insulators since 1980 in IEC TS 60815-4 and IEC 60071-5.

Generally, the minimum creepage distance of equipment is based on the “Base Voltage for Creepage Calculation” and depends on the average diameter D_a. D_a is defined according to IEC 60815-2 to -4

Specific creepage distances given as phase-to-phase value or as phase-to-ground value are to be considered only for single-phase equipment insulated to earth.

6.3 Specific Indoor Creepages for AC and DC Equipment

		CV11	CV12
		Platform	Substation
Description	**Unit**		
Subject to mixed voltage consisting of AC and DC			
Converter Hall	mm/kV	20	20
within converter	mm/kV	14	14
Subject to DC			
DC Hall	mm/kV	30	30

Table 6-1: Specific Indoor Creepages for AC and DC Equipment – Porcelain and Composite

No diameter correction is required for indoor installation in clean and dry environment.

6.4 Specific Outdoor Creepages for AC Equipment

			CV11	CV12
			Platform	Substation
Description	**D_a**	**Unit**		
Subject to AC				
phase to phase	D_a≤300 mm	mm/kV	N/A	31
phase to ground	D_a≤300 mm	mm/kV	N/A	53.7=31·√3

Table 6-2: Specific Outdoor Creepages for AC Equipment – Porcelain and Composite

For platform, specific outdoor creepages for AC equipment is applicable for transformer line side bushing only.

For larger diameters, the actual creepage distance shall be correlated to the diameter of insulators and bushings as follows:

D_a > 300 mm:

Porcelain, glass and composite insulators $K_{ad} = 0{,}0005 * (D_a/mm) + 0{,}85$

6.5 Specific Outdoor Creepages for DC Equipment

			CV11	CV12
			Platform	Substation
Description	**D_a**	**Unit**		
Subject to DC				
phase to ground	D_a≤250 mm	mm/kV	N/A	50

Table 6-3: Specific Outdoor Creepages for DC Equipment – Porcelain and Composite

For larger diameters, the actual creepage distance shall be correlated to the diameter of insulators and bushings as follows:

D_a > 250 mm:

Porcelain and glass insulators $K_{ad} = \left(\frac{D_a}{250\ mm}\right)^{0,3}$

Composite insulators $K_{ad} = \left(\frac{D_a}{250\ mm}\right)^{0,17}$

6.6 Shed profile

The shed profile shall follow the design rules of IEC/TS 60815.

	Indoor		Outdoor	
	Porcelain and Glass (non-HTM)	**Composite / Hybrid (HTM)**	**Porcelain and Glass (non-HTM)**	**Composite / Hybrid (HTM)**
Subject to AC	IEC/TS 60815-2	IEC/TS 60815-3	IEC/TS 60815-2	IEC/TS 60815-3
Subject to DC			IEC/TS 60815-4	IEC/TS 60815-4

Table 6-4: Applicable standards for shed profile determination

For DC outdoor insulators, in addition the following factors shall be respected:

		Porcelain / (non-HTM)	**Composite / Hybrid (HTM)**
Description			
Alternating shed defined by shed overhang [mm]	p_1-p_2	≥20	≥15
Spacing versus shed overhang	s/p	≥1	≥0.9
Shed Distance [mm]	C	≥60	≥55 (only valid for average diameter >250mm)
			≥45 (only valid for average diameter ≤250mm)
Creepage distance vs. clearance (highest ratio found on any section)	l_1/d_1 l_2/d_2	4	4.5
Shed angel	∝	5-20°	5-20°
Creepage factor CF	l/s	≤3.5	≤4.2

Table 6-5: Requirements for DC outdoor insulators in addition to standards

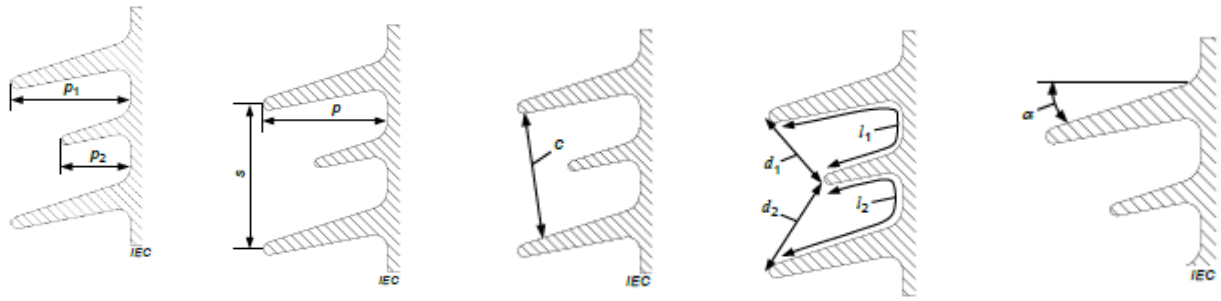

Figure 6-1: Factors relevant for defining shed profiles

For outdoor insulators with rated voltage higher 123 kV alternating shed profile is mandatory.

6.7 Clearances

Generally, the minimum AC clearance shall be determined according to IEC 60071-1.

If evidence can be provided that smaller clearances fulfill the withstand requirements, this may be acceptable. Air pressure altitude correction is already considered for installations < 1000 m above sea level. For indoor installations, further considerations of atmospheric corrections are required. The correction factors k_1 (air density correction) and k_2 (humidity correction) are according to IEC 60060-1.

7 Primary Flat and Cylindrical Terminals

7.1 Type of Terminal

7.1.1 Flat HV Terminals

The primary terminals for all HV equipment shall comply with those of IEC/TR 62271-301. This is applicable not only for switchgear and controlgear but also for other HV equipment. Threaded terminal holes are not permitted. HV terminals are to be designed to safely carry the short-circuit current.

7.1.2 Cylindrical HV Terminals

Primary cylindrical terminals are authorized for equipment like bushings and direct current measuring devices.

7.1.3 Earthing Terminals

Earthing terminals are to be designed to safely carry the short-circuit current in accordance with DIN 46011. Threaded terminal holes are not permitted.
Separate earthing connections for single parts of assembled equipment are not permitted, only one grounding point is allowed. The connection area must be marked with the earthing sign according to IEC 60417.

7.1.4 Other HV Terminals

Cylindrical HV terminals or HV terminals with thread are allowed, but not preferred.
The use of cylindrical HV terminals or HV terminals with thread shall be agreed between Contractor and the Manufacturer in advance in the project (before designing process).

7.2 Material of Terminal

7.2.1 Flat Terminals – HV and Earthing

In general, flat terminals shall be made of aluminum or aluminum alloy. Terminals of aluminum or an aluminum alloy shall not be treated.
Terminals which are not carrying continuous current can also be made of other materials, e. g. galvanized steel. For example, the terminals of surge arresters are manufactured of galvanized steel.
Earthing terminals made of galvanized steel shall be galvanized after holes and screw threads are

drilled.

7.2.2 Other Terminals

Cylindrical terminals, if required, shall be made of electrolytic copper, and silver-plated to a minimum thickness of 12 µm.

A copper alloy sensitive to seasonal cracking, layer corrosion, or crystalline corrosions shall not be used. The alloy shall have the same cracking frequency as pure aluminum.

8 Material and Workmanship

8.1 General

The material and workmanship throughout shall be in accordance with the purpose for which they are intended. Each component shall be designed to be consistent with its duty.

All supports, bolts, nuts, washers, lock-nuts and mounting hardware fabricated of ferrous metals shall be hot-dip galvanized or made from stainless steel in accordance with the applicable standards.
The Manufacturer shall furnish locking devices for threaded fasteners which will lock them in such a manner as to prevent them from coming loose in transit and in service.

All joints and fastenings shall be designed, constructed and registered in such a way that the component parts may be accurately positioned and constrained to fulfil their required function. The heads of all bolts shall be adjusted flush with the surfaces which they fasten (where applicable).

All spare parts shall be interchangeable with and shall be made of the same materials and workmanship as the corresponding parts of the work supplied under these specifications.

8.2 Color Scheme

Description	Indoor	Outdoor
Composite Insulators*	Grey	Grey
Porcelain Insulators	Brown (RAL 8016)	Brown (RAL 8016)

Table 8-1: Color scheme for the system

8.3 Cementing of porcelain insulators

Cementing of porcelain insulators must be carried out in a way to ensure durable connection between the cast iron fitting and the porcelain body.
Portland cement is to be used to ensure a strong connection even after excessive heating of the cement during a short circuit over the insulator.

* Exact colour may differ slightly due to the individual manufacturing process of the supplier.

Special attention must be paid to the sealing. The seals must be filled completely with cement. Silicone seams must not be used.

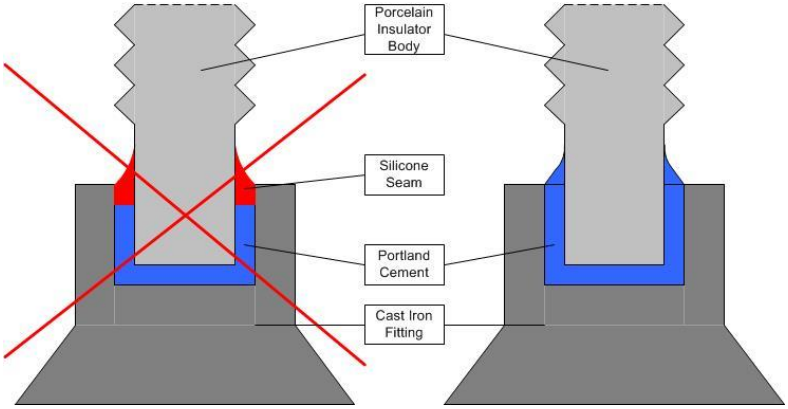

Figure 8-1: Cementing of porcelain insulators

9 Acceleration Requirement During Operation

9.1 Mechanical Onshore Requirements

For onshore stations, equipment shall be designed with PGA = 0.2g horizontal and PGA = 0.1g vertical according to IEC 62271-300.

9.2 Mechanical Offshore Requirements

For the Offshore station, equipment shall be designed and qualified in accordance with the values below. It must be made sure that the mechanical requirements are fulfilled at the place of installation over the complete lifetime. The equipment shall be suitable to withstand all mechanical stresses without any degradation of the equipment itself or its proper functioning.

9.2.1 Single Event Stress

The occurrence of a 100-year wave or the collision of a transport vessel with the platform result in a single-event stress. This will cause a mechanical stress to all equipment at the offshore platform as following:

		CV11
		Platform
Description	**Unit**	
maximum ground acceleration for design:		
horizontal	[g]	0.30
vertical	[g]	0.15

Table 9-1: Mechanical acceleration requirements for unique events.

These values can be assumed as static values and are valid at the location of the equipment itself. No further factors need to be applied to the values.

9.2.2 Fatigue Requirements

In addition to the single-event stresses, the platform may face a continuous oscillation which has to be considered in the equipment design. The stresses are described as follows:

		CV11
		Platform
Description	**Unit**	
maximum continuous oscillation for design:		
horizontal	[g]	0.05
frequency	[Hz]	0.1 - 0.2

Table 9-2: Mechanical acceleration Requirements for continuous events

If in a detailed equipment specification another value is described, the highest seismic requirement shall be used for this part of the plant which is specified.
At least the following factors shall be considered in the design:

- mechanical loads, both while in operation and during erection
- electromagnetic forces including those during internal and external faults
- wind load
- seismic forces
- forces due to expansion and contraction due to temperature variations
- load variation

9.2.3 Shipping condition from dockyard to offshore location

The following values related to the foundation footprint of the equipment have to be respected:

- Maximum forces of 0.6 g in all three dimensions
- Roll and pitch angle: +/- 10°
- Roll frequency 0.31 – 0.63 rad/sec = 0.05 – 0.1 Hz.

The need of transportation supports or special transportation measures to protect installed goods or systems and to keep the above-mentioned conditions have to be indicated by the Manufacturer in the offer documents. Necessary transportation supports and locking have to be included in the scope of supply.
Details of requirements on Transport, Packing, Storage and Marking will be defined in the relevant contract appendices in separate specifications.

10 Electromagnetic Compatibility

All equipment shall operate in its electromagnetic environment as specified, without any adverse impact on other equipment or itself. Emission and immunity characteristics shall be realized according to the specific, applicable equipment- standards.
No audible or visible corona shall be detectable at maximum operating voltage of the equipment during normal operation.
Radio Interference Voltage (RIV) shall not exceed 2500 µV.

11 Auxiliary Power Supply

All voltages are defined as supply voltages according to IEC 60038.

11.1 AC Power Supply

The tolerances for the frequency given in chapter 5 must be considered.
A redundant AC power supply system is provided for each converter station.
All equipment must be suited for operation in the specified range without failure and influence on lifetime.

		CV11	**CV12**
		Platform	**Substation**
Description	**Unit**		
Voltage			
rated value	V	400 / 230	400 / 230
tolerance	%	+/- 10	-15 / +10
Type of system earthing		TN-S	TN-S
Phases		3	3
nomenclature		L1/L2/L3/N/PE	L1/L2/L3/N/PE
colour scheme of utility		brown/black/grey/blue/yellow (or green)	brown/black/grey/blue/yellow (or green)

Table 11-1: AC auxiliary power supply

In addition, the following requirements regarding harmonics have to be considered:

Auxiliary Power Supply System

If not otherwise stated above the power quality requirements, specified **in IEC 61000-2-4** "Electromagnetic compatibility (EMC) – Part 2-4: Environment – Compatibility levels in industrial plants for low-frequency conducted disturbances", edition 06/2002, **class 3** shall be applicable to all loads, frequency converters and other devices connected to the power supply system.
The measuring location shall be the 400 V AC distribution boards of the auxiliary power supply system.

Requirements to be fulfilled by the devices connected to the Power Supply System:

All loads, frequency converters and other devices connected to the power supply system shall fulfill the following requirements

Input current ≤ 16 A:

- IEC 61000-3-2 (e.g., single EC motors, resp. single application full load current < 16 A)
- Single loads, operated in groups (full load current > 16 A) shall be equipped with power factor correction to reduce the THDi <= 50% (e.g., EC motors which are part of a large system like EC cooler bank)

Input current 16 A < … ≤ 75 A:

- IEC 61000-3-12 (e.g., FC with 4% AC-choke or equivalent DC choke)

Input current > 75 A:

- The Manufacturer must inform Siemens about currents higher than 75A.
- FCs shall be equipped with 4% AC choke or equivalent DC-choke (THDi limitation to <= 50%)

11.2 DC Power Supply

A redundant DC power supply system is provided for each converter station.

All equipment must be suited for operation in the specified range without failure and influence on lifetime.

		CV11	CV12
		Platform	**Substation**
Description	**Unit**		
DC Voltage Level			
rated value	V	220 (DC/DC Converter 110/48/24V)	220 (DC/DC Converter 110/48/24V)
tolerance	%	+/-10	-15 / +10
type of system earthing		IT	IT
Phases			
nomenclature		L+ / L-	L+ / L-
colour scheme of utility		Brown/blue	Brown/blue

Table 11-2: DC auxiliary power supply

12 Secondary Terminals and Cabinets

If installed indoors, enclosures shall have a degree of protection of not less than IP41 according to IEC 60529.
If installed outdoors, enclosures shall have a degree of protection of not less than IP54 according to IEC 60529.
Provision for an appropriate locking shall be made.
The enclosure shall be kept dry inside by suitable means of ventilation and drainage.
The Manufacturer shall employ suitable anti-condensation heaters in enclosures. A suitable cover shall prevent accidental contact of hot surfaces.
The cubicles must be furnished with an illumination lamp that is controlled by a door contact switch and a domestic general-purpose outlet, where practical, and protected by an MCB (Miniature Circuit Breaker) according to local standard.
All enclosures shall be readily accessible from ground level.
All external connections should enter the enclosure from below, unless explicitly agreed to by the Contractor. They shall not influence the degree of protection.
The cable entry of the indoor cubicles will be provided from below, realized with split slidable bottom plate and rubber sealing. Cable glands must be according to IEC 62444.
Equipment must not be mounted on doors of cubicles.

The distance between the bottom row of terminal blocks to the bottom flange or between two rows of terminal blocks shall be at least 150 mm.

Terminals shall be fit for purpose and provided with appropriate labelling. If AC and DC terminals installed in one enclosure, they must be grouped separately.

13 Motors and Operating Mechanisms

All mechanisms shall be readily accessible from ground level and comply with the clause above.
The use of suitable lubricants shall ensure proper operation not influenced by time.
A position indicating device shall be mounted at a prominent place.

Protection relay settings must regard voltage and frequency fluctuations, ensuring full operation for the entire range. Thus, for drives delivered with their protection relays, the Manufacturer shall preset all relays to parameters which allow full operation at the rated supply voltage in the complete tolerance band.

Outside of buildings, the mechanisms should be executed inside locked control cabinets.
All motors and operating mechanisms must be protected against unauthorized use with dismantling or cover.

14 Nameplates

All nameplates or means of identification shall be clean and free of any dirt or paint.
Their content shall comply with applicable standards and the equipment specification.

All equipment designations, nameplates, labels, controls and all warnings and safety information must be in English.

The nameplates shall be permanently attached in a conspicuous position and clearly visible. They shall be made of non-corrosive material, attached with corrosion resistant material. The legibility of the nameplates shall not be influenced by time and shall be suitable for complete specified lifetime of the equipment in the intended environment.

Prior to manufacturing / design freeze, all nameplates are to be approved by the Contractor.