

1 Grid Interface Standard - Scope

1.1 Scope

The grid interface standard encompasses the electrical connection from within each marine generator to the point the power is supplied to the grid or other power demand.

This scope is intended to outline the process to which the grid interface standard should be authored rather than define each aspect in particular, although examples are provided by experts in the field for reference. Anyone designing a grid interface for a marine device will rely on standards relevant to the resource assessment and device to implement design, therefore the grid interface standard must work closely with several standards listed in Table 1. The device performance testing and the outline certification standards will define a way of classifying the power that is produced by a marine generator given the resource. The marine generator must supply this power to the electricity grid and meet requirements to ensure safety and power quality. Therefore the grid interface relies on standards related to the device and to the grid to allow a grid interface to be designed and constructed. If the device performance was not accurately categorised then the grid interface designed around it may not comply with standards relevant to the grid.

Initially the author should perform a review of the work done in other IEC technical committees, notably TC88 (Wind Turbines) and existing standards to check for synergies. The following sections show examples of the areas which the grid interface standard should address and either point to existing standards if they exist and are relevant, or define new requirements utilising the author's expertise.

1.2 Grid Technical Connection Issues

There are many technical issues applicable to marine generators at stake in the standards process for grid interfaces. Marine generators require limits on the

- voltage flicker
- compatibility with the feeder protection devices
- battery backup systems for protective devices
- tripping off at appropriate times dictated by the local grid code
- anti-islanding capability
- power quality impacts on the grid e.g. total harmonic distortion

1.2.1 Power Quality

Large marine devices have the potential to cause voltage fluctuations on weak grids, and cause light flicker. The IEC already has a standard describing flicker so this could potentially be integrated into the Grid Interface standard by the author.

Many marine generators will utilise power electronic systems to interface variable speed generators to the fixed frequency grid. Such systems have potential to cause disturbance on the grid due to line commutated semiconductor switching or self commutated high speed semiconductor switching. The disturbance may be in the form of harmonic distortion and DC injection into the supply. The Grid Interface

standard must provide limits on these disturbances to ensure there are no detrimental impacts on the grid.

1.2.2 Protection Systems

Protective relays are required by utilities connecting the marine generators. The generator protection scheme must include protection as required by the local distribution or transmission company. The Grid Interface Standard should describe the relay functions required whether they are in the land substation at the connection point to the utility or built into the marine generators. If built into the marine generator this functionality may be embedded in the device controller. The Grid Interface standard should provide the requirements for testing the functionality of the protective relays and protection functionality embedded in a marine generator controller to enable testing by third parties.

1.2.3 Grid Interaction

A section will describe the low voltage ride through (LVRT) requirements of marine generators. The marine generator must be able to operate safely during grid faults as described in the local grid code and restore power output when the grid is restored or disconnect if the grid is not restored within the specified time. LVRT is verified in laboratory testing must have standard testing and reporting procedures. There is also the possibility of a feeder breaker opening with no fault on the grid, in this situation the marine generator must disconnect from the grid to prevent forming an islanded system.

A section on synchronisation will be required to specify limits on the voltage fluctuation caused by the start-up of marine generators. Systems utilising large induction generators will require soft start power electronics. Systems with power electronic inverter systems and systems with DC interconnections will require limits on the voltage fluctuation caused during the energisation phase of the DC link capacitors during start-up.

1.2.4 EMC

Marine generators must be designed to meet EMC (Electro Magnetic Compatibility) requirements. Standards covering EMC already exist so a framework to the standards must be established.

1.3 Cables

Wave and tidal devices may be either floating or fixed, requiring either dynamic or static power cabling.

1.3.1 Floating Devices – Dynamic Cables

Dynamic power cable systems have been used in the past to connect offshore platforms, typically oil and gas platforms. They will also used to connect to floating marine generators. The grid interface standard must contain the criteria:

- Selection of cable
 - Eclectically e.g. conductor diameter
 - Mechanically e.g. bending radius, loading
- Specification of bend restrictors

- Installation of cable
- Operation with flexible moorings
- Marking of dynamic cable to avoid entanglement

It is important to consider the cabling in the mooring analysis and to ensure the connector rigidity is less than that of the moorings. Heavy cables can affect device behaviour significantly, especially if the marine generator is small and lightweight. Reliability and maintenance design life will significantly affect the cost of deploying floating marine generators, standardisation the minimum requirements for these cables is required.

1.3.2 Fixed Devices – Static Cables

A framework for section and installation of sub sea cables containing the existing applicable standards.

1.3.3 Wet Disconnect Devices

Submersed marine generators may choose to utilise wet mateable connectors. These devices are currently used extensively in sub sea remote operated vehicles, the standard governing the functionality of these systems needs to be defined for marine generators. In a wave or tidal device the power connection is made permanently while the device is in operation and likely only to be disconnected during maintenance periods.

1.4 Earthing

The safe operation of protection relays and other safety devices requires suitable earthing arrangements. The earthing of floating and fixed devices will differ and requires standardisation.

1.5 Offshore & Onshore Electrical Installations

The requirements of wiring regulations within the marine generator will differ depending on whether the device is to be manned or otherwise. In general the standard must prove framework to existing standards covering the following criteria:

- Switchgear & Control Panel Assemblies
 - Construction
 - Inspection and Testing
- Power Transformers
 - Design Requirements for Power Transformers
 - Installation
 - Inspection and Testing
- Cables
 - General Cable Construction
 - Conductors
 - Insulating Materials

- Wire Braid and Armour
 - Protective Sheaths
- Control And Instrumentation Cables
 - Construction of Control and Instrumentation Cables
 - Data Communication Cables
 - Inspection and Testing
- Installation
 - Equipment Location and Arrangement
 - Equipment Enclosure, Ingress Protection
 - Batteries
 - Protective Earthing and Bonding of Equipment
 - Equipment Termination, Disconnection, Marking
- Ancillary Systems
 - Batteries
 - Emergency Power