**Technical Submission Requirements**

This document serves as the **“Technical Submission” for Technology Gate 2** noted in the Wave Energy Prize Rules. This document must be completed and submitted electronically via the Team only secured website (see instructions and required content below) by each competing Team in the Wave Energy Prize **by 5:00 PM ET, November 30, 2015** to be reviewed and judged for consideration as a Finalist/Alternate Team.

Each question/request in the Technical Submission must be answered in English and the required supporting information must be included. The response for each question/request must strictly adhere to the following criteria:

* Written responses must include response provided in TG1 submission in black text, with all new/updated TG2 information in red text. PLEASE BE CONCISE in your responses.
* Please do not include links to additional documentation in your responses.
* Please use only **SI units** in your revised Technical Submission and all drawings.
* Requested drawings must be provided in PDF format and be no larger than 10 MB per ﬁle; all ﬁle names must include the Team name and date (e.g. teamname\_questionnumber\_ﬁlename\_date.pdf); no more than ﬁve (5) drawings will be accepted per question as appropriate. All ﬁles must be of suﬃcient resolution so detail can be clearly seen. Descriptions of drawings must accompany each drawing and be clearly marked to indicate what question they refer. Please combine drawings into a single, multi-page PDF ﬁle per question when possible.

**Technical Submission Content**

The required content for answering each of the questions below is clearly provided in bold.

To help you craft your responses, a number of relevant aspects for consideration are also outlined.

**The items listed for consideration are not required, but are provided as “thought starters” when completing the Technical Submission.**

***Please note, with the exception of Question 12, all these questions relate to your device concept at full scale.***

**1. General Description**

**At a conceptual level, why will your WEC device and technical approach deliver the necessary two-fold improvement in Annual Climate Capture Width per Characteristic Capital Expenditure required to be a candidate for winning the Wave Energy Prize?**

**2. WEC Device Conﬁguration**

**Provide system level design drawings, descriptions of the drawings, and an overall description of the working principle of the proposed full scale WEC technology.**

These drawings should be to scale and, at a minimum, include views in three orthogonal planes and one three-dimensional perspective view.

**Drawings must include:**

**• Key dimensions of WEC device**

**• Total device mass (with and without ballast) and displaced volume**

**• Location of water line on device in still water and static equilibrium in installed conﬁguration**

**• Total surface area, both wetted and dry, of key device proﬁles (not components)**

**• Layout and key dimensions of mooring system and/or foundation**

**• Predominant wave propagation direction and orientation of device**

**Description must include:**

**• Description of overall working principle of the proposed full scale WEC technology (concept of operation)**

**• Description of all of the supplied WEC technology drawings**

When providing a thorough response to the above required information, consider the following aspects:

• WEC technology in operational condition system conﬁguration

• Key subsystem drawings relevant to understand the function of the WEC technology

• Visualization of key system and component motions relevant to this WEC technology

**3. Wave Energy Farm Conﬁguration**

**Provide schematic wave farm drawings of a farm conﬁguration of multiple devices, descriptions of the drawings and an overall description of the operating principle of a wave farm of the proposed WEC technology.**

These drawings should be to scale and, at a minimum, include views in three orthogonal planes and one three-dimensional perspective view.

**Drawings must include:**

**• Key dimensions of wave energy farm**

**• Drawing of umbilical, interconnection, and grid connection**

**• Predominant wave propagation direction and orientation of devices**

**Description must include:**

**• Overall operating principle of a wave farm (written with supporting drawings)**

**• Description of all of the supplied wave farm drawings**

When providing a thorough response to the above required information, consider the following aspects:

**• Distribution of WEC devices in farm conﬁguration considering**

**• Aspects of WEC farm conﬁguration and design speciﬁc to this WEC technology including**

**• mooring system with shared mooring infrastructure and shared mooring points**

**• WEC device umbilical and shared interconnection and cable infrastructure**

**• WEC farm in survival condition system conﬁguration**

**• Accessibility of individual WEC device in farm conﬁguration**

**4. Primary Power Absorption**

**Provide drawings and a description of the primary wave power conversion of the WEC technology. Description must include:**

**• Power absorption mechanism that is utilized for the primary power conversion step**

**• Absolute or relative degrees-of-freedom (DOF) and/or modes of deformation and/or**

**modes of operation that are utilized for the primary power conversion step**

**• Kinematic and dynamics description of the wave power absorption and conversion process**

**• Magnitude and dimension of key kinematic and dynamic physical quantities**

**(e.g. stroke, velocity and force or volume ﬂux and pressure diﬀerence, etc.)**

**• Approximate capture width**

Drawings should be to scale and, at a minimum, include views in three orthogonal planes and one three-dimensional perspective view.

**Drawings must include:**

**• Key dimensions of primary power conversion system**

**• Clear visualization of absolute or relative degrees-of-freedom (DOF) and/or modes of**

**deformation and/or modes of operation that are utilized for the primary power conversion step**

**• Predominant wave propagation direction and orientation of device**

When providing a thorough response to the above required information, consider the following aspects:

• Load paths

• Power ﬂow paths

• Types of materials used

• Approximate frequency bandwidth of eﬃcient power absorption

• Any inherent system properties that provide diﬀering ﬂuid-primary system interaction in

diﬀerent sea conditions with beneﬁt for energy absorption at diﬀerent incident wave power levels

• Any forms of shape, mode, orientation variation or other system adaptation that are utilized in

order to inﬂuence power absorption capabilities, power capture, and loading of the system in

diﬀerent sea conditions

• Technical solutions for the implementation of the adaptations identiﬁed in the previous bullet

• Loading on the device and mooring during operational, including stress, fatigue and wear

• Control considerations related to controlling power energy absorption and in order to maximize

wave energy absorption and/or delivery

• Control considerations related to controlling primary ﬂuid-system interaction in order to reduce

structural and other loading

• Control considerations related to adaptive control of shape, mode, orientation, or other

system adaptation

• Existence of end-stop requirements and the satisfaction of these requirements

• Maximal theoretical wave power absorption capability

• Structural loads,

• Reliability and redundancy inherent in the system

**5. Secondary and Any Further Internal Power Conversion**

**Describe the secondary and any further internal power conversion of the wave energy converter. Description must include:**

**• Type of power forms used in the secondary and any further internal power conversion steps in the power conversion chain**

**• Key characteristics of the internal power conversions steps**

**• Magnitude and dimension of key kinematic and dynamic physical quantities**

**(e.g. stroke, velocity and force or volume ﬂux and pressure diﬀerence, etc.)**

**• Approximate power conversion eﬃciency of the secondary and any further internal**

**power conversion steps**

When providing a thorough response to the above required information, consider the following aspects:

• Load paths

• Power ﬂow paths

• Types of materials used

• Power conversion schemes

• Internal short-term energy storage possibilities and their implementation

• Any inherent system properties that provide diﬀering ﬂuid-primary system interaction in

diﬀerent sea conditions with beneﬁt for energy absorption at diﬀerent incident wave

power levels,

• Any forms of internal power conversion adaptations that are utilized in order to inﬂuence

power conversion capabilities and loading of the system in diﬀerent sea conditions

• Technical solutions for the implementation of the adaptations identiﬁed in the previous bullet

• Internal loading in/on the power conversion chain and supporting structure, including stress,

fatigue and wear.

• Control considerations of internal power conversion and eﬀects to maximize wave energy

absorption, internal energy conversion and/ or while reducing internal and/or ﬁnal conversion

power ﬂows and loadings

• Existence of end-stop requirements and the satisfaction of these requirements

• Reliability and redundancy inherent in the system

• Inclusion of a drawing of the secondary and any further internal power conversion system;

these could include:

• Views in two orthogonal planes

• Clear visualization of internal kinematic and dynamic, degrees-of-freedom (DOF)

and/or modes of deformation and/or modes of operation that are utilized for the

secondary and any further intermediate power conversion steps

**6. Final Power Conversion Step to Deliver Electricity**

**Describe the ﬁnal power conversion step including the delivery of electricity. Description must include:**

**• Type of pre-ﬁnal power forms prior to conversion into electricity**

**• Key characteristics of the ﬁnal power conversions step**

**• Approximate conversion eﬃciency of the ﬁnal power conversions step**

When providing a thorough response to the above required information, consider the following aspects:

• Load paths

• Power ﬂow paths

• Any forms of ﬁnal power conversion adaptations that are utilized in order to inﬂuence power

conversion capabilities and external or internal loading of the system in diﬀerent sea conditions

• Technical solutions for the implementation of the adaptations identiﬁed in the previous bullet

• Internal loading in/on the ﬁnal power conversion step and supporting structure, including

structural stress, fatigue and wear

• Control considerations of the ﬁnal power conversion step and eﬀects to maximize ﬁnal energy

conversion and delivery and/ or while reducing internal and/or ﬁnal conversion power ﬂows

and loading

• Existence of limitation requirements of power, force, motion, current, etc. and the satisfaction

of these requirements

• Reliability and redundancy inherent in the system Power output conditioning

• Compliance with grid code

**7. Device Load Bearing Structure**

**Provide drawings and a description of the load bearing structural design of the proposed WEC. Description must include:**

**• Speciﬁcation of materials used in the structural load bearing mass and its proportion in the structural load bearing mass. Include internal, external and hydrodynamic loads**

**• Overall geometry**

**• Load/force ﬂow path**

Drawings should be to scale and include views in three orthogonal planes and one three-dimensional perspective view.

**Drawings must include:**

**• Overall dimensions of WEC structure**

**• Identiﬁcation of connection to mooring system and/or foundation to the structure**

**• Identiﬁcation of connection points of power conversion system to the structure**

**• Identiﬁcation of absolute and/or relative degrees-of-freedom (DOF) and/or modes of**

**deformation and/or modes of operation, if applicable**

**• Dimensions of mooring system and/or foundation**

**• Predominant wave propagation direction and orientation of device**

When providing a thorough response to the above required information, consider the following aspects:

• External and internal loading of structure

• Key high stress locations

• Redundancy

• Manufacturing process

• Modularity

• Assembly

**8. WEC Device and Farm Survival**

**Provide a description of the critical load cases and operational circumstances that are to be considered in the context of WEC device and farm survival.**

**Description must include:**

**• Critical survival load cases**

**• Critical survival circumstances and strategies**

**• Design and/or operational measures taken to ensure device and farm survival**

**• WEC technology in survival condition system conﬁguration with reference to previous drawing**

When providing a thorough response to the above required information, consider the following aspects:

• Observability of critical load cases of circumstances

• Loading on the device and mooring during extreme sea conditions (25/50/100 year storms)

including structural stress, fatigue, and wear.

• Fail-safe design consideration

• Any inherent system properties that provide diﬀering ﬂuid-primary system interaction in

diﬀerent sea conditions with beneﬁt for energy absorption in extreme and survival conditions

• Passive or active fast (wave time frame) or slow (sea state time frame) control

• Inherent system dynamics and wave-system interaction properties supporting survivability

**9. Technology Production**

**Provide a description of the production process of the WEC technology and the balance of plant system components.**

**Description must include:**

**• Key characteristics of production and manufacturing**

**• Key characteristic of supply chain considerations**

When providing a thorough response to the above required information, consider the following aspects:

• Production and manufacturing supply chain consideration

• Manufacturing, production and assembly process

• Required manufacturing activities at factory, at harbor, and on site

• Required production facility equipment and infrastructure

• Annual production volume

**10. Transport, Assembly, Deployment and Installation**

**Provide a brief description of the deployment and installation process of the WEC technology, the wave farm and the balance of plant system components.**

**Description must include:**

**• Key activities in sequential transport, assembly, deployment and installation process**

When providing a thorough response to the above required information, consider the following aspects:

• System and/or subsystem transportation to installation site

• Eﬀort and duration of assembly process

• Eﬀort and duration of deployment and installation process

• Required equipment and infrastructure detailing type and amount

• Possibility of implementing simultaneous installation

**11. Device and Farm Maintenance**

**Provide a description of the operation and maintenance requirements and process of the proposed. Description must include:**

**• WEC technology in maintenance system conﬁguration**

**• Key sub-systems that are expected to require planned maintenance**

**• Key sub-systems that are expected to require unplanned maintenance**

When providing a thorough response to the above required information, consider the following aspects:

• O&M strategy of WEC technology and wave farm infrastructure, e.g. cabling, mooring, substation, etc.

• Equipment and infrastructure required to implement maintenance procedures

• System, subsystem, and component repair and exchange requirements

• Consideration of monitorability, accessibility, maintainability

• Consideration of system modularity and ease of subsystem exchange

• Consideration of ease of partial operation

**12. Scale Model Construction**

**Describe the steps you will take to ensure that any scale model(s) you construct for testing during the Wave Energy Prize correctly scales the relevant physics of your WEC device concept.**

**Include consideration of Power Take Oﬀ, air compressibility, deformation, material type.**

To investigate further the scaling of the physics of a model, the following paper (Section 2.1)

is provided for your reference:

[http://www.supergen-marine.org.uk/drupal/ﬁles/reports/WEC\_tank\_testing.pdf](http://www.supergen-marine.org.uk/drupal/%EF%AC%81les/reports/WEC_tank_testing.pdf)

Note: The above link is supplied to provide a reference regarding how to scale the physics of a WEC model. Its inclusion does not imply that the Wave Energy Prize administrators require its use during the scaling of a Team’s model. All Teams are responsible for the design, scaling, and

construction of their WEC models for the purpose of assessment and testing during the Wave Energy Prize.

**13. Technology Risk**

**Provide descriptions of key technology risks. Description must include:**

**• Descriptions of the three key technology risks that you expect with respect to general technology operation and survival**

**• Descriptions of the three key technology risks that you expect with respect to achievement of high techno-economic performance and economic viability**

**• Assessment of each of the above risks and associated consequence**

When providing a thorough response to the above required information, consider the following aspects:

• Estimate for risk frequency

• Estimate for risk severity

• Corresponding risk management strategy for each of the risks within the general categories to avoid, transfer, mitigate, or accept risk

**14. System acceptability**

**Provide descriptions of any acceptability issue of the WEC technology and related solution to resolve these issues.**

**Description must consider:**

**• Lifecycle environmental acceptability**

**• Social acceptability - socio-economic impact and/or beneﬁt**

**• Legal, regulatory, and certiﬁcation acceptability**

**• Safety**

**• Risk Mitigation**

**• Insurability**

**• Market acceptability – investor, ﬁnancier, operator, utility**

**15. Characteristic Capital Expenditure**

**Provide information required to determine the Characteristic Capital Expenditure. Description must include:**

**• Maximum generator electrical power output**

**• Maximum generator torque/force**

**• Any torque/force/pressure transformation ratios in previous power conversion steps**

**• Maximal Power Take Oﬀ reaction torque/force/pressure on loadbearing structure**

**Description must include for each material type:**

**• Material type (e.g. steel)**

**• Related geometrically simpliﬁed (e.g. no stiﬀeners) surface area**

**• Grade of material (e.g. A36 steel, 6061-T6 Aluminum, etc.)**

**• Density**

**• Elastic modulus**

**• Yield stress**

**• Speciﬁc Manufactured Material Cost (CMMC) estimate ($/ton) and source information (e.g. quote)**