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Subject: Pasha Hawaii Holdings' At Berth Regulation Innovative Concept, IC-App-07

Dear Ms. Soriano,

Pasha Hawaii Holding (PHH) is looking forward to working with California Air Resource Board (CARB) in bringing zero and low emission technology onboard ships through our Innovative Concept, ATBERTH-ICApp-07. Our innovative concept utilizes green energy production onboard the vessel and minimizes emissions from the boiler resulting in significant reduction in emissions at the berth and while the vessel is transiting in CA waters. This approach will result in lower overall emissions with the ship at berth, in transit, and at sea.

PHH is a proven leader in bringing new technologies and alternative fuels to California as demonstrated with our new LNG fueled container ship, M/V George III. This will be the first ship to bunker LNG on the west coast using a new design fueling station developed by PHH. M/V George III will be followed by an additional LNG fuel sister ship and two converted LNG ships. PHH will utilize these innovative and entrepreneurial skills to bring new technologies and methodologies to their steam ships to meet the At-Berth requirements through the innovative concept program. While some of the proposed methods and technologies are specific to steam propulsion boilers, many of the technologies are applicable to ships in general and may be installed on the other ships, including ours once the concept is proven.

<u>Q1: Demonstrate and document how the Innovative Concept application will achieve equal or greater emissions reduction compared to shore power, with particular focus on emissions reductions in impacted communities.</u>

PHH proposed in our Innovative Concept IC-APP-07 a multi-tasking approach to meet the requirements. It is important to point out that presently there are no approved options available for our steam ships to meet the At-Berth Regulations. As such, our proposed approach is to invest in the following to reduce our emissions:

1. Onboard green energy production
2. Energy storage for shipboard grid stabilization
3. Energy usage reduction
4. Improved boiler efficiency at low load operations and biofuel usage
5. Limited Shore Power Usage

The first step is to establish a baseline and is in progress. PHH, through the University of California, Davis, just performed emissions measurements from the steam boilers in port, in transit, and at sea. This data still must be analyzed to establish our emissions baseline on a per kW basis for in port stays. Once we have our baseline, we will be able to better refine our plan to meet the At-Berth regulations.

1. Onboard Green Energy Production: Wind and Solar

PHH is presently installing an 18 kW WindWall (18 Micro Cube Wind Turbines) pilot program on top of a ship to shore container crane at the Pasha Stevedoring & Terminals (PST) facility in Wilmington. This is the first WindWall installation on a moving platform. We will utilize the lessons learned from this installation and apply to the vessel installation. We have engaged Marine Design and Operations Inc. (MDO) to determine the maximum number of Micro Cube WindWalls that we can install on top of the bridge and bridge wings on the ship within the weight and structural limitations of the bridge and bridge winds.

PHH has completed preliminary wind studies on top of the bridge on one of our steam ships that resulted in a 90% utilization factor (average wind speed is sufficient to produce and average of 90% WindWall rated output). Additional wind studies will be conducted to better understand the wind speed specifically at port and within CA waters. The WindWall will generate zero emissions energy during the entire time in CA waters, not just after the vessel is tied up. This will result in significant emission reductions with the vessel at berth and in transit in CA waters as well as other ports of trade. Since the production of this energy is 100% green with no emissions, it will reduce ship's overall emissions. While we are considering the installation of WindWalls on these ships a pilot program, our intention is to utilize this technology on our other ships once proven in the marine environment.

PHH has engaged MDO to perform a preliminary design to determine how many solar panels can be installed on and around the bridge deck. The initial draft estimated about 1500 sq ft of space available.

Since the WindWalls are much greater in energy density and produce energy for more hours per day than solar, the WindWalls will be maximized within the allowable space and complemented by solar as space allows. While we only plan to be able to produce a relatively small amount of power with solar, it is still 100% emissions free, and it will help reduce the average emissions produced by the ship.

2. Energy Storage

PHH will incorporate energy storage for vessel electrical grid stabilization as environmental conditions can quickly change the energy output from the Wind and solar. It is currently not feasible to incorporate an energy storage system on this ship to provide all the energy during an in port stay. There, however, is a new energy storage system technology emerging being marketed for marine use. Pasha is working towards participating in an onboard pilot program soon (see response to question 5).

Presently, PHH has two 750 kW /1.2 MWh 40-foot containerized battery energy storage systems at PST in Wilmington. There have been significant hurdles both technical and regulatory in getting this energy storage system online for use on the terminal. Significant hurdles will also exist in utilizing an energy storage system of this size onboard the ship. While it is possible to utilize similar battery energy storage systems, we believe that new technology energy systems available soon will be a better option for ships.

3. Energy Use Reduction

Energy use reduction has the same impact as adding green energy supply. If we reduce the load by 100 kW, it will have the same emission reduction result as if we produced 100 kW of green energy. Therefore, the emission reduction will reduce the average emissions produced by the ship by the same percentage as the energy reduction. It will also reduce emissions in port and during transit in CA waters, not just at the berth.

In our energy reduction effort, we will look at both operational and technical means to lower the energy load. The first will be accomplished by an onboard energy audit of the ship's operations and energy consumption with the vessel in port. We will examine our operating procedures and optimize them specifically for each California port period operations. The energy consuming equipment will be examined for optimal maintenance and operating condition/setup of the steam plant and auxiliary systems.

The energy audit will look at the condition of the steam insulation and condensate steam traps. We anticipate utilizing variable frequency drives on the condenser cooling pump, force draft fan blower, and engine room fans. We will exam upgrading the lighting used while in port to LEDs.

From the energy audit conducted on the vessel, we will quantify how much energy is being consumed by the auxiliary loads and efficiency of the steam system at the lower in port loads. The energy audit will produce specific energy conservation measures (ECMs) to be implemented.

4. Improved Propulsion Steam Boiler Efficiency at low load operations

The steam boilers onboard the ship produce steam to supply steam to both the propulsion steam turbines and the ship's service steam generator (SSSTG) turbines. It is difficult to achieve optimal propulsion boiler efficiency when they are operating at low loads as only one steam turbine generator will be in operation in port. Currently, the boilers are optimized for large at sea propulsion load. To optimize the boilers for low in port loads we will look at installing new low load fuel nozzles. There are several vendors that have specialized in providing emission reducing burners and burner management. This also includes optimizing the fuel to air ratio for the lower loads to minimize emissions. The air to fuel ratio will be optimized and verified by installing emission monitoring equipment on the boiler stack.

We have begun reviewing options for redesigning the boiler burners to reduced emissions. The first option that we are looking at is using a water/fuel homogenizer to control the combustion temperature for reduced NOx and improved combustion. This technology was used onboard the steam ships in the past but had technical difficulties with flame stability. Our plan is to design a burner assembly with water/fuel homogenizer specifically designed for our low load operations in port and not for a wide load range as the earlier application of this technology had to accommodate. While emission data was not collected in the past, we did find one publication online by Loughborough University of a Thesis, "Effect of Water Injection on Boiler Performance" by Mitchell Kane in 2017. The Thesis concluded that water injection into a small 20kW auxiliary boiler resulted in a 40% reduction in NOx and a 93% reduction in CO. Energy.gov also list water/steam injection as an emission control strategy.

Another option we are looking at is adding hydrogen into the atomizing steam going to the burner. We have not been able to find any data on this being done in the past. However, adding hydrogen into the combustion air on internal combustion engines results in significant emissions reductions. The hydrogen would be produced onboard and consumed by the boiler with minimal storage. Testing will be required to validate the emissions savings compared to the energy consumed creating the hydrogen. While we believe that this is feasible, in addition to the technical challenges, there will also be extensive regulatory approvals required.

Another technology that Pasha is exploring is the utilization of a heat pump to remove the waste heat from the SSTG exhaust before the condenser and transfer the heat energy to heat the feed water. Currently, all this heat is wasted as it is transferred to the sea water in the condenser. This is another technology that has not been utilized on marine propulsion boilers.

There are new control systems to automatically optimize the amount of combustion air admitted into the boiler to minimize emissions. We will analyze our current combustion control system and its efficiency at minimizing emissions at the low in port boiler loads compared to new available control systems.

5. Limited Shore Power Usage

The vessel is currently equipped with 600 amps of shore power. This is insufficient to operate the entire ship which requires about 2,500 amps, depending on the refrigeration container load, but we may be able to modify the system so that it can power some of the ships load, such as a breaker panel that feeds the refrigeration containers. To utilize the shore power, we would need to install a transformer to reduce the voltage down from 6,600 VAC to 450 VAC.

Ideally, we would be able to parallel the ships steam turbine generator with the shore power to maximize the available power from shore, but historically this has not been allowed. We will enquire with the ports and utility companies to see if this can be accomplished.

Q2: Identify the Pasha Hawaii vessels that will be equipped with the proposed clean energy systems and boiler energy efficiency upgrades.

Our two C8 class steam ships, SS Pacific and SS Enterprise, will be equipped with the proposed clean energy technology. Where options exist, we may try one technology on one ship and another on the other ship and compare which performs best.

Q3: If any Pasha Hawaii owned or chartered vessels are not covered by the Innovative Concept application, please indicate how those vessels will comply with the At-Berth Regulations requirements.

PHH will have a total of eight ships once we take delivery of the second new build ship, M/V Janet Marie, at the end of this year. Of these eight ships, four will utilize the alternative fuel, LNG, for compliance with the At-Berth regulation. The two RoRo ships will have shore power capability. The two remaining steam ships will comply through this Innovative Concept.

Q4: Provide an expected timetable for the installation of the proposed clean energy systems and boiler energy efficiency upgrades.

We estimate that it will take 18 months to have the technologies installed and operating from the time of receiving approval of our innovative concept. The technologies and methodologies will come online at different times within the 18-month period with the easier to implement items done first.

We will begin our engineering work for the technologies proposed as soon as we receive the approval of our innovative concept. Some of the engineering work is already in progress. Once the engineering work is complete, and regulatory approvals are obtained for each technology, we will order the equipment. The lead time for some of the equipment, can be long due to parts shortages, manufacturing lead time and supply chain issues. For example, the current lead time for the WindWalls is currently around 6-months from placement of order.

One of the first emission reduction strategies we intend to implement is the switch to biofuels. The engineering required should be minimal and modifications should be relatively small. This will allow for significant emission reduction within a 3-to-6-month period while we are working on implementing the other strategies.

Operationally, we will perform an onboard energy audit to identify energy usage reductions that can be implemented immediately. The energy audit will provide a more detailed timetable and specific energy conservation measures that we will implement.

Q5: Clarify the expected power output of the proposed solar arrays and the storage capacity of the battery backup systems.

From the review by the naval architecture firm, MDO, we anticipate being able to install about 25 kW of solar panels on the vessel in a 1,500 sq ft area. The actual amount will vary on the location and quantity of WindWalls that we are able to install. This will be known after a structure analysis of the bridge deck's ability to support multiple WindWall and their placement. This analysis is being done by MDO who is experienced with these WindWalls.

As discussed above, the energy storage system size will depend on the amount of WindWalls and Solar panels we are able to install. The energy storage system is more for the vessel's grid stability rather than long term energy storage at this point. If needed, we will explore the use of containerized battery energy storage systems like what we are using at PST or a new emerging technology to provide more zero emissions green energy during the low wind periods.

The WindWalls can be outfitted with a small capacitive energy storage system to smooth out energy production during wind fluctuations. This may be sufficient for this application. We take measurements of the ship's electrical grid and monitor the stability.

As described above, there is a new zero emissions containerized energy storage system technology that PHH is looking to team with. Our goal is to do an onboard pilot program to validate the technology. This energy system would be able to provide significant power to augment the WindWalls and Solar and provide power when environmental conditions are not favorable for energy production. While the new technology has been tested shoreside, it has not been modified or tested for shipboard use yet. If this pilot program is successful, it will be a great step forward in achieving our goal of near zero emissions ship operations while at berth without utilizing shore power.

Q6: Provide a plan for minimizing in-Port emissions if the wind turbines, solar, or battery systems become inoperable for minimizing in-port emissions.

Our plan for minimizing in-port emissions during periods when the solar and WindWalls are not producing power is to optimize the boiler plant for minimal emissions as discussed above. In addition to minimizing the loads and optimizing the boiler plant, PHH intends to switch to biofuel while the ship is secured to the pier. Although biofuels have not been tested in large marine propulsion boilers, there has been testing with biofuel use in other types of boilers that showed significant, but varying, emission reductions. We will perform emission testing with biofuel to quantify the emission reductions in this specific application.

Q7: Clarify the expected timelines for the design of and approval for use of the proposed fuel nozzles for low load operations and identify the expected emissions reductions from using the proposed fuel nozzles.

We will begin working with our vendor on the new burner design for are boilers at the reduced load and on biofuel as soon as we get the approval for this innovative concept. From our energy audit, we will have a good estimate what the reduced load will be on the boiler and can design the burner system with low load nozzles to match. In the short term, we believe that using biofuels and modification to the fuel system for its utilization will be the fastest modification with immediate emission reduction results that we can do. As such, we will verify availability of the biofuels, have MDO review the fuel system, and review with regulatory bodies for compliance requirements. As we implement other emission reduction strategies, the burner system may require redesigning to meet new lower loads and new fuels.

. Since what we are proposing to do has not been done before, it is difficult to predict with certainty emissions reductions with the new burner nozzles, burner management system, and use of biofuel. From our research, it appears that PMs could be reduced by 90%, SOx reduced by 75%, and NOx by 30% compared to our current emissions.

Q8: Clarify the duration of the Innovative Concept application by providing a timetable for upgrading the vessels to utilize shore power.

Steam propulsion boilers are not like diesel engines that can be easily secured and restarted. It takes 2 days to bring a cold boiler up and online. As such it is not feasible to "turn off" the boiler while in port. While we can secure the steam system, "bottle up the boiler", we will still need to periodically fire the boiler to maintain the pressure and temperature inside the boiler. It is our intention to utilize the methods described in this innovative concept to be able to meet the At-Berth regulations while operating the boiler(s) at minimum load to keep the boilers and steam system warm. There are numerous new technologies and fuel types that our emerging. In the future, some of these may be more easily adapted to a steam ship and a motor ship. There are a lot of large industrial boilers shore side that are also working toward utilization of better fuels and reduced emission strategies. We anticipate that we will be able utilize new green energy sources as well as produce more green energy onboard with new technologies of the future.

Q9: Consider collecting data on performance of the wind turbines and solar arrays when the vessels are within 24 nautical miles of the California coast.

The energy data from the wind and solar system will always be collected for performance evaluation. We will have the ability to quantify energy production when operating in CA waters.

Thank you for your careful review of Pasha Hawaii's responses to the proposed innovative concepts to meet the CARB at-berth regulation.

Sincerely,

Edward Washburn, Senior Vice President of Fleet Operations
Pasha Hawaii Holdings, LLC

CC: Angela Csondes, California Air Resources Board
Jeff Jacobs, California Air Resources Board