Hull and Propulsion Recommendations for Hawaiian Interisland Ferry Vessels

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Abstract

The Hawaii Department of Transportation (HDOT) and the U.S. Maritime Administration (MARAD) have authorized and funded a study to review the feasibility of bringing a new interisland ferry system to Hawaii. This study will make recommendations on whether the new vessels should use a mono hull or multi hull configuration. Propulsion fuel choices for these new vessels is a critical component of the study, as the effects of burning liquid natural gas (LNG) or marine diesel oil will affect the amount of greenhouse gases produced, the life span of the engines, the maintenance cost for the vessels and the cost of fuel. My conclusion based on the results of this study is to recommend that a mono hull vessel utilizing LNG as fuel should be used for the new Hawaii interisland ferry system. This study will draw upon lessons learned from existing U.S. ferry systems such as the Alaska Marine Highway and the Washington State Ferry, with consideration being given to the requirements dictated by the Jones Act, as well as conditions and requirements specific to the Hawaiian Islands and the lessons learned from the original Hawaiian SuperFerry and SeaFlite interisland ferry systems. As author of this study, I have firsthand knowledge of the ocean conditions, environmental concerns, and the operation and maintenance of large high-speed multi hull vessels from my experience serving as Chief Engineer of the Hawaii SuperFerry until its shutdown by the Hawaii Supreme Court. I have also been employed as a licensed marine engineer working aboard the Alaska Marine Highway System's high-speed multi hull vessel M/V Fairweather.

Keywords: LNG, SuperFerry, Interisland, Ferries, Emissions, Diesel, Marine Fuel, Hull Form, Catamaran, Mono hull, Single hull, Lubricity, MARAD, Hawaii DOT, Bunkering, Drag

Coefficient, Shipyards, Sea-Flite, ECA, USCG, Passenger Ferry, Car Ferry, CNG, Washington State Ferry System, Alaska Marine Highway

Hull and Propulsion Design Recommendations for Hawaiian Interisland Ferry Vessels.

There are eight main Hawaiian Islands separated by sometimes rough and untamed ocean passages in the ever-challenging Pacific Ocean. Long ago, Polynesian seafarers sailed from other far away islands to settle and develop this isolated archipelago before Captain James Cook became the first European explorer to encounter the Hawaiian Islands in 1778 (Demby, 2015). The sea transportation of goods and people between the islands has been an integral part of the Hawaiian culture for hundreds of years, yet in 2017, current inhabitants must take to the air to visit friends and family located on other islands. The current lack of an interisland ferry system restricts the cost-effective movement of people, vehicles and cargo between the islands and restricts the ability of the Hawaiian State Government to quickly respond in the event a natural disaster or national emergency.

By way of history, Hawaii has had several interisland ferry systems in the past, including the 'SeaFlite' hydrofoils in the 1970s and the Hawaii SuperFerry which operated from August 2007 to March 2009. Recently, MARAD and the HDOT have authorized a $550,000 study with the intent of bringing a new interisland ferry system back to Hawaii (Mattison, 2017). A review of the successes of the Washington State Ferry system, the Alaska State Highway, and other ferry systems currently in operation worldwide that use both mono hull and multi hull ferry vessels will determine the best choice for a Hawaiian Interisland ferry system.

This paper will analyze Hawaii interisland ferry vessel hull designs and engine propulsion options. The choice to use single hull vessels or multi hull vessels such as the recent Hawaii SuperFerry will have long lasting effects on Hawaii's future interisland ferry system. Impacts

such as rider comfort, the ability to transverse rough seas and the overall cost of manufacture and operation are critical to the system's success. Fuel and propulsion options such as whether to burn LNG or diesel fuel will impact the environment, the costs to operate and maintain the engines and will also affect public perception of the viability of an interisland ferry system in today's environmentally conscious environment.

This paper will recommend single hull ferries that operate on LNG as a marine fuel which will meet the specific needs of the Hawaiian Islands based on past experiences and emerging marine engineering technologies. These recommendations can be effectively implemented in a safe, cost-effective manner. This study can be referenced by the Hawaiian State Senate, the Hawaiian Department of Transportation, the Hawaii Governor, and others when determining hull design and fuel options when designing a future Hawaiian Interisland ferry system and its vessels.

Literature Review

History of Ferries in Hawaii.

Approximately 1,500 years ago, Polynesians first settled the Hawaiian Islands, having travelled over 2,000 miles by canoe from the remote Marquesas Islands. Interisland travel by canoe was common for trade, visiting families and conducting war on other islands (Kane, 1998).

In 1908, Matson Navigation Company began expanding their fleet with state of the art liner vessels that also served the needs of interisland passenger and trade services. In 1970, Matson left the passenger business to focus on containerization. Interisland passenger service between the

islands diminished, leaving air transportation as the primary means of passenger travel between the islands (Hamm, 2015).

In 1974, Hawaii saw a new interisland ferry service called “SeaFlite” which was a partnership between Boeing and LTV Corporation. Boeing used a modified 929 Jetfoil to offer interisland service between terminals in Nawiliwili, Maalaea, Kawaihae and Honolulu Pier 8. The service lasted 2 ½ years with the final voyage being in January 1978. LTV, which owned 75% of SeaFlite, was experiencing financial problems and decided to sell off its shares of non-performing stock, which included its holdings in SeaFlite.

Figure 1. Early Hawaii Interisland SeaFlite Ferry (Beat of Hawaii, 2016)

In December of 2007, a new interisland ferry began service. The Hawaii SuperFerry was a 349-foot multihull catamaran utilizing four MTU-8000 series diesel engines which used marine diesel oil as a fuel. The SuperFerry carried 866 passengers and 282 cars between Maui and Honolulu daily until March 2009, when the Hawaii Supreme Court ruled that legislation that

allowed the SuperFerry to operate without an environmental review was unconstitutional (Namata, 2016). Shortly after this court decision, the SuperFerry went bankrupt. The vessels were sold to the U.S. Government and the loading barges were sold at auction (McCabe, 2010).

Structural Design Options for Interisland Ferries.

Interisland ferries are in widely utilized across the globe to carry both passengers and cargo. The hull design of the vessel will dictate its cargo capacity, passenger capacity, ride characteristics, fuel consumption, cost to manufacture and other important metrics. The most common ferry designs are hydrofoil, catamarans, trimarans and mono hull. Hydrofoil ferries have underwater foils that stay submerged at slow speed. When the hydrofoil's speed is sufficient, the foils will lift the boats full out of the water, decreasing drag and increasing speed. Catamarans have two hulls in parallel and achieve their stability from the wide beam. Trimarans have three hulls in parallel and mono hull vessels only use one hull.

Advantages of Single Hull Ferries.

Mono hull ferries travel much more slowly than multi hull vessels. The likelihood of whale strikes is increased with multi hull vessels due to their speed. The Hawaii SuperFerry passed through whale breeding areas at a high rate of speed while avoiding whales as they appeared in the ocean by using two lookouts posted on the bridge (Wilson, 2007).

A single hull displacement hull design is not limited by wave height, whereas multi hull vessels experience wave slam in large sea conditions. Wave slam can be detrimental to the car deck structure resulting in damage to the vessel and its cargo (Giles, 1988).

Mono hull vessels can carry much more cargo than a multi hull vessel due to the low internal volume of multi hull vessels (The Motorship, 2016).

Figure 2. The Hawaii SuperFerry multihull vessel (Defense Industry Daily, 2012)

Disadvantages of multi hull ferries in Hawaii.

One of the biggest drawbacks to multi hull ferries is the lack of cargo space. The space between the divided hulls is not used, whereas single hull designs are able to load this area with cars or passengers (Motorship, 2016). The U.S. military uses a multi hull configuration in its Joint High-Speed Vessel Program (JHSV), using its modular containerization to quickly change vessel capabilities when needed.

During heavy sea conditions, large multi hull vessels are subject to a condition called “wave slam” where, when operating in rough seas, the wave impacts the bottom of the cross deck, sometimes resulting in structural damage (Giles, 1988). The limiting ride height for the Hawaii SuperFerry was twenty-foot swells. When the waves exceed the recommended height, the vessel would have to stop all forward motion to keep the waves from slamming into the bottom of the cross deck.

The passenger ride on large multi hull vessels is poor due to their sensitivity to displacement. This frequently resulted in sea sickness for passengers aboard the Hawaii SuperFerry during its time running in Hawaii.

High speed vessels such as the Superferry consume large amounts of fuel. This was the case with the New Zealand multi hull ferry that was shut down because of high fuel usage and frequent cancellations due to high seas (Lohmann & Trischler, 2012).

The IMO’s approval of the International Code of Safety for High Speed Craft came into force in January 1996 and presents a complete set of comprehensive requirements for the construction of high speed craft, including the conditions for operation and maintenance and crew requirements (Insight, 1996). IMO requirements raise the cost of operating a passenger ferry service in Hawaii by increasing crew costs and increasing vessels maintenance costs making a multi hull vessel less desirable for the Hawaiian Islands.

The Hawaiian ECA Zone.

The Hawaiian Islands lie within an emission control area (ECA) zone. The International Maritime Organization (IMO) enacted the North American Emission Control Area which encompasses all eight Hawaiian Islands. These regulations prevent marine pollution by ships by reducing Sulphur Oxides (SOx), nitrogen oxides (NOx) and particulate matter (PM) emitted into the air (Henderson, 2014). These ECAs extend out 200 miles from the coast of the United States, Canada and the French territories. Strict fuel requirements require lowering the amount of sulfur in the marine fuel worldwide to 0.5% beginning January 1, 2020 (Molloy, 2016). The special requirement for low sulfur fuel in the ECA drives up the cost and results in damage to vessel machinery from low lubricity.

Among the concerns facing the marine fuel industry is the question as to whether there will there be enough low sulfur diesel to fill the demand when the International Maritime Organization (IMO) implements the 0.5 percent sulfur cap taking effect January 1, 2020 (Wollenhaupt, 2017). As future ECA zones are added worldwide, the demand for this type of fuel will increase, encouraging the use of LNG in Hawaii and across the world.

Advantages of LNG.

LNG is a clean choice for a marine fuel as it emits fewer harmful pollutants into the atmosphere when burned than marine diesel oil fuel does. Significant reductions in NOx SO2 and particulates are achieved when burning LNG. As Hawaii sits inside the 200-mile Emission Control Areas (ECA) zone, marine fuel oils must be within the acceptable sulfur limits. Currently, heavy fuel oil and low sulfur heavy fuel are not allowed to be used within the ECA. In the future, diesel oil may not be allowed either without special scrubbing units or other emission control equipment.

LNG reduces the cost of maintenance and repairs of marine engines. LNG fueled engines require fewer oil changes and experience less wear than traditionally fueled engines. LNG powered engine rooms are cleaner and require less day to day maintenance, consuming on average 18% less than the amount of chemicals and 20% less than the lubricant of similar vessels not powered by LNG (Kliger, 2016).

The U.S. has the fourth highest natural gas reserves in the world (The World Factbook, 2016). Recent legislation was lifted allowing the export of LNG from export terminals along the east coast. New export terminals will be built and increased worldwide conversion to LNG powered equipment will take place, primarily driven by environmental regulations (Molloy, 2016).

In a test with the Ferry Vessel Viking Grace, efficiency gains were 60% greater than the average Viking line vessel and used only 16,000 tonnes of LNG compared to the 24,000 tonnes of fuel consumed by the diesel engines (Kliger, 2016). These gains in efficiency will translate to cost saving over time in an LNG powered interisland ferry system.

Disadvantages of marine fuel oils and diesel fuel.

Diesel oil fuel has 15% more greenhouse gas emissions than LNG, 92% more NOx and 84% more particle emissions (Kliger, 2016). The California Air Resources Board (CARB) concluded that Compressed Natural Gas vehicles emit 20 to 29 percent fewer greenhouse gas emissions (GHG) than vehicles that use a comparable gasoline or diesel fueled vehicle (NGVAMERICA, n.d.). Diesel oil does not mix as uniformly in the combustion chamber as LNG does. Natural gas contains less carbon than any other fossil fuel and thus it produces few carbon dioxide (CO2) emissions when burned.

Diesel oil has higher operating costs for an interisland ferry system than LNG does due to the price of the fuel. As the sulfur content of marine fuel oils decreases due to ECA legislation, diesel fuel will continue to become more expensive worldwide. When the sulfur requirements inside the ECA drop to 0.5% in 2020, low sulfur marine fuel oil will become standard for marine vessels across the world (Molloy, 2016).

Environmental concerns in Hawaii.

A prime concern for interisland ferry systems in Hawaii is whale strikes. The Hawaiian Islands are filled with breeding humpback whales from early December to May each year, and the shortest sea route between Honolulu and Maui crosses directly through some of the most prolific whale breeding grounds on earth. In partnership with several organizations, the SuperFerry would record the location of each whale encountered during their voyages. It was not uncommon to record several hundred whales during a single voyage.

In 2005, the National Marine Fisheries Service and the Marine Mammal Commission were very concerned that the Hawaii SuperFerry would hit whales. The SuperFerry employed extensive whale -avoidance plans by avoiding waters less than 600 feet deep, installing night vision systems to identify whale breeches and marking maps with the location of each whale sighted. These measures were successful as there were no whale strikes attributed to the Hawaii SuperFerry during its operation. The SuperFerry's high speed of 43 miles per hour was a big concern, as ship strikes are a significant concern with North Atlantic right whales and humpback whales (Wilson, 2007).

Mono hull vessels that travel much slower than high speed multi hull vessels have more time to maneuver around areas when whales are spotted. Damage to whales when strikes do occur are lessened at slower speeds (NOAA, n.d.).

Similar ferry systems across the globe.

There are several ferry systems worldwide that operate in open ocean conditions like Hawaii's ocean environment. By reviewing other ferry systems, we can see what works and what does not work. Similar ferry systems include the Cook Straight Ferry connecting the North and South Island of New Zealand, the Canary Islands with service provided by Fred Olsen, Naviera Armas and Trasmediterranea, the Washington State Ferry System and the Alaska Marine Highway System.

The Cook Straight in New Zealand is considered dangerous and unpredictable because of the high seas and winds which occur frequently. In 1994, the first high speed ferry was used to transport passengers across the sound, but now only mono hull vessels ply the trade. High speed multi hull ferry service was terminated in 2005 due to large financial losses resulting from the vessels' large fuel consumption and their water-jets which caused environmental damage. The maximum wave height for these vessels was four meters. The vessels frequently saw wave heights greater than four meters and cancellations were common. Today, all ferry service across the Cook Straight consists of mono hull vessels that carry passengers, cars and railcars (NZ History, 2017).

Ferry companies in the Canary Islands use both high speed multi hull ferries and mono hull ferries. Ferry systems in the Canary Islands use the most modern ferries in the world. A new multihull ferry, the Benchijigua Express offers 50-minute service between Los Cristianos in Tenerife and San Sebastian and is state of the art. This ferry holds 1291 passengers and 341 cars

and travels at a speed of 38 knots. The interisland ferry company Transmediterranea has a large fleet of all types of ferries that would be able to operate in open ocean conditions like Hawaii. The company Naviera Armas has a fleet of mostly mono hull roll-on /roll-off (RO-RO) vessels that move passengers, cars and freight throughout the islands.

*Figure 3. The Benchijigua Express High-Speed Ferry (*Direct Ferries, 2017*)*

Seaspan Ferries Corporation has commissioned two new duel fuel LNG ferries that use a combination of LNG, diesel and batteries for use in British Columbia. These new eco-ferries are mono hull and were built in Istanbul, Turkey (Haun, 2017).

Current LNG infrastructure.

LNG shipping began in 1959 with the world's first LNG tanker, the Methane Pioneer, which transported LNG from Lake Charles, Louisiana to Canvey Island in the United Kingdom. Since

then, the benefits of LNG, including abundance in the U.S., the ability to reduce emissions and low cost as compared to high crude oil prices have created a renewed interest in LNG worldwide (DNV GL, n.d.). This interest in LNG has resulted in explosive growth of LNG export terminals being planned for the U.S. as exports of LNG were recently approved (Siciliano, 2017).

Hawaii currently relies on LNG imports, and the demand is growing as more electrical generation companies desire to shift to cleaner LNG fuel. This increased demand has led the Hawaiian Electric Company (HECO) and Hawaii Gas to plan a regasification terminal for bulk imports of liquified natural gas (LNG). Unfortunately, this agreement was cancelled because Hawaii Governor David Ige opposes the importation of LNG for electrical generation, calling it a "distraction" from Hawaii's efforts to transition towards 100% renewable energy by 2045 (Trabish, 2016).

LNG is currently being used as a marine fuel in Jacksonville, Florida with the construction of a liquefied natural gas production, storage and export facility on the St. Johns River. This terminal will compress and temporarily store LNG before being transported by ocean-going vessels for export and to be used locally to bunker the new fleet of LNG vessels operating from American shores. LNG vessels operating out of this new terminal are TOTE Maritime's two 3,100 TEU LNG-powered containerships and Crowley Maritime's two LNG-powered combination container roll-on / roll-off vessels (Desormeaux, 2016).

Shipyard availability and the Jones Act.

The Merchant Marine Act of 1920, also known as the Jones Act, is a cabotage law that requires all goods transported by water between U.S. ports be carried on U.S. flag ships, constructed in the

United States, owned by U.S. citizens and crewed by U.S. citizens (Walker, 2011). The Jones Act's U.S. build requirements dictate that any new Hawaiian interisland ferries would be built in the U.S. Currently there are no LNG powered ferry vessels in the U.S ferry fleet (Marine Log, 2017).

Existing ferry systems currently operating in the U.S. such as the Alaska Marine Highway and the Washington State Ferry system show us that Jones Act compliant ferries must be built in the U.S. (Brehmer, 2017) and that multi-hull ferries such as the M/V Chenega operating in Alaska are subject to cancellations and damage due to rough seas (Juneau Empire, 2015).

Construction of large passenger / car ferries in the U.S. is limited. Washington State Ferry and the Alaska Marine Highway system have constructed many of their new ferries at Vigor Shipyard based in Bellingham Washington (Kheiry, 2016).

Due to the Jones Act domestic build requirements, the backlog of vessel orders is significant at large U.S. shipyards such as Philly Shipyard, NASSCO, with several years lead time before vessels are delivered. Other shipyards, such as Northrop Grumman and Bath Iron Works Corporation, build only military and government vessels.

The challenges of building a fleet of new Hawaii interisland ferry vessels in the U.S. are significant, but not insurmountable. If enough new vessels are ordered, a shipyard like Mare Island Drydock ltd. could be mobilized to build a series of vessels that would both meet the needs of a new Hawaii interisland ferry system and expand U.S. shipyard construction capabilities. The U.S. shipbuilding industry provides good local jobs and results in an increase in the skilled labor pool of surrounding areas.

One of the biggest drawbacks to building large multi hull vessels in the U.S. is the low availability of shipyards that can do the work. Austal USA is a shipyard in Louisiana that built the two Hawaii SuperFerries and continues to build the Joint High-Speed Vessels for the U.S. Government. As Austal USA is the only large shipyard capable of building large aluminum multi hull ferries in the U.S., they have no competition. The time for another shipyard to ramp up production of a new large multi hull aluminum vessel would be prohibitive. The specialized labor needed to build these types of vessels would take a significant amount of time to acquire.

Creative Project

Job creation in America.

Now is an ideal time to create a new public interisland ferry system for Hawaii. This new project will create new jobs in several different areas. Long term jobs will be created in the Hawaiian Islands through the operation and maintenance of the vessels and support equipment. Administrative staff such as office workers, advertising and ticket takers will be needed. Jobs will be created in the American shipyard that wins the bid to build the fleet of new vessels.

The creation of new jobs building ferry vessels in America is threatened by repeated attacks on the Jones Act as Senator John McCain is sponsoring new legislation designed to repeal the Jones Act. Open America's Waters Act of 2017 would remove the domestic build requirement allowing a new fleet of Hawaiian interisland ferries to be fabricated for much less money in a foreign shipyard (Schuler, 2017). However, this would be at the expense of creating new jobs in American shipyards that support local economies and increase the U.S. manufacturing capacity.

The U.S. Shipbuilding industry has created over 400,000 family-waged jobs and contributes $37.3 billion dollars to the U.S. gross domestic product. (Desormeaux, 2017)

The use of LNG as a shipboard fuel in Hawaii will encourage America's energy policy of the increased use of LNG by permitting new west coast LNG export terminals, such as the proposed Jordan Cove terminal in Coos Bay Oregon (Boyce, 2017). The increased use of LNG in Hawaii, through its use a marine fuel for an interisland ferry system, will create new jobs in Hawaii and support America's intention to export more LNG from mainland American sources'.

It is important that the State of Hawaii work with the Federal Government to create and implement a new interisland ferry system as quickly as possible to capitalize on the current administrations intent to create new American jobs in the shipbuilding and LNG sectors.

Passenger discomfort due to a rough ride.

The Hawaii SuperFerry was a fantastic way to move people and cargo between the Hawaiian Islands. For two years, it made daily round trip voyages between Maui and Honolulu, Hawaiian Islands separated by 93 miles of open ocean. There were two routes that the SuperFerry used to get from Honolulu to Maui, north of Molokai and South of Molokai. The routes taken were dependent on sea and wind conditions that were occurring at the time. The most common route was the Southern route, as it avoided the large waves commonly seen north of Molokai, although on calm days during whale breeding season the Northern route was preferred.

The SuperFerry was extremely fast and on days with good water conditions, it often ran at speeds upwards of 40 miles per hour. But when the waves began to get big, the large multi hull

vessel was forced to slow down due to the rough ride it produced. This rough ride would often result in passenger sea-sickness, wave slamming and a generally uncomfortable ride for the passengers. Ironically, the very important person (VIP) area was in the most forward part of the ship, near the bow where sea-sickness was the worst. Passengers were required to pay extra to sit in the VIP area with its large windows and extra service benefits (Loomis, 2015).

This rough ride was due to the vessel's sensitivity to displacement which resulted in more of a jerking motion in rough seas that can be uncomfortable for passengers (Motorship, 2016). This motion often resulted in negative reviews of the ferry system by the public. On several occasions, the ride became so rough that cars on deck began sliding uncontrollably into each other, resulting in extensive damage claims.

Mono hull vessels provide a much smoother ride for passengers while sailing through rough seas. The steady motion of a mono hull vessel is much more bearable to passengers than the jerky motion of a multi hull vessel. In large seas, multi hull vessels can make for very exciting acceleration in certain sea states (Barry, 2008).

Structural cracking of the hull.

The repeated pounding motion that multi hull vessels experience in large sea conditions may result in structural cracking. The rudder system of the SuperFerry was deformed and cracked on several occasions after experiencing excessive hull pounding due to large waves (Buls, 2009). Once the damage was examined, new structures were inserted to prevent further damage from occurring, but even with the reinforced structure, damage would continue to occur when hull slamming happened.

The USNS Spearhead is a U.S. military expeditionary fast transport ship that is the military version of the Hawaii SuperFerry (Axe, 2012). Both vessels were built by Austal and they are similar in hull design, engine type and both are fabricated from aluminum. Hull slamming that occurred in three to five foot waves caused $511,000 of structural damage while crossing the Atlantic (Kay, 2016).

Mono hull vessels do not experience hull slam in the same way, as there is no area between the hulls to trap the water. When experiencing large swells of 20 feet or more, the multi hull vessel would tend to "jump" the wave, often resulting in a full slam that would cause damage. To prevent this from happening, the vessel operators would slow the vessel to a near stop, allowing the vessel to ride over the swell without jumping it. Although this prevented the hull from slamming, it also ceased forward motion leaving the vessel at a stop while extending the duration of the voyage.

Trip cancellations due to rough weather.

Multi hull vessels experience many more trip cancellations due to weather than mono hull vessels. The open ocean passages of Hawaii experience changes in weather conditions frequently, and trips were cancelled when waves were expected to be 20 feet or more. Company policy limited operations to a 15-foot wave height due to passenger comfort (Haig-Brown, 2009). These cancellations impacted both passengers and the commercial cargo that the SuperFerry was carrying. The SuperFerry was popular with the Loves Bread Company, taro root farmers and companies that frequently moved shipments of live plants and flowers. When large seas prevented the ferry from completing its voyage for several days in a row, commercial cargo shipments would

not be made and the companies that shipped them would suffer economic damage due to the spoilage of the goods being transported.

When trips were cancelled due to rough weather, passengers that were taking automobiles often suffered the consequences as they were not able to keep their intended schedule. Many times, passengers were forced to fly home and leave their vehicles on another island until the weather calmed down and scheduled trips resumed.

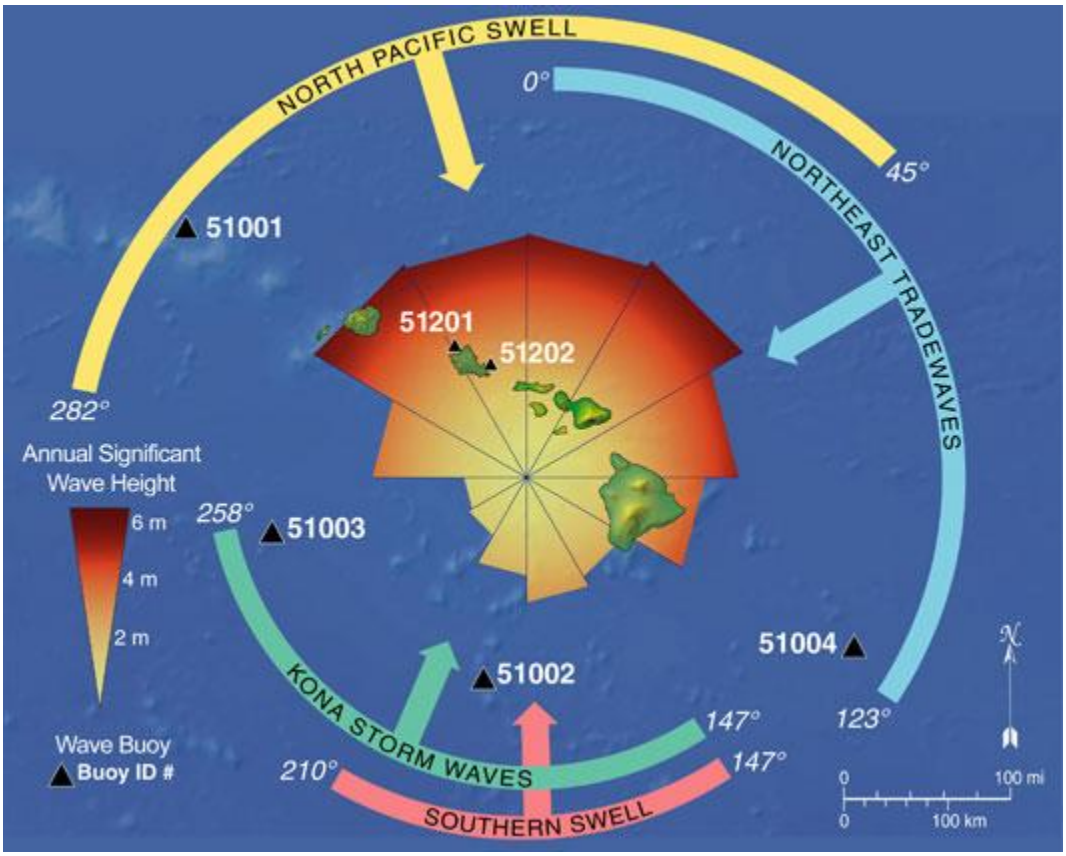

*Figure 4. Coastal Hazard Analysis Report (*Vitousek, 2009*)*

Hawaii State Harbor Pilot Captain Ed Enos suggested that a single hull vessel would provide a slower and smoother trip than the Hawaii SuperFerry provided (Eagle, 2014).

Vessel speed.

Vessel speed from port to port is a critical component of a ferry system. Passengers and businesses want to complete the voyage as soon as possible to get to their destinations, but the economic cost for fast speed is significant. The power required for a vessel to reach a given speed is proportional to the cube of the speed, therefore a 25% increase in speed requires twice as much power. Although the SuperFerry was rated to run at 43 miles per hour, it usually ran at a much lower speed, including times when only two engines operated to save fuel. The SuperFerry consumed 8,000 gallons of diesel fuel on a roundtrip voyage from Honolulu to Maui. This high fuel consumption rate was directly proportional to the speed of the vessel. To reduce fuel consumption, the vessel while underway was slowed down, resulting in longer trips which defeated the purpose of having a high-speed ferry, yet saved fuel (Haig-Brown, 2009).

High operating costs.

The multi hull ferry that ran between the North and South Island of New Zealand was discontinued because of high operating costs and frequent cancellations due to rough waters (Lohmann & Trichler, 2012). The SuperFerry in Hawaii only made a profit on a small percentage of its voyages due to the prohibitive costs of operation, the large amount of business overhead required and the construction costs (Lohmann & Trichler, 2012). The demand for an interisland ferry system in Hawaii is high, but without significant grants or state and federal subsidies to make up for the high operating costs, the risk is too large for private companies to guarantee a profit for their shareholders.

A mono hull vessel can use smaller engines which results in lower operating costs. A public interisland ferry system could receive funding from the State and Federal Government with the result of lower ticket prices for passengers. Many ferry systems, such as the Washington State Ferry system and the Alaska Marine Highway system, are public ferry systems that utilize tax dollars to provide transportation services within their state's waters. Hawaii is no different, and as our 50th state, it deserves a public transportation system between its islands for use by its residents. Lauren Brand is an associate administrator for MARAD said "almost no ferry system in the country is self-sustaining…The vast majority of them have to have public dollars to help them keep on." (Bussewitz, 2016).

High speed crew endorsements are needed for high speed vessels.

Special high-speed endorsements are needed for the crew when operating high speed multi hull vessels. These endorsements are unique and designed so that the crew members operating the vessel are multi-functional. The Chief Engineer on a high-speed vessel operates a control station on the bridge located directly behind the Captain's operating console. This arrangement facilitates direct lines of communication between the Chief Engineer and the Captain in the case of an engine malfunction or other emergency. The high-speed endorsement requires that engineering officers learn how to maneuver and steer the vessel in case they are required to drive the vessel if the Captain or Chief Mate are unable to do so. Conversely, the Captain and Chief Mate are required to learn how to operate the vessel's engines in case of emergency. When a high-speed vessel is travelling at such high speeds, there is very little time to react, which is why all shipboard officers are trained to operate all aspects of the vessel. High speed vessel endorsements must be renewed

every two years or they become invalid. The requirement to renew operating licenses limits the pool of available officers, which in turn limits the capabilities of the vessel to meet its schedule if crew members are unable to work and qualified replacement officers with proper endorsements are not available.

Mono hull vessels do not require special crew license endorsements above the standard U.S. Coast Guard licenses, thus widening the pool of qualified available crew. The slower speeds of mono hull vessels allow more time to react to emergency situations, and do not necessitate the Chief Engineer always being at the console on the bridge. Having a Chief Engineer always on station on the bridge console restricts the amount of work accomplished underway; as a result, the engineering department does very little machinery maintenance while underway, and instead monitors the machinery by making rounds of the engine spaces (Haig-Brown, 2009).

Hawaii SuperFerry was shut down due to its landing barges moored in the ports.

Multi hull vessels require special docks from which to load and unload passengers and vehicles. The landing docks used in Hawaii were considered new harbor equipment and required an environmental impact study (EIS). The EIS was not completed for the landing barges when the SuperFerry was running in Hawaii and this was the primary factor in the Hawaii SuperFerry going bankrupt. Hawaii had ruled that the SuperFerry did not have to complete an EIS for the barges and this ruling was challenged in the Supreme Court by environmental groups. The Supreme Court ruled that bypassing the EIS was illegal and shut down the SuperFerry as a result. Without being able to make money by carrying passengers and cargo, the SuperFerry went bankrupt soon after (Associated Press, 2009).

It interesting to note that the SuperFerry itself did not require an EIS, because ships from all over the world regularly visit ports, and an EIS is not required when a ship visits a port. International maritime law indicates that a country's ports are open to all vessels as maritime trade is essential to global economic success (Abdulrazaq, 2012).

*Figure 5. Hawaii SuperFerry landing barge (*Shimogawa, 2013*)*

Cargo volume is lower with multi-hull vessels.

The cargo volume of multi hull vessels is much less than that of a mono hull vessel of the same size. This severely limits the cargo load size available and impacts the economic viability of the ferry system. Small and large businesses were frequent customers of the Hawaii SuperFerry, and the impact it made on the Hawaiian economy was significant. Garage door installation companies could take their work to other islands, taro farmers could transport tons of crops without having to pay for their cargo to be moved expensively by air. A big benefit of an interisland ferry system is the inexpensive and timely movement of cargo. For cargo that is light but voluminous, like bread

and flowers, air travel is very expensive and the ability to move cargo by ferry is a suitable alternative. Currently, the alternative to the movement of goods by air in Hawaii is a weekly barge service operated by the Young Brothers company. Car collectors and motorcycle enthusiasts were reluctant to move their vehicles by a barge service that took days to complete the move when they could ride the SuperFerry along with their vehicle and drive it the same day on another island. The Maui County Carnival was cancelled this year due to a 40% increase in the past three years for shipping between the Hawaiian Islands using Young Brothers, raising the cost of moving the fair to over $500,000 per year, which includes the cost estimate of $10,000 to $15,000 in damage to the equipment while being shipped (Sugindono, 2017).

Limited shipyards are available to build large multi hull vessels in the U.S.

The Jones Act requires that vessels that visit port to port in U.S. waters be built, crewed and owned by Americans. This law dictates that without a waiver, Hawaiian interisland ferries must be made in American shipyards. Unfortunately, there is only one shipyard in the U.S. that is building very large multi hull vessels like the Hawaii SuperFerry: Austal USA. Austal USA builds large multi hull vessels under a U.S. government contract. Before Austal expanded to build the Joint High-Speed Vessels, they built the Hawaii SuperFerries. It was only after the Hawaii SuperFerry had proven itself in Hawaiian waters that Austal obtained the JHSV contract from the Government. The ability for the Austal shipyard to fabricate large aluminum vessels is due to their ongoing contracts with the U.S. government. Without a specialized skilled workforce to fabricate these state of the art aluminum multi hull vessels, the shipyard ramp-up time would be excessive. The only way a new shipyard in America can begin production of large multi hull aluminum

vessels is to create an assembly line with multiple vessels on order. If workers skilled in fabricating large multi hull vessels lost their jobs, they would move on to other careers and not be available when needed to build another vessel.

Mono hull vessels have a lower initial cost of construction.

Jones Act build requirements are not insurmountable, as can be seen with the Washington State Ferry System and the Alaska Marine Highway System. Both U.S. ferry systems regularly update their fleets with large mono hull vessels built in America. The cost to build these ferries in America is much lower for steel mono hull vessels, as more shipyards can build them. Competition between shipyards results in a lower price, whereas Austal USA is the only shipyard capable of building large multi hull aluminum vessels and can dictate the price they charge to customers. Estimated costs of construction for a 700-ton naval vessel were 50% more for a catamaran, and 100% more for a trimaran than a single hull vessel (Cooper, 2010).

The Washington State Ferry (WSF) reviewed 39 ferry vessels built in the U.S. in the past 20 years to find out how their vessel replacement construction costs compare with other ferry operators in world, what factors affect the total construction costs and which leading practices are used in vessel construction to contain costs and maintain quality (Sonntag, 2013). The review indicated that vessel construction costs can vary widely due to the regulatory environment in Washington State and the process used to order new vessel purchases. Direct construction cost comparisons between vessel configurations are difficult as WSF built their first Jumbo Mark II class ferry vessel, which has a capacity of 2,500 passengers and 202 vehicles, for $200 million dollars. By the time the third Jumbo Mark II ferry vessel had been completed the price had been

reduced by $45 million dollars due to design and fabrication efficiencies. The Hawaii SuperFerry multi hull vessels were constructed for $95 million dollars each and are capable of transporting approximately 866 passengers and 282 cars (Conrow, 2008).

High speed multi hull vessel use in the Alaska Marine Highway is limited.

The availability of the Alaska Marine Highway's two multi hull vessels is limited, with regular cancellation due to rough sea states. Operators must be cautious as a damaged vessel must be taken out of service for repairs and will not serve the ferry system during that time. Companies and passengers that rely on a regularly scheduled series of voyages must make other plans when voyages are cancelled. If the ocean stays rough for several days, and the ferries do not run, they will lose ridership and cargo contracts due to interruption of reliability issues. High speed ferry service between the North and South Islands was discontinued due to a combination of high operating costs and low reliability. Mono hull ferries currently in use have longer transit times, but are more cost effective and reliable than multi hull vessels that were discontinued.

LNG fueled engines have longer maintenance periods than diesel engines.

A major benefit of the use of LNG in engines is that the maintenance and repair periods are lengthened. Less engine maintenance and longer service intervals save money over the long run and results in more reliable machinery.

One of the world's first LNG-powered passenger vessels, Viking Line's Viking Grace, experienced a service interval of 24,000 hours whereas a typical marine engine operating on heavy fuel oil (HFO) has a recommended service interval of 16,000 to 18,000 operating hours. The

Viking Grace's engine room is cleaner than a conventional engine room and only uses 18% of the chemicals and 20% of the lube oil of a conventional engine room (Kliger, 2016).

LNG fueled engines produce lower emissions than diesel fueled engines.

Sulfur emissions while running on LNG are near zero, while greenhouse gas emissions are cut by more than 15%, NOx emissions are reduced by 92% and particle emissions are reduced by 84% (Kliger, 2016). The use of LNG to reduce emissions is being driven by environmental air quality standards being implemented across the globe. Research has shown that LNG can significantly reduce pollutants from vessel operations (Tomson, 2015).

LNG is less harmful to the environment and should be used more often when possible.

As the world is realizing that burning fossil fuels like coal, oil and gas are contributing to global warming, a push to use more renewable energy like sun, wind and water (hydro-electric) is underway. Although LNG is a fossil fuel, it burns much cleaner than other types of fossil fuels such as HFOs and coal. This clean burning ability makes it a great candidate to be used as a crossover fuel source until renewable energy technology can become more efficient and less expensive.

LNG is utilized as a marine fuel in internal combustion engines as duel-fuel or pure LNG (gas only) engines. Duel-fuel engines utilize both LNG a traditional marine fuel such as diesel or heavy fuel oil while pure LNG engines can only run on LNG (Wollenhaupt, 2014).

Innovative technology is being developed that will present alternative clean energy options for future marine engine propulsion options. Fuel cell propulsion will utilize a combination of fuel

cells, solar cells and battery systems to greatly reduce greenhouse gas (GHG) emissions (Mohit, 2017).

The Hawaiian Islands lies within an Emission Control Area.

The major reason to have Hawaiian interisland ferry vessels use LNG is the ECA. Air quality standards are regulated and LNG is a much cleaner fuel used to meet or exceed ECA standards. The cost to use diesel oil as a fuel is more than LNG and diesel oil may not conform to ECA standards in the future.

Figure 6. North American Emission Control Area (Sanders, 2012)

America has a huge LNG supply

America is expected to become the world's biggest supplier of liquefied natural gas by 2035 (Collins, 2017). Currently the U.S. has about 70 million tons a year of LNG available for use, which compares with Australia's 87 million tons and Qatar's 82 million tons.

*Figure 7. America's LNG exports (*Collins, 2017*)*

BC Ferries in Vancouver Canada has a fleet of three LNG vessels. The LNG fuel for these vessels costs about 40% less than the ultra-low-sulphur marine diesel oil, the traditional marine fuel for BC Ferries (Sasitharan, 2017).

LNG vessels have a lower operating cost than diesel powered vessels.

LNG fuel is more economical than diesel oil fuel by providing more energy per unit of fuel. This lowered operating cost will result in cost equity approximately six years earlier than with

standard diesel fuel. The cost of machinery maintenance, repair and service is also lower as LNG fueled engines run cleaner than diesel oil engines. Even the cleanliness of LNG vessels engine rooms is improved over traditional diesel-powered engine rooms, resulting in fewer workers needed to clean LNG engine rooms and less cleaning chemicals needed to clean LNG engine rooms (Kliger, 2016).

LNG bunkering already exists in the U.S.

TOTE Maritime's new LNG fueled containerships bunker in a new bunker facility located in Jacksonville, Florida. This new LNG bunkering terminal also serves other vessels and vehicles from land. Having a reliable source to fuel LNG ships is an important part of establishing LNG as a fuel. LNG bunkering facilities are a cornerstone to the new LNG vessels being able to operate in different areas. Without a bunkering facility, tank trucks of LNG are used and this can take a long time and become inefficient. The new Jacksonville LNG bunkering terminal is expected to be fully operational in late summer 2017.

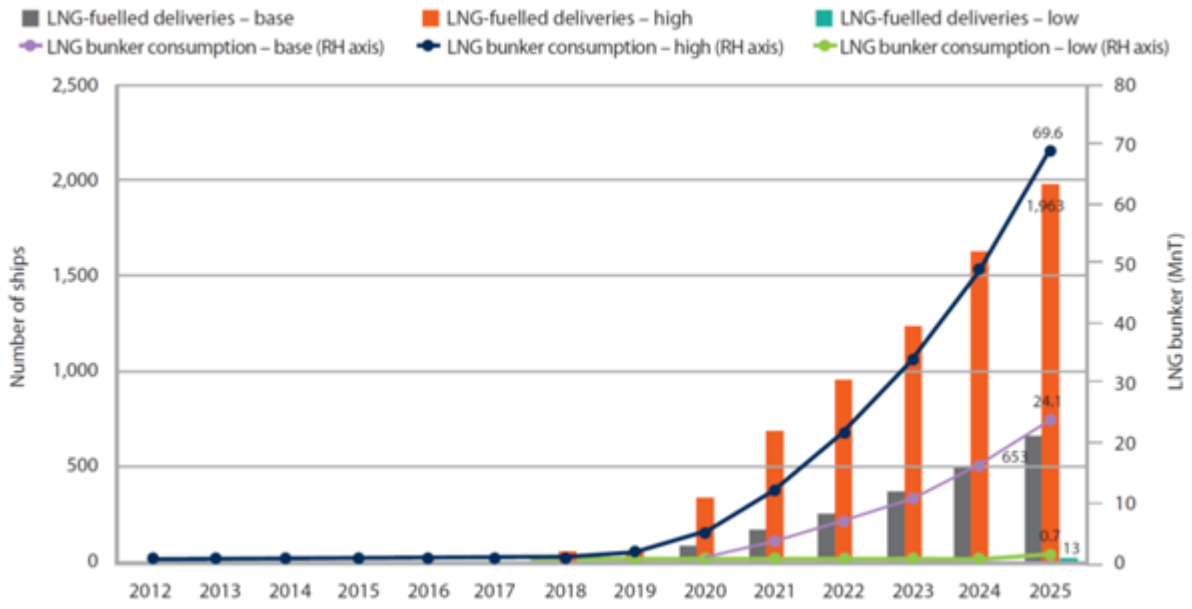

*Figure 8. LNG Bunkering Usage (*Lloyd's Register, 2012*)*

LNG is being utilized as a marine fuel across the globe.

LNG is being used across the globe mainly due to its low emissions and cost. The regulations are in place and the industry is expanding rapidly as the benefits of LNG are realized. As the price of crude oil rises, so will the interest in using LNG as a fuel. Stricter environmental regulations are leading companies to spend the money to shift to LNG instead of using scrubber technology or burning low sulfur marine fuels. Worldwide natural gas reserves are expected to last much longer than the world's oil reserves, which are only expected to last for another 50 years (Chia, 2017).

In the chart below, existing LNG terminals are in blue, and future LNG terminals are in green.

*Figure 9. Planned and Existing LNG Terminals (*Morris, 2013*)*

Companies in North America are building and operating LNG vessels.

Several large shipping companies are building or operating LNG vessels in North America today. Carnival Corporation is building two new LNG cruise ships that will operate at-sea and in-port on pure LNG. These two state of the art cruise ships will be delivered in 2020 and in 2022, making a total of seven LNG ships slated to join their fleet (Piellisch, 2016). TOTE Maritime is currently operating two LNG containerships between Jacksonville, Florida and San Juan, Puerto Rico, with the ships being delivered in 2015 and 2016. These new state of the art LNG containerships were built at the NASSCO shipyard in San Diego and have been in operation successfully since their launching. Matson Navigation Company has ordered two LNG container

roll-on/roll-off ships from NASCCO shipyard. These new LNG fueled ships will replace three diesel-powered ships, which will then be placed into reserve status (Thomas, 2016). New low sulfur fuel requirements are forcing Matson to retire seven of its older vessels in 2020 (Bonney, 2016).

LNG ships have been estimated to be between 10% and 25% less expensive to operate than traditional heavy fuel ships. Savings are realized due to a 10% cheaper capital costs, less expensive operational and insurance costs and a fuel savings of 20% to 40% over traditionally fueled vessels (Andersen, 2011).

Regulations are already in place to design, build and operate LNG ships and ferries.

Regulations that specify how LNG vessels will be constructed, operated and tested are in use across the world. Regulations about how LNG fuel will be used are made to protect human lives and the environment, and are successfully being implemented in a variety of industries, including the shipping industry. Current regulations will be adjusted as the industry gains new experience with LNG by reviewing accidents and adjusting the regulations to meet our understanding of how to safely use, manufacture and transfer LNG. Regulations have grown quickly as its use has increased across the globe. LNG use presents major risks such as explosions, low oxygen environments and extremely low temperatures. Traditionally these risks have been mitigated by focusing on technology, training, regulations and procedures (Thomas, 2017).

LNG is very safe for use in the Hawaiian Islands if spilled because it vaporizes very quickly and dissipates leaving no residue behind and will not harm aquatic life or damage waterways

(Dodge, 2014). LNG use is considered much safer than crude oil shipping and the P&L insurance rates are 25% less for LNG container shipping than crude oil shipping (Dodge, 2014).

A driving force behind new LNG regulation is the implementation of air quality regulations to protect the environment. As more ECA zones are implemented worldwide, the demand to use LNG as a fuel will increase. As demand grows, so will LNG infrastructure such as the ability to store and transfer LNG fuel to vessels. International regulations that govern the growth of the LNG industry ensure an even, safe playing field across the globe that allows for uniform standards of equipment and operations.

Summary

The U.S. Maritime Administration and the State of Hawaii are considering bringing a new interisland ferry system to the Hawaiian Islands. They have commissioned a study to answer questions such as whether the new ferries should be mono hull or multi hull and what type of fuel they should burn. Hawaii's most recent interisland ferry system, the SuperFerry, was a multi hull catamaran that utilized diesel fuel, and although the enterprise only lasted two years, there are many lessons learned that will guide the U.S. Maritime Administration and the Hawaii Department of Transportation to make an informed choice with the information available.

A frequent problem with large high speed multi hull ferry boats such as the Hawaii SuperFerry is wave slamming. Wave slamming occurs when wave height exceeds the vessel's limits and waves slam into the bow and under the car deck of a multi hull ferry. In addition to limiting the times when the ferry system can operate, a wave slam can cause considerable damage to the vessel's hull and significantly slow crossing times between ports. Structural cracking of the ship's

steering posts was seen while operating the SuperFerry in Hawaiian waters when rough sea conditions exceeded 20-foot wave height. Because severe damage to the vessel was seen to occur in large seas, trip cancellation occurred to prevent further damage. These trip cancellations affected both passengers and commercial cargo carriers who used the ship daily. Mono hull vessels do not experience structure damaging wave slam in the same way as a multi-hull vessel does, and are not limited to maximum wave height restrictions as a multi hull vessel is. The Alaska Marine Highway operates two high speed multi hull vessels that are frequently kept at the dock due to large sea conditions.

The design of a multi hull ferry creates uneven motion for the passengers, and passenger discomfort is common. The resulting sea sickness onboard the Hawaii SuperFerry created a negative perception of the interisland ferry system, especially as the worst sea sickness underway was felt by VIP passengers that paid more for their tickets and were seated in the front of the vessel. The desire to use the speed capabilities that were inherent in such a large multi hull vessel as the SuperFerry resulted in excessive fuel consumption, and passenger discomfort for even when the waves were not large, the high speed and awkward motion of the vessel resulted in sea sickness for passengers. Mono hull vessels do not experience the same type motion as multi hull vessels and although passengers may still get sick on open ocean voyages, the number of sea sick passengers is much less.

Large multi hull ferry vessels burn a lot of fuel; a round trip on the Hawaii SuperFerry from Honolulu to Maui consumed approximately 8,000 gallons of diesel oil (Loomis, 2015). Mono hull vessels run at a much slower speed and consume less fuel than a multi hull high speed ferry.

Interisland ferry systems such as the interisland ferry in New Zealand stopped using large high-speed ferries because of the excessive fuel costs and the unreliability of not being able to operate in large seas.

Liquid natural gas is the fuel of choice for marine engines that operate in ECAs such as in Hawaii. LNG produces much lower emissions than traditional marine diesel oil and costs less per unit of energy created. LNG is a clean burning fuel that is proven to extend engine life and reduce breakdowns and maintenance requirements. Even the engine room on an LNG vessel is cleaner than on a vessel that burns marine diesel oil.

Hawaii is in an ECA area, which limits the amount of pollutants that may be released by a marine vessel. Liquid Natural Gas when used as a marine fuel releases much less greenhouse gases, Nitric Oxide, particulates and almost no Sulfur Oxide. LNG also has the benefit of releasing more energy for less cost than traditional diesel oil. As the rules defining ECAs evolve, standard diesel fuel that falls under the ECA limits now, may not be clean enough in the future.

The environment in Hawaii is a big concern when operating an interisland ferry system. The Hawaiian Islands are a haven for whales, including breeding grounds that fall between the islands. Although the Hawaiian SuperFerry never had a whale strike occur, hundreds of whales were spotted and recorded during each trip. A mono hull vessel moves much more slowly and operators of the vessel can observe and turn away from active whale areas.

Crew licensing requirements onboard high speed multi hull vessels are much more strict than standard mono hull vessels due to their speed and complexity of operation. On a large, high speed multi hull vessel, the Chief Engineer sits in a console directly behind the Captain. This is in case

of an emergency; communications are immediate and all officers are trained to operate both the engine and the controls of the ship. High Speed license endorsements are only valid for two years, thus limiting the pool of mariners that can work on high speed, multi hull vessels.

Cargo space onboard a multi hull vessel is much less than a mono hull vessel. This is due to the wasted space between the hulls on a multi hull vessel. Cargo is a very important consideration when operating an interisland ferry system as cargo creates revenue to augment passenger ticket prices that may be set artificially low. Currently in Hawaii, the only choice to move cargo and passengers is air transportation and weekly barge service. Taro root farmers, bread companies and flower companies preferred using the Hawaii SuperFerry to move their goods as airline transportation costs significantly more than sea transportation, especially when the goods being moved are heavy.

The Jones Act cabotage law in America specifies that ships going from port to port in the U.S. be built, manned and owned by American citizens. This law restricts the manufacture of a new interisland ferry fleet to U.S. shipyards. There is currently only one shipyard in America that can build large multi-hull ferries: Austal USA. Austal built the two Hawaii SuperFerries and proceeded to build a line of similar high speed multi hull vessels for the U.S. government, the Joint High Speed Vessels. The cost for another U.S. shipyard to manufacture high speed multi hull ferries is prohibitive due to the specialized work of building large aluminum vessels using a specially trained workforce. Mono hull vessels, on other hand, can be built at a variety of U.S. shipyards, as can be seen at the Alaska Marine Highway and the Washington State Ferry System when they order new replacement vessels.

As the world embraces LNG as a fuel, so should Hawaii use LNG as fuel for a new interisland ferry system. Florida now has a LNG bunker facility and America has large supplies of LNG that will last well into the future. American companies are embracing LNG and several companies including Matson Navigation and TOTE have LNG fueled ships either on order or already running. LNG is cost effective and is much better for the environment than traditional marine fuels.

Hawaii needs a public ferry system that operates between populated islands and in areas of severe landside congestion such as from the route from Honolulu to Barbers point. Currently there is no sea passenger service between the Hawaiian Islands, leaving travel by air as the only alternative. An interisland ferry system is a vital alternative to airline travel and would provide critical services between the islands in the case of a natural disaster or national emergency. Due to the excessive cost of building and operating an interisland ferry system, the system should be in the form of a public water transportation system such as is operated in Alaska and Washington State. Although large multi hull vessel technology has advanced in the past twenty years, experience with multi hull ferries in Alaska, Hawaii and New Zealand has shown us that these vessels are limited by large ocean conditions such as those experienced in Hawaii. The excessive cost of large multi hull vessels and the limited construction availability in the United States due to Jones Act requirements restricts the availability of these vessels, whereas large single hull passenger vessels that can move cargo and vehicles are commonly built in a variety of shipyards located in the United States. Worldwide restrictions on marine fuels that cause damage to our environment are becoming stronger each year. The use of LNG has been proven as less damaging to the environment and is being implemented in ferries successfully worldwide. LNG is abundant in the United States and is low cost. Hawaii should consider large scale utilization of LNG,

creating infrastructure that will facilitate the transition from traditional fuels to alternative fuels such as wind and solar. Hawaii can import LNG from large reserves held in the continental United States while exporting LNG to users across the world while supplying domestic Hawaiian LNG users such as the ferry system and power plants.

Recommendation for Single Hull LNG Powered Ferry Vessels for Hawaii

After reviewing similar ferry system across the world, working as Chief Engineer of the Hawaii SuperFerry and utilizing my education as a Marine Engineer, it is my explicit recommendation that any new interisland ferry system in Hawaii be comprised of mono hull vessels that use LNG as their source of fuel. Mono hull vessels are better suited for use in the Hawaiian Islands because of their ship handling characteristics in rough ocean conditions, their ability to carry more cargo than a multi hull vessel and the increased availability of shipyards in the U.S. that build mono hull vessels. Any new Hawaii interisland ferry vessels that are built should utilize LNG as their primary marine fuel to reduce pollution in the environment, lower fuel and engine maintenance costs and create LNG bunkering infrastructure that will benefit the Hawaiian Islands.

I recommend the Hawaii Department of Transportation continue to work with Hawaiian lawmakers and MARAD to bring a public interisland ferry system to Hawaii. This new interisland ferry system will transport passengers, vehicles and serve the needs of Hawaii's residents, tourists and the government of the U.S. when needed in a disaster or national emergency.

I conclude that future Hawaiian interisland ferry vessels will be of a mono hull vessel design and utilize engines that use LNG as a marine fuel. This conclusion was reached after reviewing the experiences of past ferry systems and taking into consideration emerging technology. Mono hull vessels that use LNG as a marine fuel can be designed, built and operated in a safe and cost-effective manner in the U.S. while meeting current Jones Act vessel building requirements. The Hawaiian State Senate, the Hawaiian Department of Transportation, the Hawaii Governor, and others are encouraged to reference this study when determining hull design and fuel options for a future Hawaiian Interisland ferry system and its vessels.

Implementation process.

1. The HDOT is currently awarding a $550,000 to study the feasibility of bringing a new interisland ferry service to Hawaii. The results of the study and its recommendations must be completed by August 28, 2018 to be used in the 2018 Hawaiian legislative sessions.
    a. The study will review past Hawaiian ferry systems, conduct a market study and develop business and financial plans. An operating plan will recommend the vessel type (mono hull or multihull) and types of shore facilities needed (Offutt, 2017). Environmental plans will ensure the project meets State and Federal laws protecting wildlife such as whales, restricting movement of invasive species and reducing pollution.
    b. The HDOT study could recommend a public or private ferry system. If the HDOT agrees with the recommendation, request for proposals will be made.

2. Request For Proposals (RFP) will seek contractors to design and build the new vessels and shore facilities such as loading docks and passenger terminals.
    a. RFP for an operator to operate and maintain the vessels and all maintenance and operations. This operator will usually operate and maintain all vessels and equipment, provide human resources and payroll services and ticketing.
    b. RFP to design, build and service a fleet of new passenger cargo ferries for use interisland in Hawaii. Used ferry vessels available and qualified should be considered for conversion to LNG for this service. Multiple new vessel orders will reduce costs, improve quality and support shipbuilding in America.
    c. RFP to supply fuel to the fleet of new vessels. LNG bunkering facilities should be close to LNG import / export terminals or storage facilities.
3. Public opinion and government involvement.
    a. Federal grants are available in the Passenger Ferry Grant program (49 U.S.C. 5307(h)) to establish new ferry services such as a Hawaiian interisland ferry service. The federal portion of the grant must not exceed 80% of the net project cost for capital expenditures with the State or ferry system owner making up the remaining 20%.
    b. Public opinion on issues such as the movement of invasive species and drug movement between the islands, concern over whale and porpoise deaths and island overcrowding is strong and must be handled by having meetings and providing transparency in the process.

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