M/V Guemes CY2019 Lifecycle Valuation and Propulsion Study

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References

1. Operational Cost Estimate, 28-Car Electric Ferry, Glosten Memorandum, dated March 10, 2019

2. *M/V Guemes* Ferry Replacement Plan, Elliott Bay Design Group, dated November 22, 2013

3. Tech Memo CESKA007.003-TM001-0, Art Anderson, dated July 28, 2016

4. QSK-19 Total Cost of Ownership Detailed Summary

Appendices

A. *M/V Guemes* 2019 Valuation Survey and UT Inspection Plan, Art Anderson Associates, dated February 25, 2019

B. *M/V Guemes* Thruster Bracket Analysis and Recommendation Memo, Art Anderson Associates, dated July 15, 2019

C. *M/V Guemes* Condition and Valuation Survey, Delphi Maritime, dated July 31, 2019

D. *M/V Guemes* Ultrasonic Gauging Survey, International Inspection, dated March 2019

E. *M/V Guemes* 2019 Generator Load Study Plan, Art Anderson Associates, dated September 25, 2019

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G. *M/V Guemes* 2019 Generator Replacement Requirements, Art Anderson Associates, dated December 18, 2019

H. Generator Load Study and Replacement Options

Introduction

Skagit County operates the *M/V Guemes* on a limited route of approximately 0.5 miles between Anacortes, WA and Guemes Island, WA. The vessel was built in 1979 and has been in service with Skagit County since. In its forty years in service, the vessel has been well maintained and has obtained structural and mechanical upgrades in several critical areas to help extend its service life. These upgrades include, but are not limited to; main engine replacement (2005), generator set replacement (most recently in 2017 and 2020), engine foundation replacement and renewal (2005 and 2017), thruster bracket renewal (2017 and 2019), and miscellaneous structural renewals in way of high wear areas such as the main deck (2019 and during previous dry dockings). At the end of its intended life span, the *Guemes* is at a critical juncture in which a decision will soon be made regarding the future of the vessel as it pertains to Skagit County.

This study has been requested by Skagit County to provide technical documentation and analysis to assist in determining the *Guemes's* fate, based on one of the following three scenarios:

1. The vessel is retained as the primary ferry for longer than anticipated if the new electric ferry's acquisition period is delayed.
2. The vessel is retained as an interim ferry for when the new electric ferry is out of service.
3. The vessel is sold.

The study focuses on providing and analyzing the following information to assist Skagit County in making one of the above three decisions:

1. Vessel valuation and condition survey determining the current market value of the vessel and its condition as determined by a qualified marine surveyor.
2. Hull condition evaluation supported by a comprehensive structural survey to determine the condition of the decks, side shell, bottom, framing, piping, etc.
3. Propulsion study analyzing the current engine and determining the anticipated life span remaining and providing engine replacement options.
4. Generator study identifying new generator options and requirements for a system sized to support only the vessel's loads.
5. Recommended maintenance/modification items to extend the vessels life to support its use for any of the three options above.
6. Discussion of risk and risk items that can affect the three above decisions.

Vessel Valuation Survey

History of Past Surveys

The *Guemes* has had condition and valuation surveys completed in 2010, 2012, 2014, 2015, and 2017. The results have been consistent and have shown the vessel to be in an overall good condition and

of consistent value. These past surveys did a good job of capturing the structural and mechanical conditions of the vessel as well as the types of equipment on board and the vessel's overall condition from the view of the surveyor as seen on that day. However, they did not take an in depth look at the vessel's mechanical or structural maintenance history nor did they identify the anticipated vessel costs and future use as desired by this study.

Vessel Changes Affecting Valuation Since Last Survey

Since the 2017 valuation survey (immediately following the 2017 dry docking), the *Guemes* has operated under its normal conditions. In the fall of 2018, the *Guemes* crew identified missing bolts in both mounting plates where the thrusters attach to the thruster brackets. Temporary repairs were then made and the vessel continued to operate until its scheduled dry docking in March 2019. During this dry dock period, routine maintenance and the following major work items were performed [C]:

1. No. 1 z-drive replaced with rebuilt drive
2. Propeller seals replaced on No. 2 z-drive
3. Fire pumps replaced
4. Auxiliary generator engine overhauled
5. Main Engine 1 fuel and freshwater pumps replaced
6. Main Engine 2 heads, turbo-charger, fuel, and freshwater pumps replaced
7. Deck plate renewed in way of ramp landing location on both ends
8. Thruster brackets repaired and a vibration analysis completed to determine root cause of cracking and develop mitigation and monitoring plan
9. Comprehensive structural ultrasonic testing (UT) survey of the hulls plating and structural members

Goal of 2019 Valuation Survey

The goal and scope of the valuation survey is outlined in detail in the Valuation Survey and UT Inspection Plan [A]. In general, the surveyor was tasked with providing the following:

1. The general structural and mechanical condition of the vessel
2. The major maintenance expenses that can be expected to maintain the vessel in its current service over the next 2, 5, and 10 years
3. The replacement cost, fair market value, and liquidation value of the vessel

He was also asked to provide guidance on other considerations which may affect Skagit County's decisions as to what will happen to the vessel over the coming years.

2019 Valuation Survey Results

Overall, the *Guemes* remains in excellent condition, both structurally and mechanically. The below sections highlight the findings from the survey in Appendix C.

Structural and Mechanical Condition

The vessel's structure was found to be in satisfactory condition and notes that the hull has minimal wastage and wash boarding and that the super structure appears to be in satisfactory condition as well. The surveyor inspected the UT report in detail and identified that the deck in way of the terminal aprons was deteriorated and replaced. A visual inspection of the hull voids showed no deterioration and satisfactory conditions as well. Although not part of the UT inspection during this dry dock, the internal piping was inspected and found to appear in excellent condition. It should be noted that the internal piping has been inspected and replaced over the past several dry dockings and continues to be kept up in this fashion. The steel structures are estimated to be serviceable for another 20 years without major repairs if routine maintenance is adhered to as it has been to this point in the vessel's life.

The vessel's mechanical systems were also found to be in satisfactory condition. The surveyor conducted a thorough inspection of the maintenance records for all major machinery (main engines, auxiliary generator, reduction gears, thrusters, etc.). The survey identifies that the main systems, although well maintained, are approaching technological obsolescence with regard to propulsion, air emission, noise, and environmental standards. It also states that with the recent maintenance and renewals, the machinery has approximately 10 years of remaining serviceability. Discussion regarding the maintainability of the main machinery and the associated risk with keeping them in service will be presented in the propulsion and risk sections of this report.

Maintenance Expenses

The *Guemes's* maintenance expenses have been tracked very accurately over the past 30 years, and these records were the basis for the surveyor's analysis and cost forecasting. Figure 1 shows the existing main machinery, their specifications, and year and estimated hours since last overhaul. Note that this table was updated with current information on 3/31/2020. Based on the past maintenance costs, current machinery hours, estimated hours until overhaul and estimated cost to overhaul; 2, 5, and 10-year maintenance cost projections were made. In total, it is estimated that annual maintenance costs will average $750,000/year, an increase in the previously analyzed data from References [1] and [2]. The total cost to maintain the main engines and z-drives can be seen in Figure 2.

Further discussion regarding the previous maintenance costs and how they affect the projections will be had in the further analysis and recommendations of this section.

VESSEL MACHINERY

NAME	MAKE/ MODEL	SERIAL #	H.P. /kW/ Ratio	RPM	Last Overhaul	Hrs. since overhaul
No. 1 ME	Cummins KTA-19	3721-7216	530 HP	1800	2017	13,980
No. 2 ME	Cummins KTA-19	3721-9054	530 HP	1800	2017	11,690
Red Gear No. 1	ZF Model 550	2006-5972	0.936:1		2019	5,500
Red Gear No. 2	ZF Model 550	2007-0386	0.936:1		2019	5,500
No. 1 Z-drive	Ulstein DF-370	3721-9054	4.2:1		2015	14,247
No. 2 Z-drive	Ulstein DF-370	3721-7217			2019	5,500
Auxiliary	JD 4045TFM85		74 kW	1800	2019	New
Generator	Bollard MG65		65 kW			New

Figure 1: M/V Guemes Main Machinery

Item	2-year outlook	5-year cost outlook	10-year cost outlook
Main Engines	$250,000.00	$500,000.00	$1,000,000.00
Z-drives	$250,000.00	$600,000.00	$1,200.000.00

Figure 2: Main Engines and Z-Drives Cost to Maintain Outlook

Vessel Valuation

The three types of desired vessel values were replacement cost, fair market value, and liquidation value. Below is a summary of the values determined by the survey:

1. The replacement cost of the *Guemes* is estimated at $10,980,000. This is based on historical data and industry sources. More detail can be found in Appendix C. The basis of this estimation is an estimated $10,000,000 dollar replacement value from 2012, adjusted for inflation.

2. The current fair market value of the *Guemes* is estimated at $2,975,000. This was determined using a cost approach, in which the vessel value is estimated assuming a buyer will not pay more for an asset than the cost of acquiring a substitute property of similar value. Note that sales or listings of vessels of similar size and function could not be obtained to create a fair market value based on comparisons.

   The fair market value was also projected over 2, 5, and 10 years using a value for annual depreciation and taking into account the likelihood of a vessel extension being required within 10 years to accommodate a growing population. This requirement was originally identified in Reference 2.

3. Liquidation value was not specifically addressed. However, a $40,000-dollar scrap value was identified. The report also identifies that the value of the vessel can be significantly affected by the buyer and their intended use for the vessel. If the vessel will be acquired and operated under its best use as a short route passenger/car ferry, then it will command a higher value

than it being acquired for a different purpose. Thus, the liquidation value can differ significantly depending on the time required to get rid of the vessel and the type of buyer able to be found in that period.

The 2, 5, and 10-year projections also identify the vessel's cost to cure at these intervals. These values take into account the continued depreciation of the vessel's fair market value and the costs to maintain the vessel at these intervals. The cost to cure at these times is important because it shows the net positive or negative financial gains to Skagit County if the vessel is retained and sold at these future dates. Note that after two years of continued operation, the cost to maintain the vessel is significantly higher than its value. Figure 3 is an excerpt from the survey detailing these values.

2-year Projection
The estimated costs/values of the M/V Guemes in two [2]-years (2021) is as follows:

Fair Market Value	$2,188,000.00
Cumulative Cost to Cure	$1,500,000.00
Difference of between cost and FMV	$688,000.00

5-year Projection
The estimated costs/values of the M/V Guemes in five [5] years (2024) is as follows:

Fair Market Value	$1,367,500.00
Cumulative Cost to Cure	$3,750,000.00
Difference of between cost and FMV	($2,383,500.00)

10-year Projection
The estimated costs/values of the M/V Guemes in ten [10] years (2029) is as follows:

Fair Market Value	$3,444,000.00
Cumulative Cost to Cure	$9,818,322.00
Difference of between cost and FMV	$(6,374,322.00)

Note that the increase in FMV from 5-years to 10-years is due to the extensive renewal, betterments and upgrade during year 2024. The estimated $5,100,000.00 cost to lengthen and refurbish the vessel creates a new depreciation schedule and revised cost to cure.

It should be noted that the above estimates are for costs and value of the physical assets with no adjustment for income/revenue to offset cost to cure. Income/revenue data was not available to the undersigned surveyor.

Figure 3: M/V Guemes Costs to Cure

Detailed explanations of how values were determined are presented in Appendix C.

Further Analysis and Recommendations

The valuation survey was very comprehensive and valuable in supporting the goals of this study. The only further analysis required to expand the information in the survey report is a more detailed analysis of the anticipated vessel maintenance requirements and cost over the next 10-years. This data will expand on the information presented in References 1 and 2 and Appendix C. Reference 1 determines average annual maintenance costs between 2012 and 2017. A combination of expenditures and budgets determined that maintenance costs were ~$650,000 per year. The average dry docking and associated routine work was $360,000, or $210,000 per year when averaged. This identifies that the costs for machinery parts and repairs are ~$440,000 per year, to include major overhauls. It is important to note that these figures are based on averages over a period of time when shipyard costs changed dramatically from year to year. Therefore, it is believed that the projected shipyard costs are higher than presented and the machinery costs are lower. However, total forecasted annual maintenance costs as presented by the surveyor are realistic. For example, the below figures represent the lowest bid for each dry dock:

- 2012: $233,306
- 2014: $366,657
- 2015: $662,457
- 2017: $662,888
- 2019: $568,850 (Note that 2019 was added for reference and to support the rise in routine dry dock work costs)

Note that these costs are for similar scopes and do not include the machinery overhaul costs. They also do not represent the emergent repairs such as deck and thruster bracket repairs. The dramatic rise in dry dock costs are believed to be associated with an increase in environmental regulations and material handling requirements by shipyards and the added costs associated. For example, the car deck was stripped and re-coated in 2014. The bid proposal for spot coating the car deck was originally $47,000, and then the change order cost for re-coat ended up being an additional $30,290. The same scope of work (strip and re-coat the car deck) was a bid item in the 2019 contract, and the shipyard's bid was $143,469. The shipyards have also mentioned that with the tightening of environmental policies, costs have increased for mitigation. For example, the shipyards used to pay for the *Guemes's* diesel, remove it from the vessel, centrifuge it and re-use it. Now, they charge to remove it from the vessel because they can no longer re-use it, and they have to dispose of it at a significant cost.

The cost averages are also affected by the more frequent dry dock periods (closer than two years) than required by USCG. These were in part to ensure timely repair of significant issues such as the engine foundation cracks. It is not anticipated that dry dockings at these closer intervals will be required as frequently in the coming years. Therefore, the average costs per dry dock can be treated as the higher values seen in 2015-2018 while the machinery costs reduced in line with the forecasts identified by Cummins [4] and the surveyor [C].

Hull Condition Assessment

History of Past Ultrasonic Testing (UT) Inspections

As described in the 2019 Valuation Survey and past valuation surveys, the *Guemes's* hull has been well maintained and continues to be in an overall excellent condition with minimal wastage or areas of concern. The three exceptions to the above statement are the deck plates in way of where the terminal ramp and its apron land, the engine foundations, and both ends' thruster bracket. Other than visual inspections by the crew, USCG, shipyards, etc., the vessel has had some level of ultrasonic testing dating back to 2010 as highlighted below:

- October 2010: Side Shell Plating, Bottom Shell Plating
- October 2012: Bilge Plating IWO Aft Bulkhead #7 to Forward Bulkhead #7
- September 2014: Side Shell, Sea Chests, Bottom Shell
- October 2014: Car Deck

Few discrepancies were identified during these tests and the ones that were found were fixed. It should be noted that the 2010 through 2014 inspections show wastages of approximately 20% on the bilge strike plate under the keel coolers on the vessel's starboard side. After these repeated and consistent readings, it was determined that the vessel had an incorrectly sized sheet of steel (5/16") added during construction. This plate was removed and replaced with a 3/8" plate in 2015, making the hull plating uniform.

History of Local Structural Deficiencies

The main engines were replaced in 2005 and at the time, the engine foundations were re-designed and installed new. Between 2005 and 2016, visible cracking developed on parts of the engine foundations directly under the main engines and most prominently, on the deck foundation which supports the thruster brackets [3]. In 2016, the foundation under the main engines was slightly modified and the deck portion of the thruster foundations was redesigned. In 2017 these new foundations were installed. As of this report, there have been no further known cracking issues.

The thruster brackets (below the main deck and attached to the outer hull just above the waterline) have a history of repeated cracking dating back to 1995. During the Spring 2017 dry docking, several cracks were found on the No. 1 and No. 2 end thruster brackets. An emergent repair plan and stiffening plan to re-enforce the brackets was developed and installed in order to get the vessel back in service with minimal delays. In the fall of 2018, several bolts at the connections between the thrusters and thruster bracket were found missing, backed out, or deformed. The missing bolts were replaced. The Guemes was then dry-docked for its regular overhaul period at Foss Shipyard in Seattle, WA on 25 Feb 2019. The thruster brackets were inspected and the No. 1 end found to have one (1) missing bolt and several cracks in welds throughout the bracket. All cracks were at or near where the emergent repairs were made in 2017. Due to the recurrent issues, a comprehensive vibration and stress analysis of the thruster brackets was conducted following the 2019 dry dock period [B]. It was determined that the cracking was not due to vibrations, but rather high quasi-static loads due to the

propellers' thrust. It was also determined that the cracking between the 2017 and 2019 dry dockings was likely caused by poor weld preparations and procedures during the 2017 emergent repairs. These welds were repaired using a heavily controlled preparation, inspection, and documentation process. A detailed monthly inspection plan and required submittal to the Coast Guard was initiated. Since then, there have been no further concerns as of the writing of this report.

Vessel Changes Affecting Structural Condition Since Last Surveys

There were no major changes in structural arrangements or major repairs/modifications between the 2014 UT inspection and the 2019 inspection. The major local structure repairs and modifications are identified in the history in the above section.

2019 UT Inspection

The 2019 UT inspection was born from the desire to conduct a comprehensive structural survey to help determine an expected remaining lifespan of the hull structure and determine if components which have never been ultrasonically inspected remain satisfactory after 40 years of service. Specific areas of concern were areas that have a higher likelihood of expedited corrosion. These areas were inspected using a two-foot grid while other areas used a four-foot grid. All plating, stiffening, and girders were inspected in all voids, tanks, and the exterior hull surface. Appendix A details out the inspection requirements.

The results show that the hull remains in excellent condition without any significant wastage. The full results can be seen in Appendix D.

Further Analysis and Recommendations

Based on the results from the 2019 UT inspection, the results from the thruster bracket analysis, and the satisfactory monthly inspections on the brackets, immediate further analysis or abnormal maintenance procedures are not warranted. The hull and its primary members shall be inspected and maintained at their normal intervals as required to maintain the vessel's certificate of inspection (COI). As recommended in the thruster bracket analysis memo, the brackets should be monitored closely. If further cracking or missing bolts are found, then the brackets should be re-designed and replaced in whole. During the next dry docking, the welds should be ultrasonically tested.

Propulsion Systems Condition and Replacement Assessment

History and Current Propulsion Configuration

The *Guemes's* propulsion system's main components consist of two sets of main engines connected to a reduction gear boxes which feeds azimuthing thrusters. The thrusters' steering systems are controlled by engine driven hydraulic pumps. The original main engines were replaced in 2005 with the existing KTA-19s. The reduction gears are ZF model 550s and were installed with the main engines

in 2005. The azimuthing thrusters are Ulstein model 370-DFs. The thrusters replaced the original Murray Tregurtha thrusters in 1990.

Goal of 2019 Propulsion Study

A machinery condition survey of the current engines, generator, and associated systems was conducted with the goal of identifying the service life remaining. Additionally, a study was completed identifying possible engine replacement options. The priority when researching engine replacement options was identifying a Cummins diesel that can be integrated as simply as possible into the existing vessel structure. If a Cummins solution couldn't be identified, other engines were to be considered with and emphasis easy integration. AA notes that the operators of the *Guemes* believe she is currently underpowered for her operations. AA was asked to consider options to increase power and the ramifications to doing so.

Main Engine Assessment

The current main engines on the *Guemes* are Cummins KTA-19 engines, producing 530 HP at 1,800 RPM. This model engine is no longer produced by Cummins and there were initial concerns of a lack of supportability with regards to parts and trained technician availability. However, after discussions with Cummins, this is not a perceived issue. At this time there is no plan to make these engines obsolete and in theory they could be maintained until the useful life of the vessel has been reached. Cummins plans to maintain adequate parts and technicians for the foreseeable future, and at least for the next 10 years. Additionally, the cost for overhauls is not expected to change except for an increase aligned with inflation. Keeping the current engines comes with a relatively low risk and an understanding of what the maintenance requirements and costs will be, unless regulations (specifically emissions) change which require the engines to be replaced. Discussion is found about this in the risk sections below.

Main Engine Replacement Options

The most logical replacement of the Cummins KTA-19 main engines would be the Cummins QSK-19 Tier III engines, producing 500 HP at 1,800 RPM. This engine has been deemed a suitable replacement, due to nearly identical specifications and minimal changes required for the foundations. Additionally, the mechanical connections to the existing gearbox and gearbox to thrusters would not require any changes be made either. This is in part due to the QSK-19's ability to change bellhousings to match that of the mating component. Similarly, power take-offs, will also need minimal, if any changes to the existing set-up for the hydraulic steering and fire pumps. Both the engine and the pumps have SAE A and SAE B thru drives.

The annual maintenance costs for the proposed QSK-19, Option B (500 HP version) [4] are projected to be ~$505,000 dollars over 20 years, or $25,250 per year, for both engines. This assumes the vessel operates ~3,000 hours per years and requires a major overhaul every 18,000 hours, or 6 years. The actual engine operating hours per year are closer to ~5,000, thus requiring an overhaul every 3 – 4 years, or 4 in a 20-year period, adding ~$200,000 to the maintenance costs. This brings the cost to maintain to ~$35,250 dollars per year. This cost compared to the existing KTA-19s is comparable and

therefore implies that if the vessel is maintained for the next 10 – 20 years, there is no clear financial benefit to installing new engines unless environmental regulations change, or some other unanticipated factor occurs. Note that the capital costs to acquire and install the engines is not included in the above annual maintenance costs.

If the vessel is re-powered with new engines, extending the machinery life span beyond the current 10-year projection, consideration must be made for how this affects value if the vessel is sold. Extending the surveyor's comments on value to potential buyers to this topic, understanding the value added by installing new engines is difficult to quantify due to a buyer being willing to pay based on the vessels best use. If a buyer intends on purchasing the ferry to be used in its current application as a short range, inland car/passenger ferry, then there may be value in the installation of the new engines. As time goes on, the likelihood of the emissions requirements increasing on the vessel or the parts and maintainability of the engine going away will increase.

Re-powering the *Guemes* with more powerful engines is not advisable. The results of the thruster bracket vibration analysis showed that the re-occurring cracking is likely due to high quasi-static loads produced by the propeller thrust. It was found that the existing KTA-19 engines had been programmed to run at 600 HP for the past several years, a condition that likely contributed to this problem. If the vessel is re-powered to produce more thrust, then a thruster bracket redesign will be required and possibly different thrusters too. However, given the vessels current and potential future missions, a re-power does not seem appropriate.

Thrusters Assessment

Both thrusters on the *Guemes* are Ulstein model 370-DFs, driving four-bladed, 52" propellers. The drive trains are rated at 500 hp with 1800 RPM input for continuous duty but are capable of intermittently transmitting 100% of the rated power. The thrusters are no longer produced and can only be serviced by Pacific Star Marine. Skagit County owns three complete units and has them on a rotation such that they always have a fully functioning spare ready to place on the vessel. The original scope of this study included conducting a detailed analysis of the thrusters current condition and looking at replacement options. However, it was determined that Skagit County has a good understanding of their condition and forecasting their maintainability and the associated risks. Thus, this tasking was shifted to focus on the generator replacement study.

Other Systems Assessment

The other systems aboard the *Guemes* such as the hydraulics, piping, electrical, electronics, etc. are in satisfactory condition as with the vessel's major components. Unless major changes are made such as engine replacements, load bank installation, etc., these auxiliary systems can be operated for the remaining life span of the vessel. If the aforementioned items are installed, then the modifications required to the auxiliary systems will be of relatively low impact. Therefore these systems are seen to be neutral as to how they affect the decision of what happens to the *Guemes*.

Generator Assessment and Replacement Plan

Generator History and Existing Generator

The M/V Guemes has one auxiliary generator serving the vessel. The current generator set is a 65kw Bollard MG65 generator mated to a John Deere 4045TFM85 Tier 3 diesel engine. This generator is sized to and serves to power the vessel's normal electrical loads, the vessel's fire pump (extra), and the Anacortes and Guemes Island Ferry Terminals' ramp (when shoreside power is lost). This generator was installed in March 2020 after the previously installed Yukon generator set was damaged during severe weather and to an extent beyond repair.

Under most conditions, the generator is loaded at less than 30%, which can lead to significant maintenance and efficiency problems. During the fall of 2019 and winter 2020, much deliberation occurred between Skagit County, Art Anderson Associates, and several generator suppliers with the goal of determining the most effective way to continue providing power to the vessel and its electric fire pump and the terminal. Part of this process included conducting a load study to determine actual loads being drawn by the vessel, fire pump, and terminals. This data verified the load requirements and can be found in Appendix F and G. After analyzing the study's data and the different solution options presented, it was determined that Skagit County preferred to maintain a configuration and capabilities like the existing arrangement. However, it was determined that installing a load bank to increase the load on the generator was the best solution to increase resistance to wet stacking and other maintenance problems caused by the under loading; see Appendix H.

Recommended Maintenance and Modifications

Structures

As previously discussed, the overall condition of the *Guemes* is excellent. Continuing the current maintenance plan will be satisfactory to keep the vessel's hull and structure operating for another 10+ years. However, the foundations which have a history of deficiencies shall be closely monitored. The main engine foundations, thruster bracket deck foundations, and thruster bracket hull foundations will require close observation and preparations to make further repairs if further cracking is discovered. If the main engines, are re-powered to increase the vessel's power, the reduction gears and z-drives must also be replaced, and the thruster brackets must be redesigned.

Primary Mechanical

As with the structures, the existing maintenance plan is sufficient to extend the life of the engines, thrusters, and gear boxes for another 10 years. Major modifications are not recommended unless regulations which require them come into effect or Skagit County determines they would like to provide a higher emissions standard on its own accord.

Skagit County has determined that they would like to keep the existing electric fire pump and the *Guemes's* ability to power the terminals during power outages. With this in mind, the recommended solution is to pursue the installation of a load bank for the generator. This requires the fewest

components (no back-up generator at the terminals) and minimizes alteration to crew routine/operations. The newly installed Bollard generator shall continue to be in operation for its remaining life span (~40,000 hours to overhaul). However, it should be noted that this expected life span assumes that the generator is run under optimal conditions and loading. The new generator is more efficient than the previously installed Yukon model, however, it should still be closely monitored for poor exhaust conditions due to the anticipated underloading. This underloading will also lead to quicker wear on the system. Therefore, a load bank shall still be installed at the earliest opportunity and prior to the load back installation, the exhaust shall be cleaned. In February 2020, the process of developing a load bank installation plan began. However, this was disrupted by the malfunction of the Yukon generator set and the emergency replacement with the Bollard MG65. It is recommended that this work be continued.

Other

The vessel's other systems such as hydraulics, electrical, electronic, piping, etc. do not require a maintenance plan different than what is currently in place. Modification should only be required to support the previously recommended modifications.

Risk Discussion

There are many different risks and risk levels associated with the vessel and how they relate to the three potential scenarios that this study is centered around. This section will address different risk factors and how they pertain to each scenario. Four categories of risk have been developed and identified as having significant influence on each scenario. Each risk category is not independent, and they all interrelate to some degree. This correlation will be discussed as applicable. The four categories are described as follows:

1. Physical: the risks associated with the physical components of the vessel and maintaining their ability to continue operating in a satisfactory manner.
2. Regulatory: the risks associated with changing regulations at the federal, state, and local levels.
3. Financial: the risks that will have negative or positive financial impacts to Skagit County.
4. Societal: the risks associated with the vessel not meeting the "wants" of the general public or crew and the pressures for change associated with them.

Physical Risks

The risks associated with the physical components of the vessel differ depending on the component. The physical risk categories align with the structures, main machinery, and auxiliary systems. The risk of major complications or unexpected occurrences with regard to the structures and auxiliary systems are low given any of the three outcomes for the *Guemes*. However, the main machinery (including auxiliary generator) have slightly higher risks, which affect Skagit County differently depending on what they choose to do with the vessel.

As previously discussed, there is a level of risk associated with the Ulstein thrusters and the fact they are no longer in production and that a sole company retains all parts and ability to service them. Additionally, this company is not a major industrial organization. With Skagit County maintaining an additional thruster and the parts to support three fully functional units, the ability to maintain and operate the *Guemes* for the next 10 years is seen as fairly low risk. Additionally, it is unlikely that Pacific Star Marine will not maintain their ability to support during this time. Additionally, Cummins has indicated the same regarding the main engines and present a low risk in terms of not supporting for the next 10 years. The new auxiliary generator run with a load bank that allows the load to be at greater than 30%, is expected to be a low risk item as well.

If the vessel is sold in the near future, these items present relatively low risks to Skagit County in all regards. However, if the vessel is retained, whether in active service or as an interim vessel, the risks associated with a structural failure or loss in serviceability/lack of parts for the main engines and thrusters, increases with time, specifically beyond 10 years from now. Additionally, if the vessel is transitioned to an interim vessel, there is a chance of the suppliers determining that the overhead costs associated with storing parts and maintaining a service capability for these pieces of machinery are not worth it.

Regulatory Risks

There are two types of regulatory risks involved in the discussion of the *Guemes's* propulsion system and potential to upgrade. The first is based on the current regulations and the second is based on potential future regulations.

Current Regulations

Existing vessels are not required to continually update their systems to meet new and changing regulations. However, NVIC 10-81 provides guidance regarding the application of USCG rules and regulations relating to certain categories of existing vessels. Specifically addressing the potential requirement to upgrade the entire vessel to meet the current regulations. NVIC 10-81 states: "…when a major conversion or modification of an existing vessel is planned, there is a definite intent to extend the service life of the vessel, when this is the case, it is appropriate to bring the entire vessel into compliance with the latest safety standards where reasonable and practicable." NVIC 10-81 further defines a major conversion or modification: "Re-powering may be deemed a major conversion if the intent is to extend the economic life of the vessel. Other re-powering modifications may not be deemed a major conversion if the economic savings of the conversion would be realized during the vessel's normal life." The Commandant makes the determination on whether a vessel's modification meet the major conversions definition outlined above.

Based on *Guemes'*s operations and current engine emissions, Art Anderson does not anticipate the USCG deeming the repower a major conversion or modification as outlined above. If USCG does deem the repower a major conversion or modification, it is not expected the *Guemes* would require excessive modifications to meet the current standards, though a thorough review of the CFR's and discussion with the local inspectors would be required.

Future Regulations

Future regulations are more difficult to predict, and it is unlikely USCG will change many regulations requiring major alterations to the *Guemes*. The more likely scenario is a new state or local regulation like California's Air Resource Board's (CARB) Commercial Harbor Craft regulations. CARB regulations are very similar to the EPA's (40 CFR), though there are added requirements to repower vessels with older tier engines based on time of operations or change of ownership. With Governor Inslee launching the Maritime Blue 2050 initiative there could be additional state and local regulation changes which could impact the *Guemes* in the near future. Though the extent of these future regulations is unknown, Art Anderson anticipates any future emissions regulations to have an implantation grace period allowing adequate time for the county to react. Additionally, it is expected these regulations will not require vessel's engines to exceed EPA standards, but instead will take a similar approach as CARB and focus on replacing older engines within the existing vessels. Meaning if the *Guemes* has engines meeting the current EPA standards (Tier III) it is unlikely these future regulations will require excessive modifications to meet the future standards.

Overall Risks

As with the physical risks, the effects of the regulatory risks on Skagit County differ slightly depending on what they choose to do with the vessel. Selling the vessel in the near future presents almost no risk unless a regulation change come into effect. If the vessel is retained, then the risk of new regulations causing the need for major vessel changes increases with time.

Financial Risks

The financial risks to Skagit County are high regardless of which action the county takes. With remote populations growing throughout regions like the Pacific Northwest, British Columbia, Alaska, and elsewhere, there will likely be a need for ferries that meet the operational profile of the *Guemes*. However, these markets are small and difficult to find. It is unlikely the County will receive the reported fair market value in the near future and may require the vessel to sit on the market waiting for a buyer. If the vessel is sold to a customer who has the intentions of modifying it for a different purpose and is mostly interested in the steel hull, then a significant discount below fair market value will be requested. However, this is unpredictable and likely a difficult market to find. If the vessel is retained, either for interim or full time use, the vessel's cost to cure becomes negative after a couple years, as discussed in detail by the surveyor.

Societal Risks

Societal risks are difficult to quantify but are present in any public transportation system. Although regulations may not require changes to the vessel, the crew or passengers may desire changes to improve the overall experience of riding the vessel and its impact on the environment. As time goes on, and newer, cleaner, and quieter vessels become commissioned, there will likely be more pressure for change to update the *Guemes.*

Conclusion

The information presented in this study is aimed at providing Skagit County information to assist in determining which one of the following courses of action they take with regard to the *Guemes:*

1. The vessel is retained as the primary ferry for longer than anticipated if the new electric ferry's acquisition period is delayed.
2. The vessel is retained as an interim ferry for when the new electric ferry is out of service.
3. The vessel is sold.

Overall, the *Guemes* is in great condition for a vessel of its age, as verified by the valuation survey, UT inspection, and propulsion study. Relatively few deviations from normal maintenance practices and no major modifications should be required to provide value to a future owner or Skagit County if they keep the vessel. There are physical, regulatory, financial, and societal risks associated with all three courses of action. However, selling the *Guemes* as soon as the all-electric ferry comes on line and has been brought up to normal, predictable service will be the most cost effective scenario for the county. The longer the vessel is retained, the more expensive it will become and the harder it will be to recoup the costs to maintain it. It is the intention of the information presented here to be a tool for the decision makers to help identify the pros and cons associated with each case.

Appendix A

M/V Guemes 2019 Valuation Survey and UT Inspection Plan

Contact Information:
Conor Shannon, Project Manager
(360) 479-5600

Produced By:

ART ANDERSON
202 PACIFIC AVE., BREMERTON, WA, 98337

February 25, 2019

Table of Contents

References

1: Dwg. No. 77083-01-2 Rev A_Inboard Profile and Hold Plan

2: Dwg. No. 77083-01-3 Rev A_Deck Arrangements Plans

3: Dwg. No. 77083-02-2 Rev A_Main Deck Plating and Deck House

4: Dwg. No. F-208-102_Deck Framing

5: Dwg. No. 77083-01-2 Rev -_Scantlings & Bulkheads

6: Dwg. No. 77083-59-1 _ Engine Cooling & Fresh Water Systems Arrangement

Introduction

Skagit County Washington has contracted with Art Anderson (AA) to conduct a lifecycle valuation and propulsion study along with the Guemes's FY19 dry dock and overhaul period. The purpose of this study is to assist Skagit County in determining the Guemes's future based on the following three potential scenarios:

1. The vessel is retained as the primary ferry for longer than anticipated if the new electric ferry's acquisition period is delayed.
2. The vessel is retained as an interim ferry for when the new electric ferry is out of service.
3. The vessel is sold.

Two key components which will provide supporting information for this study are a vessel condition and valuation survey conducted by an accredited marine surveyor and a thorough hull structural ultrasonic testing (UT) inspection conducted by a reputable marine inspection service. This document serves to provide guidance and expected outcomes for these two services.

Vessel Condition and Valuation Survey

History and Scope

The Guemes has had condition and valuation surveys completed in 2010, 2012, 2014, 2015, and 2017. The results have been consistent and have shown the vessel to be in an overall good condition.

This year's survey will seek to provide the following information and present the findings in the form of a comprehensive report:

1. The general structural and mechanical condition of the vessel.
    a. The scope of this review will include a visual inspection and inventory of all machinery and electronics.
    b. A review of all logs and maintenance and repair documents.
    c. A visual internal and external inspection of the ships structure as viewable at the time of survey during the dry dock period.
    d. A review of the UT inspection report.

2. The major maintenance expenses that can be expected to maintain the vessel in its current intended service.
    a. These expenses will be provided in the context of a 2, 5 and 10 year outlook.
3. The following current values of the vessel:
    a. Replacement Cost
    b. Fair Market Value
    c. Liquidation Value

Surveyor

The condition and valuation survey will be conducted by Captain Jeff Slesinger of Delphi Maritime. Jeff has over 40-years of experience as a tug captain, port captain, safety director, marine surveyor, auditor and author. Jeff holds accreditation from the Society of Allied Marine Surveyors.

Requirements

In order to complete the condition and valuation survey as accurately as possible, the following documents shall be made available:

1. Main engine and auxiliary machinery maintenance, repair and replacement records. Shall include information such as when the equipment was purchased, current operating hours, major maintenance (heads, rebuild etc.), and the costs associated with this information.
2. Comprehensive list of work items being accomplished during the FY19 dry dock period.
3. Copy of FY19 UT inspection report.
4. Copy of completed shipyard work orders.
5. Copy of Pacific Star work order and invoice for repairs/refurbishment of the drive units.

Additionally, the following spaces shall be accessible:

1. All tanks and voids.
2. Engine and generator compartments.

3. Thrusters and supporting structure.
4. All other machinery spaces/accesses.
5. Pilot house.
6. Passenger cabin.
7. Crew lounge.

UT Testing

History and Scope

The purpose of this inspection is to gain a comprehensive understanding of the Guemes's structural condition and use this information to more accurately determine the vessels value and assist Skagit County in determining the future of the vessel. UT testing has been conducted on portions the Guemes several times in the past. However, the scope of these inspections has been limited and focused on certain parts of the vessel. Below is a summary of past UT inspections and their scope:

- October 2010: Side Shell Plating, Bottom Shell Plating
- October 2012: Bilge Plating IWO Aft Bulkhead #7 to Forward Bulkhead #7
- September 2014: Side Shell, Sea Chests, Bottom Shell
- October 2014: Car Deck

It has been five years since the last UT inspection and Skagit County has requested a comprehensive structural inspection to include the vessel's shell plating, decks, and framing. The outdrive brackets under the deck are not part of this scope and are being inspected as part of the shipyards work requirements. Specific areas of concern or areas that have a higher likelihood of expedited corrosion will be inspected using a two-foot grid while other areas will use a four-foot grid. Additionally, the inspectors will remain vigilant of surrounding areas and if other areas of potential concern are identified, they will test the region in a smaller pattern sized based on their judgment.

Inspector

International Inspection Inc. of SEATAC, WA has been selected to conduct the UT inspections of the Guemes. They have performed the previous testing as outlined above and have a good baseline knowledge of the vessel's arrangements and the requirements of this scope.

Requirements

The following requirements are set forth regarding the inspection patterns. Note that this will serve as a general guide but can be modified at the discretion of the inspector. For example, if areas initially required to be inspected in a four-foot grid appear to be in poor condition, the inspector may refine the grid size and pattern to ensure an accurate assessment of the vessel's structure is achieved. If the inspector finds themselves in a situation in which they believe structure is in a condition which will require more gauging then planned, Art Anderson shall be notified as soon as possible with the discrepancies and anticipated additional costs identified.

Main Deck

The last main deck UT inspection was completed in 2014. It showed areas of high wear near the Number 2 bow and Number 1 engine. Both bows receive heavy abuse due to the repeated cycles of the vehicle loading ramps impacting the deck and the vehicles themselves on-loading and off-loading. Both of these regions will receive an inspection with a two-foot grid. The areas around both engines, thrusters, and the generator are prone to greater wear due to vibrations and are prone to pooling water and other mechanical fluids. These will be inspected with a two-foot grid. This area includes the deck within the machinery compartments. There are many access hatches across the deck allowing entrance into the vessel's voids. These areas can also be prone to excessive corrosion due to moisture access and will be inspected with a two-foot grid within an approximately five-foot radius. All other areas on the main deck will be inspected using a four-foot grid. See red outlines in Figure 1 and Figure 2 for two-foot grid areas.

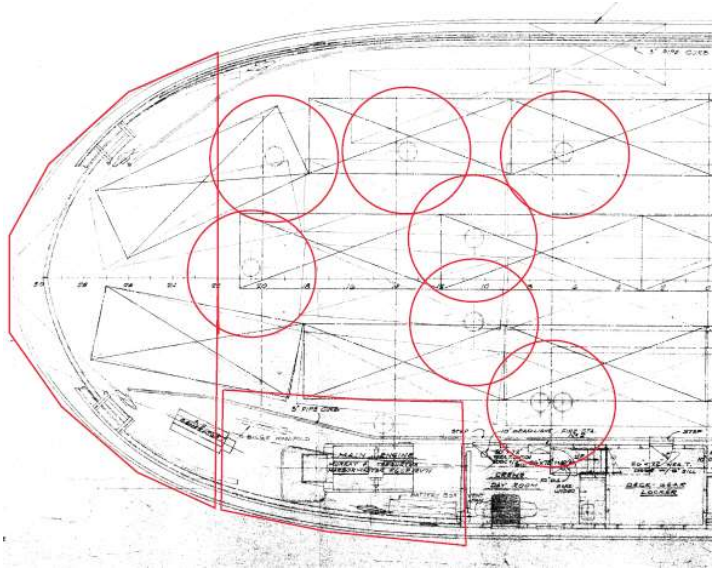


Figure 1: Number 2 End Deck UT Inspection Plan

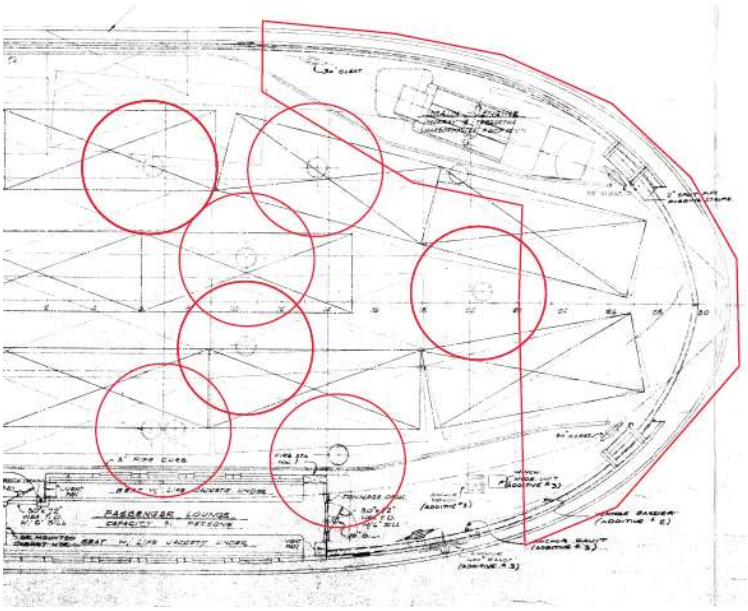


Figure 2: Number 1 End Deck UT Inspection Plan

Side Shell, Bottom Plating, and Skegs

The side shell, bottom plating, and skegs were last inspected in 2014. All areas looked good with the exception of the bottom plating in way of the keel coolers between Frame 7 on the No. 1 end and Frame 7 on the No. 2 end. A two-foot grid shall be competed between Frames 10 and 20 (opposite ends from each other) and from four-feet in board to four-feet outboard of the keel coolers, see Figure 3. The keel coolers are channels protruding from the hull as seen in Figure 4. The two-foot grid shall also include the internal plating on top of the keel coolers within the voids. These areas can be identified by measuring from the outboard most chine inboard and by referencing the cooling piping penetrations.

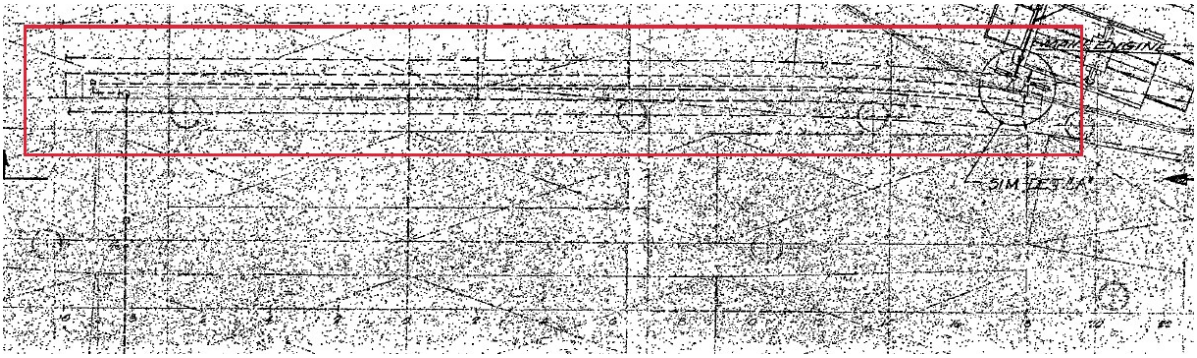


Figure 3: Keel Cooler Inspection Area

Figure 4: Keel Cooler Plating

A two-foot grid shall also be completed within approximately four feet of all structural connections to the hull such as the skeg to hull and thruster bracket to hull joints. Note that the thruster brackets themselves are not part of this scope. Additionally, a few parts of the skegs themselves showed the beginning of deterioration. A two-foot grid shall be completed on the skegs themselves, see Figure 5.

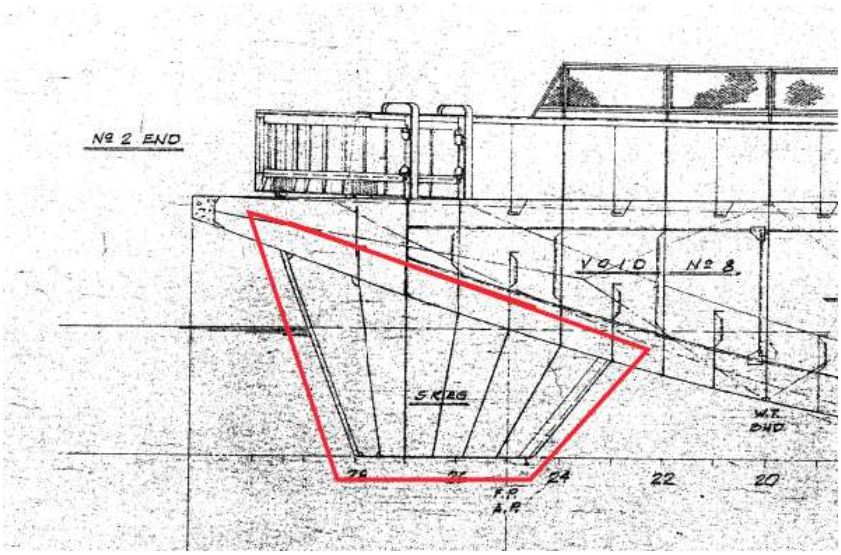


Figure 5: Skeg Two-Foot Grid Inspection Area (No. 1 End Similar)

Internal Framing and Bulkheads

The internal bulkheads and framing of the Guemes have never been inspected beyond the scope of visual inspections by Skagit County, USCG, or independent surveyors. A thorough UT inspection of all bulkhead plating, bulkhead stiffening, and other longitudinal and transverse framing below the main deck will be performed. For the stiffening and framing, shots on both webs and flanges will be taken. For the two-foot grid areas discussed below, a shot on the web and flange of each member will be taken approximately every two feet. For the four-foot grids, a shot will be taken on the web and flange every approximately four feet. In the following figures, a red dot represents a UT shot on plating and a blue dot represents a shot on a web and flange in that location.

In general, the majority of the underdeck structure within the voids and tanks will be completed using a four-foot grid. Areas planned to be a two-foot grid include the deck stiffening and transverse bulkheads or framing directly below the five-foot radius around the hatches as described in the Main Deck section and as shown in Figure 1 and Figure 2. The entire bulkhead below these areas does not need to be a two-foot grid, just the upper two feet needs to be shot around the hatch. An example in shown in Figure 6. If areas are identified by the inspectors as showing visible signs of excessive corrosion or are arranged in a manner such that they can facilitate expedited corrosion, the inspector will refine the inspection grid to ensure an accurate assessment of the structural condition in that local area. Two areas that may fall into this category are the two bows where significant numbers of framing come together, as seen in Figure 7.

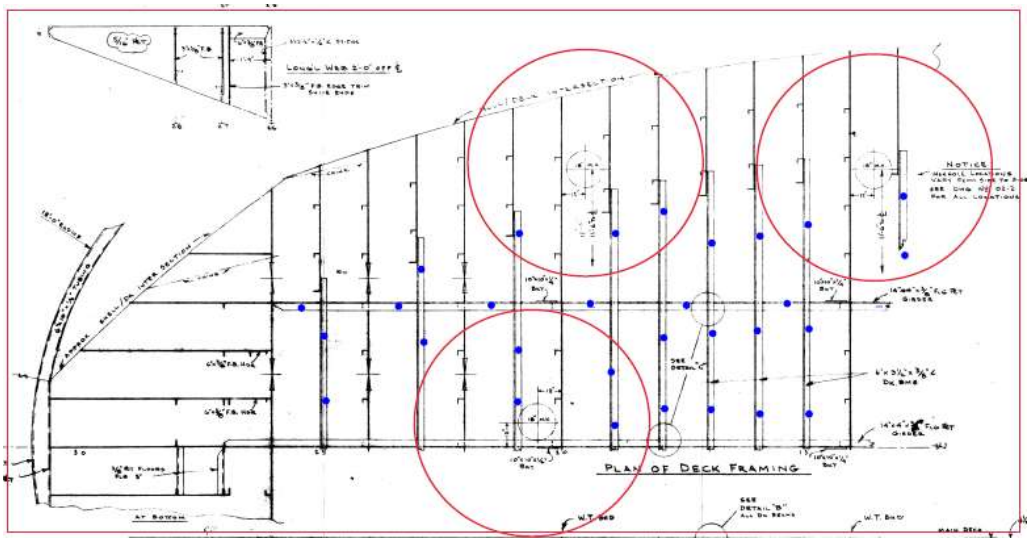


Figure 6: Deck Framing Inspection Guide

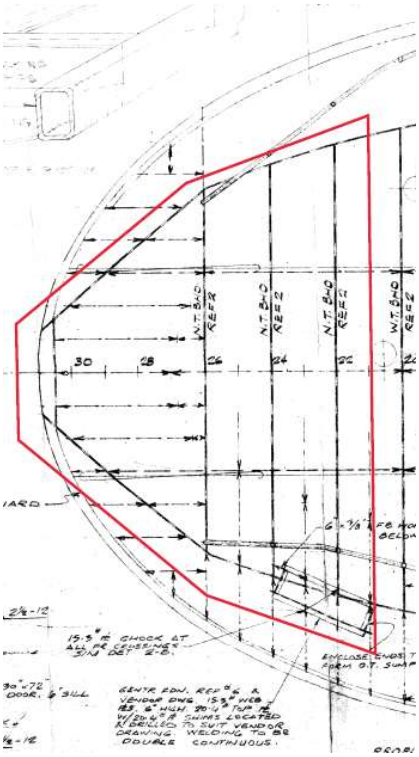


Figure 7: Bow Framing

The Guemes has seven watertight (Frames 20, 14, 7, 0, 7, 14, 20) and six non-tight (Frames 26, 24, 22, 22, 24, 26) transverse bulkheads traversing from side shell to side shell. These bulkheads shall for shot at four-foot intervals, to include the vertical stiffening. See Figure 8 for representative pattern for these bulkheads.

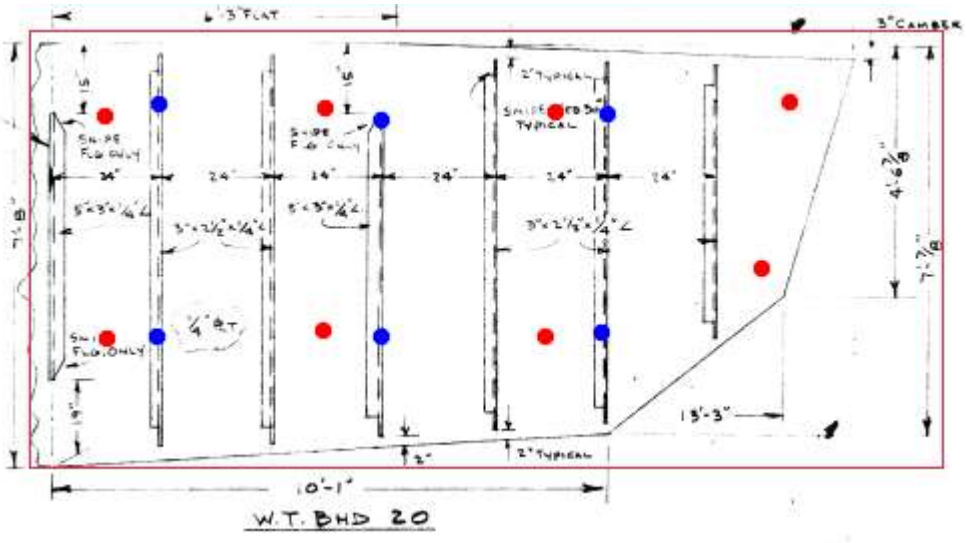


Figure 8: Watertight Bulkhead Inspection Guide

The Guemes has transverse framing every two feet. Where there is not a bulkhead, there is a built-up frame consisting of varying sizes of plates and stiffening. These frames and their associated stiffening shall be shot on a four-foot grid. Note, that the amount of shots and their locations will vary from frame to frame as they are mostly different sizes. Figure 9 shows a representative pattern of plate and stiffening inspection locations.

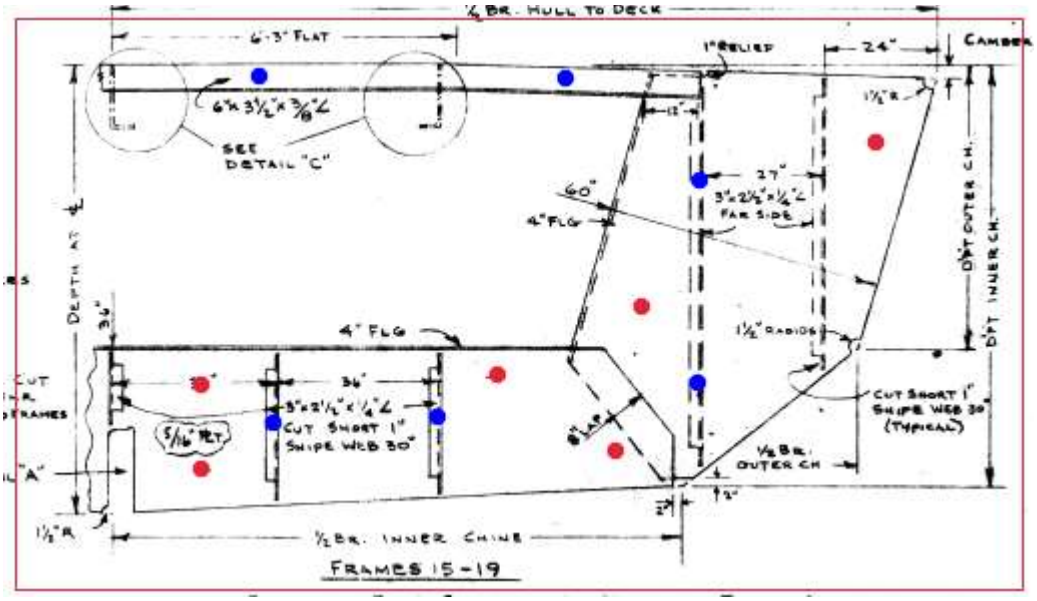


Figure 9: Transverse Framing Inspection Guide

The vessel has three primary longitudinal girders running the length of the hull, one on centerline and two six feet off centerline, port and starboard. There are also two watertight longitudinal bulkheads running six feet off centerline, port and starboard, between Frames 7 and 7. These form the ballast tank boundaries. These longitudinal members, bulkheads, and their stiffening will have UT readings taken at four-foot intervals as shown in Figure 10 and Figure 11. Note that there are two cross flooding trunks at Frame 6 and 6. These shall have readings taken as well.

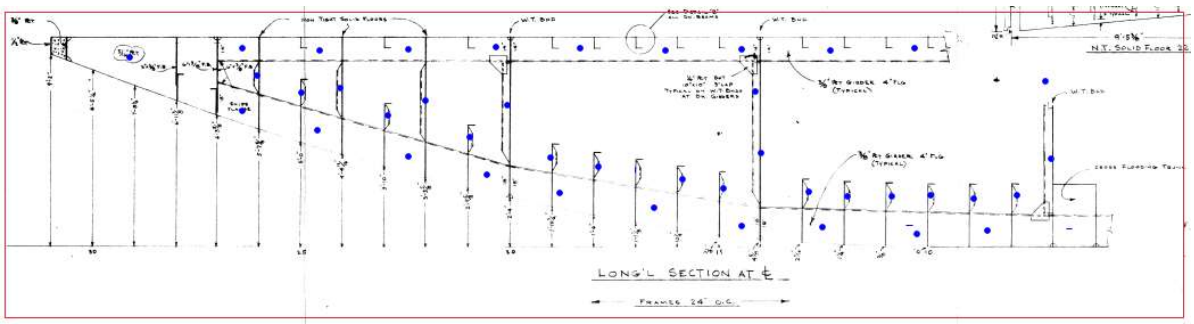


Figure 10: Longitudinal Girder Inspection Guide

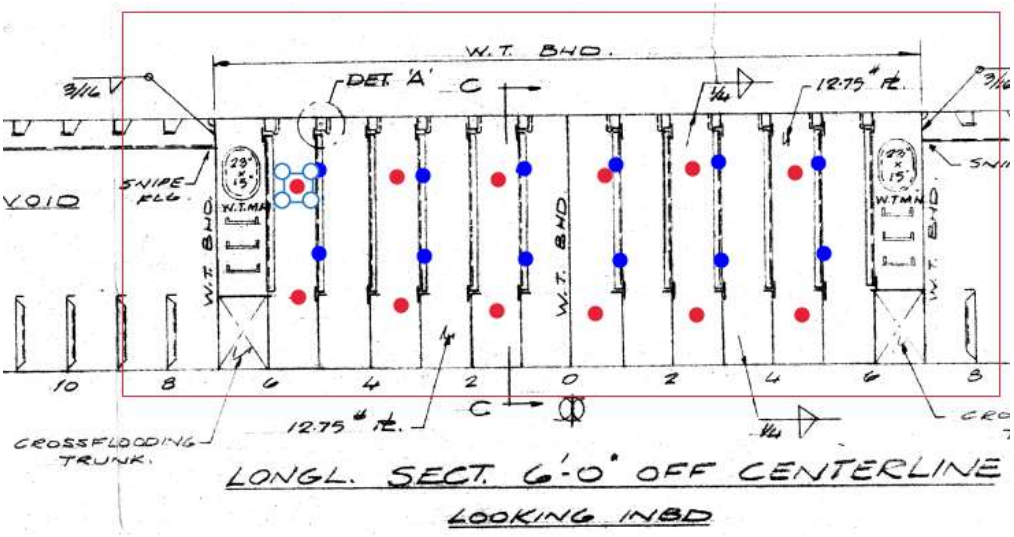


Figure 11: Longitudinal Bulkhead Inspection Guide

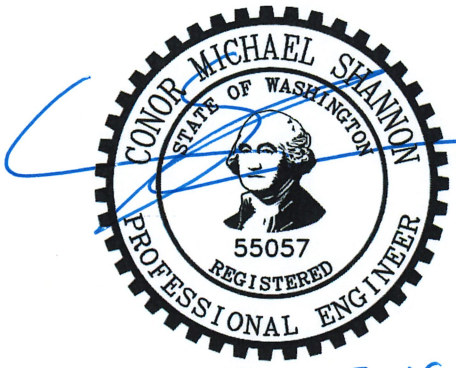
Due to a higher likelihood of water intrusion and corrosion, all framing directly below and within close proximity to the void and tank access hatches will be inspected with a two-foot grid. These are the areas circled in red in Figure 1 and Figure 2. Additionally, the deck stiffening under the machinery foundations on the No. 1 and No. 2 ends shall be inspected using a two-foot grid.

Appendix B

ART ANDERSON

TECHNICAL MEMORANDUM

Date:	15 July 2019	AA Ref:	CESKA007.014
To:	Captain Rachel Rowe, Ferry Operations Division Manager, Skagit County Public Works	Client Ref:	C20150646
From:	Conor Shannon, P.E., Naval Architect, Art Anderson Associates		
Subject:	*M/V Guemes* Thruster Bracket Analysis and Recommendation Memo		



15 Jul 2019

References

[A] *M/V Guemes Thruster Bracket Analysis,* Art Anderson Associates, 23 June 2017

[B] *End No. 1 and End No. 2 Thruster Bracket Emergent Repairs,* 22 March 2017

[C] *Guemes Island Ferry, Outdrive Bracket Stress Survey Report,* Noise Control Engineering, 13 March 2019

[D] *Guemes Island Ferry Propulsion and Power Study,* Art Anderson Associates, 17 June 2016

Appendices

1. Propeller Thrust Calculations

Introduction

The *M/V Guemes's* thruster brackets have a history of developing cracking in their plating and welds and of missing bolts at the connection of the thruster unit to the bracket. The recent years' history of cracking dates back to the FY2017 and FY2019 dry dock while missing bolts were first discovered in the Fall of 2018. However, the USCG has documentation from past inspection reports identifying cracking in at least one incident in the mid-1990s. Art Anderson (AA) has been providing Naval Architecture support to Skagit County since 2017 in matters pertaining to the thruster bracket issues. This included developing an emergent repair plan during the FY2017 dry dock to repair the cracked

welds and plate. Weld cracks were again identified during the FY2019 dry dock. Following repair of these cracks, vibrations and stress testing was completed on both brackets along with a more thorough analysis of the developed thrust and its effects on the bracket. This memorandum serves the following three purposes:

1. Provide an overview of the history of thruster bracket deficiencies and the remedial actions taken prior to 2019.
2. Provide a detailed description of the deficiencies found in 2019 and the remedial actions and analysis' taken.
3. Provide a recommendation for monitoring the thruster brackets until the next dry dock.

History

Mid-1990s

During the FY2019 dry dock the USCG inspector identified reports of cracking in the thruster brackets while reviewing past inspection reports. The cracking was for a single incident sometime in the mid-1990s. The locations, extent, and details of the cracking, or remedial action taken to fix the cracking is not known.

FY2017

During the FY2017 dry-dock, several cracks were found on the No. 1 and No. 2 end thruster brackets. Art Anderson developed an emergent repair plan [B] to re-enforce the brackets. An FEA analysis was then completed to validate the structural sufficiency of the brackets while applying the thrust loading from the thrusters. The thrust used (9,400 pounds) was a calculated value provided by Ulstein (the thruster manufacturer) for the original three bladed propellers. The analysis shows satisfactory results when looking at the static principal stresses in the bracket with this load applied. A 10 year fatigue life was established by this analysis which equated to a required stress range of less than 19 KSI. End No. 1 passed the fatigue criteria and End No. 2 failed the criteria. The results of this analysis are found in Reference [A].

Fall 2018

During an inspection of the thruster brackets, missing bolts were identified on the plate that connects the thruster to the bracket on both ends. The End No. 2 missing bolts were replaced and the nuts tack welded to the bolt to prevent rotation. The End No. 1 missing bolts were replaced and left unwelded.

Note that during the FY2019 dry dock, all End No. 2 bolts were in place while one End No. 1 bolt was missing.

FY2019 Dry Dock

At the beginning of the dry dock period, both brackets were magnetic particle tested. Several cracks were found in the welds of the No. 1 End (Figure 1). End No. 2 only showed one small weld crack at connection between the doubler plate on the top of the thruster bracket and the flanged plate that

connects from the above structure. Upon notification of these cracks, the USCG inspector dictated that a detailed evaluation of the root cause of these recurrent cracks be conducted in order to maintain the vessel's COI. A plan was formulated and provided to the inspector and temporary repairs authorized while the analysis was being conducted. The cracked welds were repaired by being ground out, the base metal magnetic particle tested for cracking, the structure welded, then the welds magnetic particle tested and inspected.

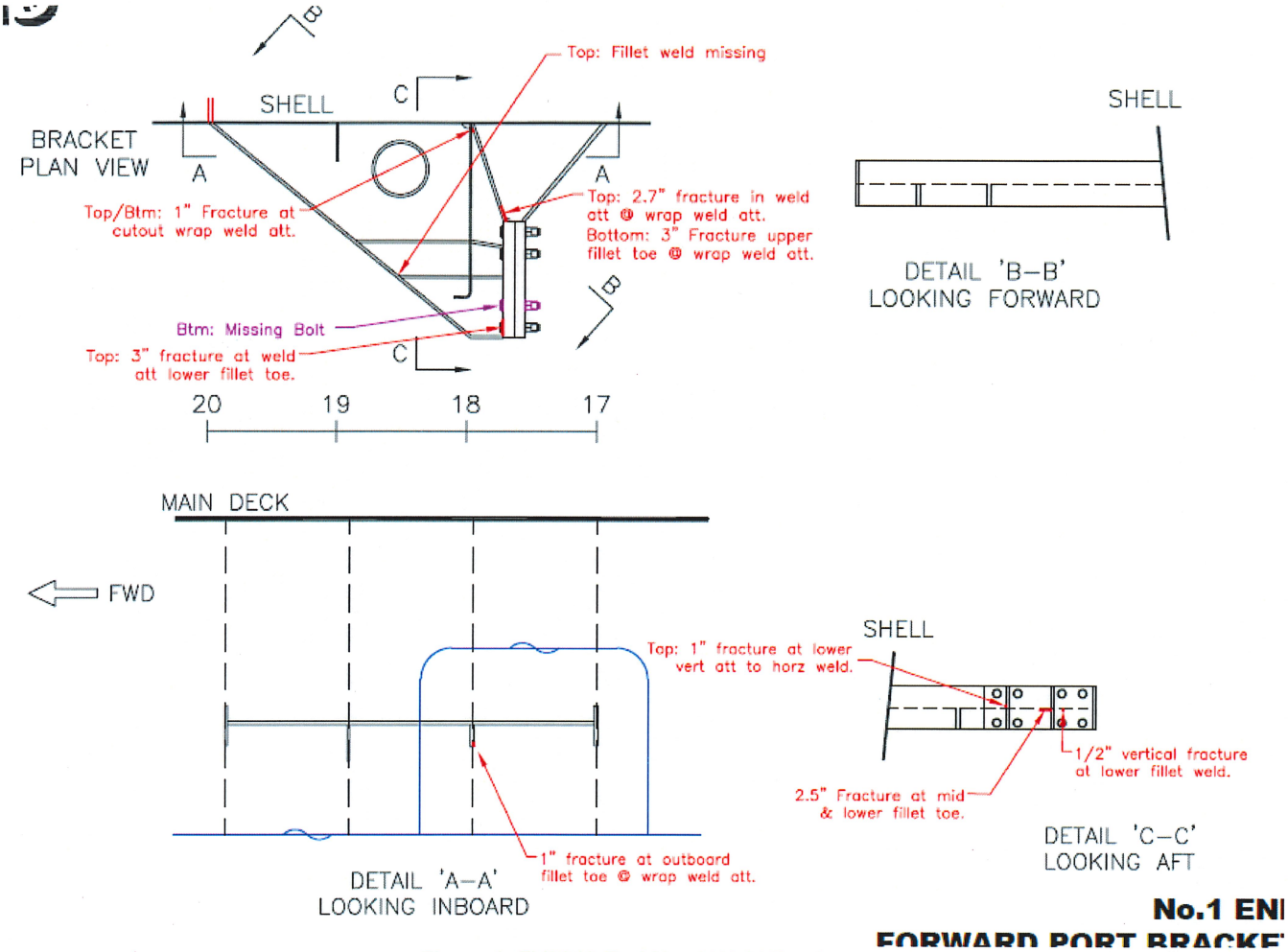


Figure 1: FY2019 End No. 1 Weld Fractures

Vibration Study and Post FY2019 Dry Dock Analysis

Introduction

At the request of Skagit County and the USCG, the following analysis was conducted to attempt to determine the root cause of the recurrent cracking in the thruster brackets. The following three hypothesis were developed and investigated:

1. The cracking is fatigue related and caused by cyclic loading being induced by severe vibrations in the bracket structures.

2. The thrust used in the original principle stress analysis [A] is the thrust delivered by the propeller at the vessels design speed of 9 knots, where the propeller is most efficient, not where the propeller has the potential to deliver the highest thrust. Thus, the principle stresses in the brackets are higher than originally determined.

3. Since all of the cracks in the End No. 1 bracket were in welds, the welds were faulty from the beginning.

The below sections describe the engineering undertaken to prove and/or disprove the hypotheses in whole or in part.

Vibration Testing and Analysis

To investigate the first hypothesis, vibration testing and follow on analysis was conducted. Noise Control Engineering, an industry leading expert in sound and vibrations testing and analysis, was sub-contracted to complete this phase. Their final report detailing the testing, analysis, and recommendations can be viewed in Reference [C]. Below is a brief summary of what they accomplished and their results and recommendations:

1. Strain gauges and accelerometers were placed on several locations on the thruster brackets and main deck above the thruster.

2. The brackets were tested in dry dock to determine their natural frequency

3. Steady state and in-service stress and acceleration data was collected. Note that due to the location of the brackets and their proximity to the waterline, it was very challenging to maintain strain gauge connections during in-service testing. However, enough useful data was collected to perform the analysis and develop confident results.

4. It was concluded that the weld cracking is not due to vibrations. During certain periods of the *Guemes's* channel crossing, the propeller does cause a forcing frequency leading to a small resonance. However, the resulting stress amplitudes are very small and not of concern. The additional cyclic stress data and accelerometer data (both on the brackets and on the main deck) are not at levels that show indications of vibration induced cracking.

5. The bracket welds have the potential to fail due to fatigue caused by high quasi-static principle stresses caused by stress reversals during the ferry's transit between Anacortes and *Guemes* Island. The principle stress levels collected on End No. 1 at the location closest to the bracket's bolted connection show stress levels and frequencies indicating the potential for weld cracking in five years or less, depending on the assumptions made and how the stress levels are extrapolated to certain operating conditions.

Propeller Delivered Thrust

To investigate the second hypothesis, an analysis of the maximum thrust potential for the propeller while operating on its normal route was conducted. The following three pieces of information were used to accomplish this analysis:

1. Estimated propeller curves using a combination of actual and estimated parameters for the current four-bladed Kruger and Sons propellers.

2. Engine performance curves for the Cummins KTA-19-M3 engines.

3. Engine Log Data from the 2016 Propulsion Study in Reference [D].

Using the three items above, the goal was to determine the actual thrust being produced by the propeller during known operating and engine conditions as measured in 2016. The propeller and engine parameters were input into the vessel performance prediction program *NavCad. NavCad* was then used to determine the propeller thrust output at several different known engine conditions captured in Reference [D]. Appendix 1 details the results of these calculations.

The analysis made the following conclusions:

1. The thrust value of 9,400 pounds that was used in Reference [A] was confirmed as being associated with the vessel operating at a design speed of nine knots.

2. Peak thrust during the departure from Anacortes was determined to be approximately 13,600 pounds.

3. Maximum potential thrust which the propeller can deliver at 1800 engine RPMs is approximately 15,000 pounds.

4. While the vessel is arriving Guemes Island there are several instances of fluctuations between low RPM/power and high RPM/power as the vessel slows down. These fluctuations can cause large swings in thrust delivered by the propeller.

Figure 2 and Figure 3 show the operational conditions analyzed and the corresponding thrust values. Figure 4 shows these conditions plotted on the propeller curve. It is important to note that the exact thrust values and number of cycles produced as the vessel approaches Guemes Island are difficult to predict due to the rapid fluctuation in engine speed, vessel speed, and propeller orientation. However, it is known that the propeller sees many fluctuating instances of low to high advance coefficients during this transition and thus high cycles of thrust loading. Based on the analysis conducted in Appendix 1, the thrust imparted on the bracket, the principle stresses, and the number of cycles are higher than determined in Reference [A]. This will reduce the fatigue life from those calculations.

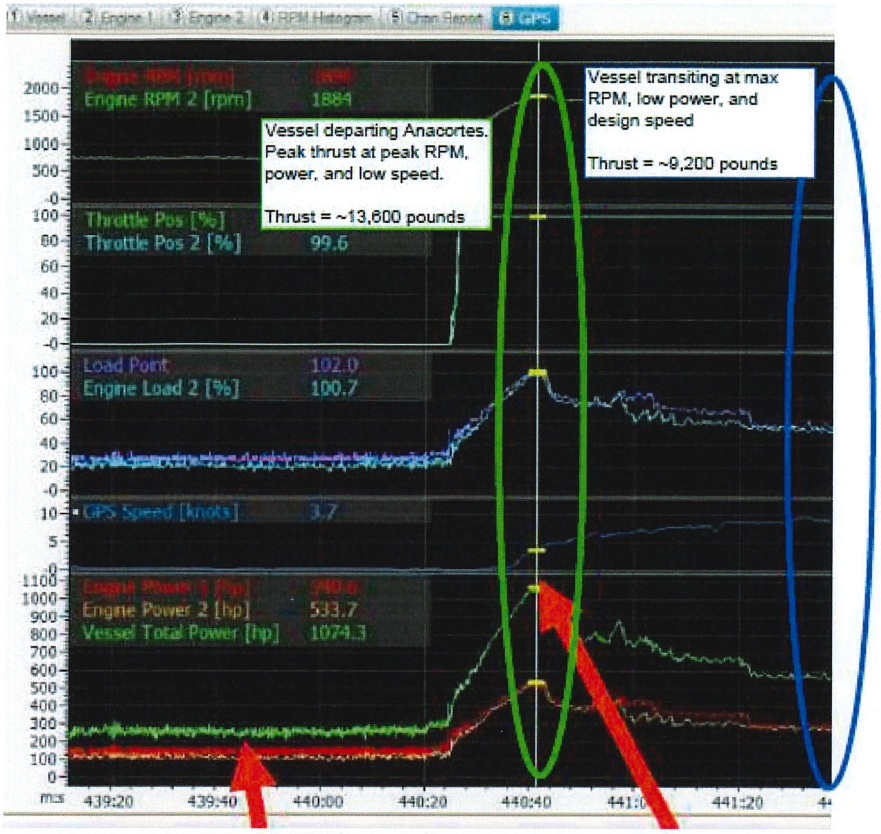


Figure 2: Engine Performance Leaving Anacortes

Figure 3: Engine Performance Arriving Guemes Island

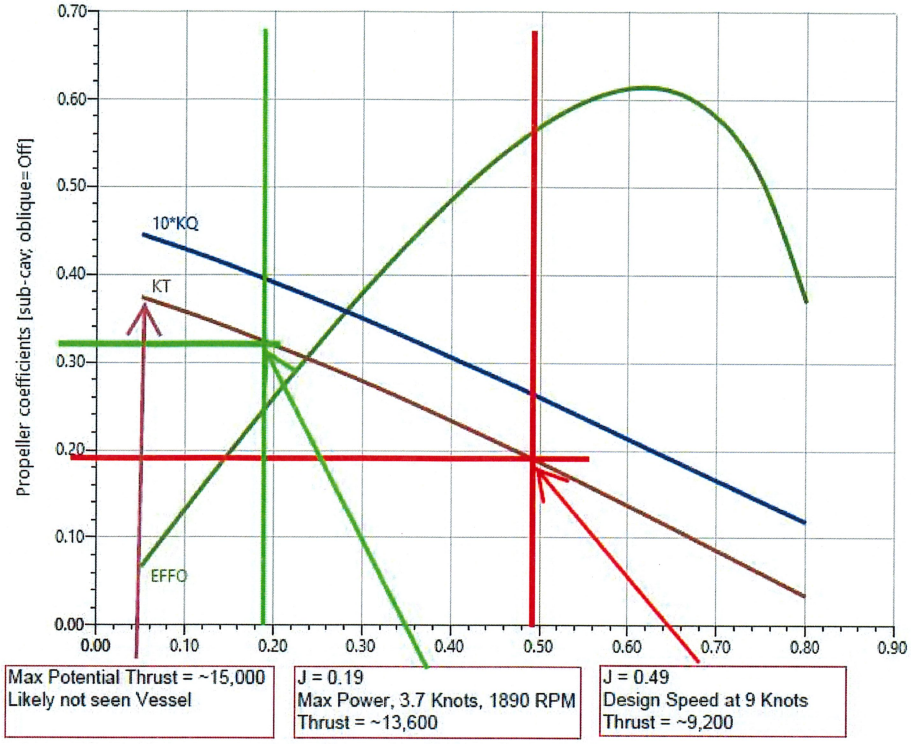


Figure 4: Gawn Propeller Curve (P/D = 0.7, Expanded Area Ration = 0.8, Blades = 4)

Another goal of determining the actual thrust being produced by the propeller was to input it into the FEA model [A] and determine the affect of the higher static thrust loading on the principle stresses of the brackets. The thrust input into the FEA model (13,600 pounds) is an increase of about 43% from the previously used value of 9,400 pounds. The increase did not cause any of the structure to fail due to yielding. However, the magnitudes of stress ranges increased significantly, indicating a decrease in fatigue life. The stress range at the location of the highest measured stress (End No. 1, location 3) from NCE's testing was also investigated. The stress range output by the FEA model aligns closely with their measured values. This information will serve to validate the thrust to be used if the thruster brackets are re-designed in the future. Figure 5 and Figure 6 show results of the higher thrust value input into the FEA model. Location 3 is labeled.

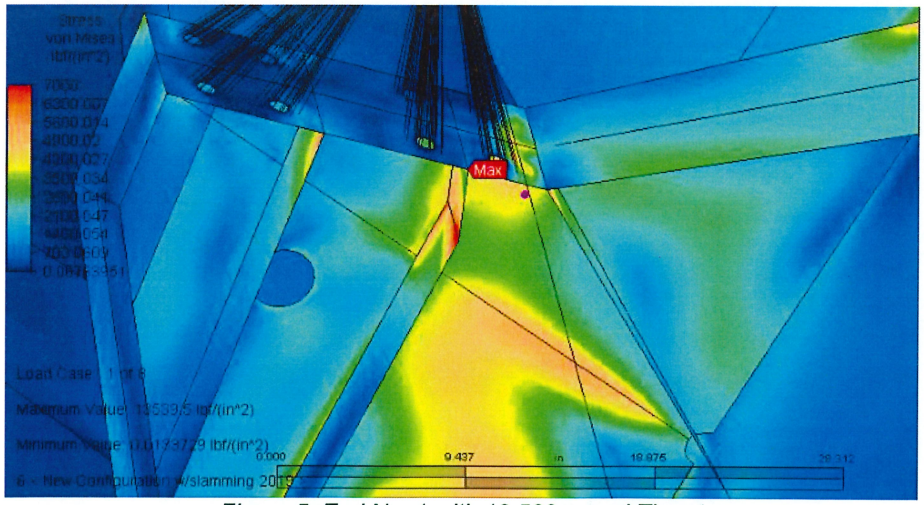


Figure 5: End No. 1 with 13,500 pound Thrust

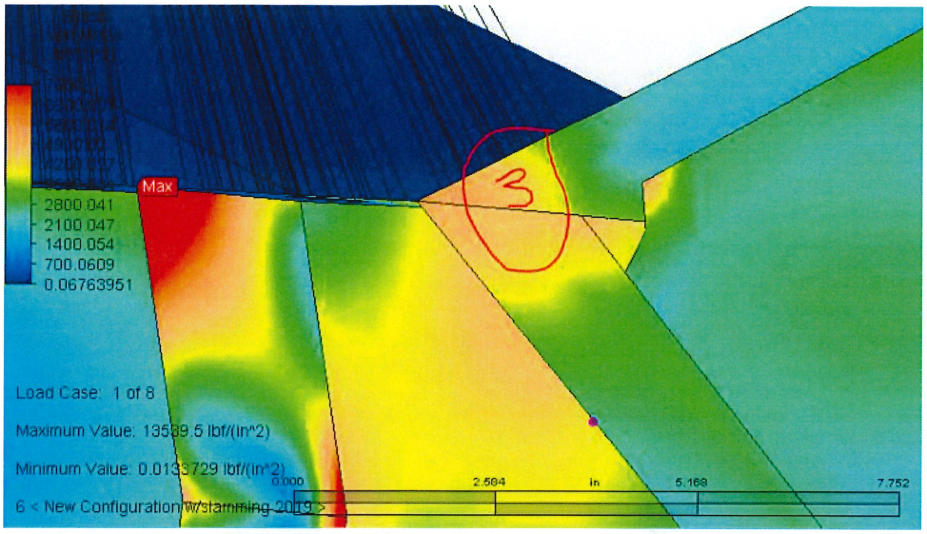


Figure 6: End No. 1 with 13,500 pound Thrust

Weld Analysis

The investigation of the third hypothesis is based mostly off of observations. Four of six cracks discovered during the FY 2019 dry dock were at or near locations of weld repairs or new welds during the FY2017 emergent repairs. These welds were made under a short timeline and in the difficult locations posed by the thruster brackets. AA obtained documentation from Foss Shipyard regarding these repairs. There was no indication of how the weld areas were prepared or of quality control or post weld inspections. Based on visual inspection by a former welder now working with AA, it was clear that several of the welds were of poor shape and contained many features in their geometry that can lead to expedited cracking. Additionally, none of the base metal underneath these welds was cracked as verified by the magnetic particle testing in the 2019 repairs.

Other Notes

The cause of the bolts falling out was initially thought to be caused by excessive vibrations. However, NCE confirmed that they did not see vibrations that could reasonably be assumed to vibrate off the nuts if they had been properly torqued. In their experience, this is not something that happens. The cause of the bolts falling out is likely due to the nuts being slowly de-torqued due to the reverse loading caused by the high thrust forces. Eventually, the nuts are backed off enough to where they loosen to the point of the small vibrations causing them to rotate off the bolt. Additionally, a visual inspection of the bolts removed and replaced during the FY2019 dry dock indicate signs of scarring on the threads, which supports this hypothesis. There were no indications of bent bolts or fractures to indicate the bolts were breaking. It is believed that ensuring the bolts are properly torqued and that tack welding the nuts to the bolt shaft will assist in preventing this from occurring.

There was also concern over the effect of running the engine at 600 HP versus the detuned rating of 530 HP. This was checked in *NavCad*. At the high RPM, high power, and low speed conditions, about 1,000 pounds of additional thrust was produced with the 600 HP engine setting. This does not have a tremendous effect of the stresses the thruster brackets see. However, it is another contributing factor to reducing overall bracket strength during fatigue loading.

ART ANDERSON

Conclusion

The goal of this analysis was to formally investigate and attempt to quantify the reasons for the repeated cracking on the *Guemes's* thruster brackets. Three hypotheses were developed and investigated. The first was to determine is the cracking was caused by excessive vibrations. NCE performed stress and vibrations testing on the brackets and determined that the cracking is likely due to fatigue loads cause by high quasi-static stresses in the brackets. They do not believe the cracking is caused by excessive vibrations. The second hypothesis was to prove that the propellers are producing higher thrusts than originally determined and used in previous analyses and thus causing higher stresses in the bracket. This was confirmed and the effects on the brackets correlated with the NCE results. Lastly, it is believed that since most of the cracking found during the FY2019 dry dock was on new or repaired welds from 2017, that poor welds were a contributing factor to the cracks developing so quickly. Although this is difficult to prove concretely, it is believed this is the case after visual inspection of the welds and lack of quality control documentation from when the repairs were made.

Recommendation

AA does not believe that the thruster brackets needs to be re-designed immediately. This is based on the following facts:

1. Brackets are only failing due to fatigue criteria and fatigue is a very un-exact science and requires many assumptions.

2. Only one bracket recently failed and four of the six failures were around new welds of known poor quality. The FY2019 weld repairs were QA'd very thoroughly and accompanied by magnetic particle testing of both the welds and base metal.

3. The bolts didn't show signs of shearing, but rather the nuts backing out. We believe this could be from improper toque (which was not well documented/QA'd, like the poor welds). If this is the case, the tack welds should keep the nuts in place.

4. The vibration analysis and the experts that conducted it are confident this isn't a vibrations issue.

5. The vessel will be going into annual dry docks. If it shows cracks at the next dry dock, then it should be re-designed.

6. The *Guemes* is nearing the end of its lifespan and we do not believe it is necessary to make such a major modification for a problem that has been ill defined until now. Additionally, the cracking that has occurred has not caused any impacts to the safety of the vessel or its ability to perform its mission.

A thorough monthly inspection plan is recommended to be conducted over the next year prior to the FY2020 dry dock. The plan should include:

1. Visual inspection of the brackets' structure for visible signs of cracking or deformities.

2. Visual signs of the bolts for signs of the nuts backing out or the bolt being deformed.
3. Check torque on bolts (if they are not all tack welded).
4. When the vessel arrives in its next dry dock, magnetic particle tests of all areas with a history of cracking shall be conducted.

	Task	CESKA007 Task 014	Date:	5/2/2019
	Title	Vibration Study and Follow On Analysis	Prep:	CMS
		Propeller Thrust Calculations	Check:	NBA
		Appendix 1	SHT:	see footer

Introduction:
The Noise-Control Engineering testing did not find indications of vibration induced fatigue stresses at a level likely to cause structural failure. However, the testing revealed higher quasi-static stresses in the brackets than those found in the FEA analysis conducted in June 2017. This indicates that the actual thrust loads applied to the brackets may be higher than those used in the 2017 analysis. The thrust loading applied to brackets in 2017 was 9,400 lbs, as specified by the manufacturer, Ulstein. The hypothesis is that this value is representative of the propeller's steady state thrust produced at the vessel's design speed, and not representative of its maximum thrust. This calculation serves to determine a theoretical maximum thrust of the Guemes's engine / propeller combination. This thrust will then be input into the same FEA model developed in 2017 and the thrust bracket stresses re-analyzed and compared to the NCE test results. NavCad was used to input the propeller and engine parameters and calculate thrust at defined conditions.

References:

[1] M/V Guemes Thruster Bracket Analysis, 23 June 2017, Art Anderson Associates
[2] Guemes Island Ferry, Outdrive Bracket Stress Survey Report, 13 March 2019, Noise-Control Engineering
[3] Applied Naval Architecture, Robert B. Zubaly
[4] Ulstein 379-DF Info.pdf
[5] Kruger & Sons Propeller Specifications
[6] Guemes Island Ferry Propulsion and Power Study, Art Anderson Associates, 17 June 2016
[7] Guemes Ferry Data Export Log 1_CMS Filtered for Task 014.xlsx

Determine Propeller Characteristics:
Design Speed Condition
[4] provides the propeller and thruster specifications for the original combination supplied to the Guemes. [5] provides the propeller specifications for the current propeller.

Diameter =	52.2	in
Pitch =	36.6	in
Number of Blades =	4	in
Expanded Area Ratio =	0.8	estimated
P/D =	0.70	
RPMe =	1800	rpm
Reduction =	4.2	
RPMp =	429	rpm
Design Speed =	9	knots
	15.19	ft/s
J =	0.49	Advance Coeff.
rho =	1.99	lb-s^2/ft^4
NavCad Thrust Output =	9295	lbs

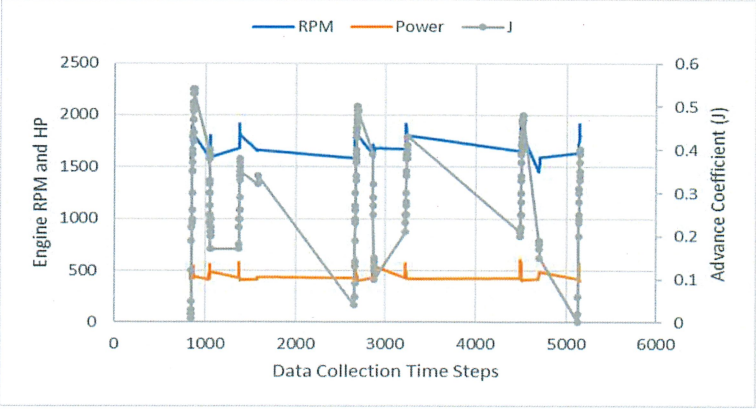
Actual Condition at Peak Power Leaving Anacortes

RPMe =	1890	rpm
RPMp =	450	rpm
Speed =	3.7	knots
	6.24	ft/s
J =	0.19	Advance Coeff.
NavCad Thrust Output =	13619	lbs

Condition During Transition from Crossing to Docking at Guemes
While the vessel is arriving Guemes Island there are several instances of fluctuations between low RPM/power and high RPM/power as the vessel slows down. These fluctuations can cause large swings in thrust delivered by the propeller. It is difficult to determine the exact values of these thrust fluctuations since the advance velocity entering the propeller can not be determined accurately. It can be assumed to be the vessel speed at the greatest but is likely lower depending on the angle of the thruster to the vessel direction of movement. This indicates that the thruster bracket may be seeing more cycles of higher thrust (and thus higher stresses) than originally determined.

Excerpt from [6]

The engine log data that produced the above figure was filtered and analyzed [7] to determine the potential thrust magnitudes and cycles. The data in this range was filtered for instances when the Engine 1 is producing more than 400 hp and the RPM is greater than 1500. Since the vessel is slowing, these parameters will produce the greatest thrust potential. The graph below is from [7] showing these peaks. The advance coefficients were calculated based on vessel speed and are thus estimated to be conservative. As discussed above, it is challenging to determine the exact thrust. However, the data shows 29 instances of J < 0.2 which corresponds to a thrust of at least 13,000 pounds. Of these 29 instances, they are divided into five groups, indicating that there are potentially five low to high thrust cycles. This indicates the potential for more high thrust/stress cycles being imparted into the thruster brackets than originally anticipated.



Graph from [7]

Appendix C

DELPHI MARITIME

Harness the Expertise of a Mariner's Eye

Delphi Maritime, LLC
22431 91st Ave. W.
Edmonds, WA 98026

206-793-5680
jeff@delphimaritime.com

Car/Passenger Ferry M/V "Guemes"

Condition and Value Survey

Survey No. 2019-0753

Date of Survey: March 4 & 14 , 2019
Date of Report: July 31, 2019

Delphi Maritime, LLC
22431 91st Ave. W.
Edmonds, WA 98026
(206) 793-5680 (Mobile)
jeff@delphimaritime.com

THIS IS TO CERTIFY

that the undersigned Surveyor at this port did at the request of Mr. Marty McKay, PE, Art Anderson, 202 Pacific Avenue, Bremerton, WA 98337 and Captain Rachel Rowe, Ferry Operations Division Manager, Skagit County Public Works, 500 Ave. Anacortes, WA 98221 survey the welded steel:

Passenger/Car Ferry M/V "Guemes"
91 Gross Registered Tons
of Anacortes, Washington

Owners:
Skagit County A Municipal Group

Operators:
Skagit County Public Works
1800 Continental Place, Mt. Vernon, W

for the purpose of ascertaining the condition and value of the vessel and 5- and 10-year cost to cure outlook.

On March 4 and 14, 2019 the attending Surveyor proceeded to Foss Shipyard, Seattle, Washington where the vessel lay in dry-dock subsequently undergoing maintenance, repair, USCG Certificate of Inspection Examination and the subject survey and upon examination the following conditions were found:

EXECUTIVE SUMMARY

The "M/V Guemes" is an all steel single deck, open car deck, double-ended ferry boat with elliptical ends outfitted with large skegs. Two [2] azimuthing Z-drives, mounted through the deck apron are configured such that they are diagonally opposed on opposite ends of the vessel. Decks have no sheer forward and with the deckhouse amidships, starboard side with single-drum anchor winch forward (No.1 end).

The main engines are Cummins Model KTA 19-M3, 6-cylinder, 530 horsepower each (1,060 H.P. total), 1800 RPM, driving bronze four [4] blade 52" x 36" fixed pitch propellers through ZF Model 550 reduction gear, 0.936:1 ratio with drive shaft to Ulstein Model DF-370 azimuthing thruster, 4.2.1:1 ratio.

Condition Summary

The vessel is forty [40] years old and in active service as a passenger/car ferry. The hull was recently gauged and found with minimal wastage with the exception of the car deck in way of car ramp. This area was cropped and renewed in March 2019. The vessel's machinery, equipment, electrical systems, lifesaving and firefighting equipment meet regulatory requirements for compliance with a USCG Certificate of Inspection for inspected passenger service. The remaining useful life of the hull structure is estimated at 20-years. However, the machinery and equipment, although well maintained, is approaching technological obsolescence with regard to propulsion, air emission, noise, and environmental standards.

Valuations

The three generally accepted methods of valuation (Cost, Income, and Sales Comparison) were all considered for the purposes of this analysis. The Cost Approach was used with adjustments made for capital investments that extend the life of the vessel and major maintenance or renewal due within the next five [5] years.

Current Fair Market Value

The following factors and assumptions were considered in estimating the fair market value of the "M/V Guemes":

- $10,980,000.00 estimated replacement cost
- 10-year remaining useful life
- $40,000 Scrap Value
- 2019 Dry-docking maintenance and repair
- 2019 Gauging Report
- Vessel to hold a valid USCG Certificate of Inspection

The results of this analysis yield a current:

Estimated current fair market value	$2,975,000.00
Estimated replacement cost	$10,980,000.00

EXECUTIVE SUMMARY (Cont)

Projected Valuations

The following factors and assumptions were considered in estimating the future fair market value of the "M/V Guemes":

- $10,980,000.00 estimated replacement cost (2019)
- Remaining Economic Useful Life (instead of remaining useful life)
- 5-year remaining Economic Useful life in present condition (Terminal date 2024)
- $273,500.00 depreciation per annum until 2024
- $750,000 cost to cure per annum pre-upgrade
- Upgrade with addition of mid-body extension in 2024
- $5,100,000.00 cost of 2024 upgrade
- $4,700,000.00 FMV in 2025 after upgrade
- 15-year extended economic useful life in upgraded condition (Terminal date 2039)
- $314,000 depreciation per annum after upgrade
- $300,000 cost to cure per annum post upgrade
- $40,000 Scrap Value
- Vessel to hold a valid USCG Certificate of Inspection

2-year Projection
The estimated costs/values of the M/V Guemes in two [2] years (2024) is as follows:

Fair Market Value	$2,188,000.00
Cumulative Cost to Cure	$1,500,000.00
Difference of between cost and FMV	$688,000.00

5-year Projection
The estimated costs/values of the M/V Guemes in five [5] years (2024) is as follows:

Fair Market Value	$1,367,500.00
Cumulative Cost to Cure	$3,750,000.00
Difference of between cost and FMV	($2,383,500.00)

EXECUTIVE SUMMARY (Cont)

10-year Projection

The estimated costs/values of the M/V Guemes in ten [10] years (2024) is as follows:

Fair Market Value	$3,444,000.00
Cumulative Cost to Cure	$9,818,322.00
Difference of between cost and FMV	$(6,374,322.00)

Note that the increase in FMV from 5-years to 10-years is due to the extensive renewal, betterments and upgrade during year 2024. The estimated $5,100,000.00 cost to lengthen and refurbish the vessel creates a new depreciation schedule and revised cost to cure.

MAIN PARTICULARS OF THE "M/V GUEMES"

Official Number:	601686
Year Built:	1979
Builder:	Gladding-Hearn Shipbuilding, Somerset, Massachusetts
Call Sign:	WDE 7121
Length (registered):	124'
Length (BP)	100'
Breadth (molded):	34'
Depth (molded):	7'
Registered Gross Tons:	91 GRT
Registered Net Tons:	91 GRT
Main Engine(s)	Two [2] Cummins KTA-19-M3
Horsepower (Total):	1,060 HP Total
Propulsion Type:	Z-drive
Fuel Capacity:	6,352 Gallons
Passenger Capacity:	100
Car Capacity:	20

PREVIOUSLY DRY-DOCKED
The vessel was last in dry-dock in March 2019 at Foss Shipyard, Seattle, WA for maintenance, repair, and USCG Certificate of Inspection dry-dock and internal structural examination. The next full dry-docking is scheduled in 2021.

CLASSIFICATION AND LOAD LINE
The vessel is not classed and does not hold a Load Line Certificate (Not required).

INTENDED SERVICE
The vessel is intended to engage in a car and passenger ferry service between Anacortes, Washington and Guemes Island Washington not more than one [1] mile from land.

FLAG AND CREW
The vessel is of United States coastwise registry

Port of Registry: Anacortes, Washington

The crew reportedly numbers three [3] and may only work 12 hours in any 24-hour period:

Master
Deckhands [2]

DOCUMENTATION

Certificate	Yes/No	Expiration Date	Notes
Certificate of Documentation	Yes	Feb 29, 2020	Issued: January 11, 2019
U.S.C.G. Certificate of Inspection	Yes	April 13, 2023	Issued: April 13, 2018
A.B.S. Load Line Certificate	No		Not required
A.B.S. Class Certificate	No		Not required
A.B.S. Tonnage Certificate	No		Not required
A.B.S. Int Tonnage Certificate	No		Not required
Stability Letter	Yes		Issued: December 5, 2007
Stability Booklet	No		Not required
FCC License	Yes	Dec 31, 2028	Issued: October 12, 2018
Communications Safety Radio Telephone Certificate	Yes	Nov 5, 2023	Issued: November 5, 2018

GENERAL DESCRIPTION AND ARRANGEMENT

HULL AND DECKS

The "M/V Guemes" is an all steel single deck, open car deck, double-ended ferry boat with elliptical ends outfitted with large skegs. Two [2] azimuthing Z-drives, each mounted through the deck apron are configured such that they are diagonally opposed on opposite ends of the vessel. Decks have no sheer forward and with the deckhouse amidships, starboard side with single-drum anchor winch forward (No.1 end).

It should be noted that frames are numbered from amidships (0) to No.1 and No. 2 ends. Henceforth in this report the No. 1 end will be "forward" and the No. 2 end will be "aft". Voids are numbered from forward to aft, No. 1 Void forward at the No. 1 end; No. 8 Void aft at the No. 2 end.

The deckhouse is two-level level of welded steel construction from Frame No. 14 forward to No. 11 aft and divided into passenger lounge, deck gear locker, and crew's day room. The raised pilothouse is accessed by an interior stairway from the main deckhouse and is outfitted with navigation/communication equipment, engine and Z-drive controls, gauges and alarms and inclined windows to reduce glare.

MAIN DECK

The main deck is open with access at both ends for passengers and drive-on vehicles. The main deck has a capacity for twenty [20] standard sized vehicles and is outfitted with anchor winch No. 1 end starboard, eight [8] cast cleats and four [4] closed chocks. Main engines are mounted on suitable engine beds welded to the main deck at No. 1 end port and No.2 end starboard and

GENERAL DESCRIPTION AND ARRANGEMENT (Cont)
MAIN DECK (Cont)

housed in steel compartment equipped with hinged access doors. Main engines are protected from vehicles by a 3" pipe guard rail. The auxiliary engine is housed in a similar steel cabinet No. 2 end starboard side aft of the No. 2 main engine. The deckhouse described above is located on the starboard side

A 42" high steel bulwark reinforced by flat bar stanchions and stiffeners surrounds the perimeter of the main deck port and starboard to No. 1 and No. 2 end loading aprons.

Four [4] steel watertight doors provide access to the accommodation spaces into the main deckhouse.

O1-DECK

The exterior of the 01-Deck has two life jacket storage boxes with top opening covers, one mounted forward and one aft of the raised pilothouse. Each box stows eleven [11] children and twenty-two [22] adult life jackets. An additional job box is mounted forward. The 01-Deck interior is occupied by a crawl space below the pilothouse which houses emergency batteries, battery charger and potable water tank.

PILOTHOUSE

The raised pilothouse is accessed by an interior stairway from the from the crew's day room. The raised pilothouse is equipped with center console containing main engine and azimuthing drive controls, wood chart desk with cabinets forward, navigation and communication equipment mounted on the overhead, and gauge, alarm and electrical panels located throughout. The top of the pilothouse has one [1] 18" diameter quick opening escape hatch.

The vessel is fitted with one freestanding, mast located on top of the pilothouse supporting navigation and communication equipment antennas and radar.

ACCOMMODATIONS

The main deck passenger lounge is accessed from the No. 1 end and deck side and can accommodate twenty-eight [28] walk-on passengers. It is outfitted with electric heat, bench seats, lifesaving and firefighting equipment. The crew's day room is electric heated, has wood cabinet with laminate counter and single basin stainless sink forward, chairs and laminate table.

HEAD
There are no toilet facilities on the vessel.

GENERAL DESCRIPTION AND ARRANGEMENT (Cont)

UNDERDECK COMPARTMENTS

There are seven [7] water tight transverse bulkheads located at Frame No. 0 and 7, 14 and 20 forward and aft. Underdeck compartments are defined by the above transverse bulkheads and part length longitudinal bulkheads dividing the underdeck space into ten [10] compartments:

- Two [2] forepeaks
- Two [2] pump tank compartments
- Two [2] voids
- Two [2] ballast tank voids
- Two [2] ballast tank compartments.

STRUCTURAL DETAILS

The "M/V Guemes" hull, deckhouse and pilothouse are of welded mild steel plate and steel framing construction. Frames are on 24" centers.

Hull Scantlings

Deck	Plate	1/2" steel plate
Sides	Plate	3/8" steel plate
		5/16" plate above the chine
Bottom	Plate	3/8" steel plate

Bulkheads

Transverse:	Plate	1/4" steel plate
	Stiffeners	3" x 2-1/2"" x 1/4" L
Swash	Plate	1/4" steel plate
	Stiffeners	3" x 2-1/2" x 1/4" L
Longitudinal	Plate	5/16"" steel plate
	Stiffeners	5" x 3-1/2" x 1/4" L

Frames

Underdeck	Transverse	6" x 3-1/2" x 3/8" L
Sides	Shell Frame	5/16" x 4" FlgPlt
	Stiffeners	3" x 2-1/2" x 1/2" L
Bottom	Transverse	36" x 4" x 5/16" FlgPlt
	Stiffeners	3" x 2-1/2" x 1/4" L

Girders

Underdeck	Longitudinal	14" x 4" x 3/8" FlgPlt
Bottom	Longitudinal	18" x 4" x 3/8" FlgPlt

Scantlings (Cont)

Skegs	Plate	5/16" plate
Bulwarks	Plate	3/8" (estimate)
	Stanchions	6" x 1/2" FB
	Stiffeners	3" x 1/2" FB
	Cap rail	6" x 1-1/2" x 1/4" L

Full Builder's plans and scantlings were not available at the time of survey. Scantlings referenced off International Inspection Ultrasonic Gauging survey March 2019.

WELDING
Fastenings are electric welded.

TERMINOLOGY

The following terminology is used through this report to describe the condition of the inspected parts of the vessel:

Good:	Like new condition. Better than average in all respects, or strength; performance unimpaired; no maintenance or repair required
Satisfactory:	Light wear. Condition average; minor deficiencies not in need of correction, wear and tear evident but original strength/performance not significantly affected.
Serviceable:	Moderate wear. Condition below average; wear and tear evident and original strength/performance affected but not in need of immediate maintenance or repairs.
Unsatisfactory:	Heavy wear. Below average: deficiencies in need of immediate maintenance or repairs
Poor:	Requires immediate attention or repair. Condition deteriorated in all respects; beyond practical repair, and requires renewal or replacement.
NA	Not applicable
NI	Not inspected—i.e. functionality and performance not verified

STRUCTURAL DETAILS (Cont)

WATERTIGHT INTEGRITY

The watertight integrity of the vessel appears satisfactory. The passenger lounge, crew day room, and deck gear locker are accessed by watertight doors from the main deck. Underdeck voids are accessed by 18" diameter single action Baier type hatches.

CONDITION: Accessed by visual inspection only. Doors, hatches, windows and portlights were not chalk tested or otherwise tested for tightness.

Doors	Number:	Three [3]
	Type:	Hinged 2-dog
	Material:	Steel
	Size:	30" x 72"
	Location:	Deckhouse No. 1 end and main deck
	Sill:	6"
	Condition:	Satisfactory, visual inspection only
	Number:	One [1]
	Type:	Hinged 2-dog
	Material	Steel
	Size:	26" x 72"
	Location:	Deckhouse gear locker
	Sill:	6"
	Condition:	Satisfactory, visual inspection only
Hatches	Number:	Eighteen [18] (approximate)
	Style:	Hinged Single acting Baier
	Size:	18" diameter
	Material:	Steel
	Location:	Main deck
	Coaming	Flush
	Condition:	Satisfactory, visual inspection only

STRUCTURAL DETAILS (Cont)
WATERTIGHT INTEGRITY (Cont)

Windows	Number:	Ten [10]
	Located:	Passenger Lounge [8]
		Crew Day Room [2]
	Size:	35" x 29"
	Style:	Metal frame fixed
	Condition:	Satisfactory
	Number:	Eight [8]
	Located:	Pilothouse
	Size:	Various
	Style:	Four [4] slide opening
		Four [4] Fixed
Portlights	Number:	Four [4]
	Size:	10" Round
	Type:	Bronze frame
	Located:	Main deckhouse doors
	Condition:	Satisfactory

CONDITION: Accessed by visual inspection only. Doors, hatches, windows and portlights were not chalk tested or otherwise tested for tightness. It should be noted that watertight integrity was found satisfactory by the attending USCG Inspectors for Certificate of Inspection Examination.

STAIRS AND LADDERS
Stairs and ladders providing access to the different levels of the vessel, both in the interior and exterior were found satisfactory with either grated treads or satisfactory non-skid coating.

Stairs	Material:	Welded steel
	Location:	Main deckhouse (Exterior)
		Crew Day Room to Pilothouse (Interior)
	Condition:	Satisfactory, found with suitable non-skid
Ladders	Material:	Welded Steel
	Location:	Access to underdeck voids
	Style:	Side rails 3" x 3/8" steel
		Rungs 3/4" square stock
		Rung spacing 12"
	Condition:	Satisfactory

STRUCTURAL DETAILS (Cont)

Handrails

Location:	Bulwarks
Material:	Steel
Height:	25"
Size:	1-1/2" pipe, 1-1/2" pipe stanchions
Style:	2-course
Condition:	Satisfactory

Location:	01 Deck (Main deckhouse roof)
Material:	Steel
Height:	42"
Size:	1-1/2" pipe, 1-1/2" pipe stanchions
Style:	2-course
Condition:	Satisfactory

Location:	Pilothouse
Material:	Steel
Height:	42"
Size:	1-1/2" pipe, 1-1/2" pipe stanchions
Style:	2-course
Condition:	Satisfactory

Deck Fittings

Describe	Number	Size	Material	Location
Cleats	Eight [8]	30"	Cast steel	Bow/Stern Port/Starboard
Closed Chock	Four [4]	12"	Cast Steel	Port/Starboard

Condition: Satisfactory, visual inspection only, Not NDT tested

Hull Guards/Fendering

Type	Formed steel guard encircling main deck apron extensions
Condition:	Satisfactory

Anodes

Number:	Thirty [30] ZHS-23 Zinc on hull Six [6] each on Z-drive lower legs Two [2] on generator grid cooler
Condition:	Removed and replaced new at 2019 dry-docking

Sea Valves

Number:	Two [2]
Location:	Forward and aft centerline
Condition:	Good—Inspected at 2019 dry-docking

PROPULSION AND MACHINERY

The main engines are Cummins Model KTA 19-M3, 6-cylinder, 530 horsepower each (1,060 H.P total), 1800 RPM, driving bronze four [4] blade 52" x 36" fixed pitch propellers through ZF Model 550 reduction gear, 0.936:1 ratio with drive shaft to Ulstein Model DF-3270 azimuthing thruster, 4.2.1:1 ratio.

Engines are controllable from the raised pilothouse. The main engines are electric started and cooled by channel keel coolers. Exhaust is dry exhaust by flexible steel piping lagged in engine cabinet and muffler located in stack.

The vessel is also equipped with one [1] auxiliary engine, Fiat Power Train (FPT), Model NEF45 4-cylinder, 1800 RPM, 480v, 3-phase, 60 kW auxiliary engine located main deck starboard side aft of No. 2 main engine starboard cabinet. Auxiliary engine is electric started. Cooling for the auxiliary engines is grid cooler.

Steering is hydraulic consisting by way of azimuthing thrusters mounted forward port side and aft starboard side. Steering solenoids are actuated by electric azimuthing control handles in the pilothouse.

VESSEL MACHINERY

NAME	MAKE/ MODEL	SERIAL #	H.P. /kW/ Ratio	RPM	Last Overhaul	Hrs. since overhaul
No. 1 ME	Cummins KTA-19	3721-7216	530 HP	1800	2017	8,480
No. 2 ME	Cummins KTA-19	3721-9054	530 HP	1800	2017	6,190
Red Gear No. 1	ZF Model 550	2006-5972	0.936:1		2019	0
Red Gear No. 2	ZF Model 550	2007-0386	0.936:1		2019	0
No. 1 Z-drive	Ulstein DF-370	3721-9054	4.2:1		2015	8747
No. 2 Z-drive	Ulstein DF-370	3721-7217			2019	New
Auxiliary	FPT NE 45	J600-00881229	65.5	2800	2019	--
Generator	Stamford		60 kW			

Propellers

Number:	Two [2]
Blades:	Four [4]
Diameter:	52"
Pitch:	36"
Manufacturer:	Kruger & Sons
Material:	Bronze
Condition:	Good, Inspected and polished 2019 dry-dock

MACHINERY AND EQUIPMENT

Additionally, the vessel carries the following equipment:

No.	ITEM	MAKE/MODEL/SPEC	Location
One [1]	Fire Pump	15 H.P. Electric Barnes Series 25CCE	No. 2 Void No. 7
Two [2]	Fire Pump	Hydraulic Barnes Series 25ICU-1	No. 1 and No. 2 Main Engines

Note that fire pumps were installed new at the 2019 Dry-docking at Foss Shipyard

PILOTHOUSE

No.	ITEM	MAKE/MODEL/SPEC
Two [2]	Radar	Furuno 8062 with RP 150 Display
Three [3]	VHF Radios	SEA 157
One [1]	VHF Radio	Standard Horizon GX 2150
One [1]	Loud Hailer	One SEA -857
One [1]	UHF Radio	Kenwood TK-8180
One [1]	Intercom	Elctro Voice PAA-60
One [1]	GPS Navigator	Garmin GPS Map-7608
One [1]	Depth Sounder	Furuno FCV-620
One [1]	Magnetic Compass	Dirigo 6" Adjusted 2019
One [1]	Satellite Compass	Furuno SC-502
One [1]	AIS	Furuno FA-150
Two [2]	Search light	Carlisle Finch 12" Diameter
Two [2]	Binoculars	
Two [2]	Trim Gauges	Lev-o-gauge
Two [2]	Windshield Wipers	
One [1]	Ship's clock	Tempo Atomic
One [1]	Barometer	Swift 5"
One [1]	Anemometer	Sou'wester
One [1]	Computer	Laptop
One [1]	Bilge Alarm Panel	Murphy 7-station
One [1]	24-volt Distribution Panel	Equipped with Volt gauge
One [1]	Emergency light	Navy Style
Two [2]	Ship's Whistle	
Two [2]	Azimuth Controls	Ulstein Combi handle and joystick

ELECTRICAL SYSTEM

Pilothouse, accommodation spaces and electrical machinery are all served by the 110/220-volt A.C. electric system serviced by one [1] FPT generator and shore power receptacle and 24-volt DC from storage batteries. Wiring is of all electrical conductors of plastic and basket weave armor covered, multi-strand, marine type wiring. Fixtures and switches are of marine grade.

ELECTRICAL SYSTEM (Cont)

Dead front circuit switchboards with circuit breakers and master switches are located in engine compartments and battery room.

The 12/24-volt D.C. system is served by two [2] battery banks located in No. 1 and No. 2 Engine Compartments. Each bank consists of two [2] 12-volt marine type 8-D batteries in series and one [1] 12-volt battery connected to plastic covered, multi-strand, copper cables located in corrosion proof, covered, well ventilated boxes in each engine compartment. The vessel is additionally equipped with a 24 to 12-volt converter.

Pilothouse equipment is served by one [1] bank of three [3] 12-volt batteries located under the pilothouse.

Batteries are kept charged by 100 ampere alternators mounted on each main engine and by 24-volt battery charger and 12-volt constavolt.

Lighting consists of dual white/red illumination for bridge and stairwell, sodium and quartz lights for deck illumination and vapor proof globe lights on the deckhouse.

TANKS
The following tank capacity of the vessel is as follows:

Fuel oil tanks (Four)	6,352 gallons
Fresh water	275 gallons
Ballast Water	23,747 gallons

Fuel Oil

Capacity & Tanks:	6,352 U.S. Gallons reported in four [4] freestanding, independent tank
Material & Location:	1/4" Welded mild steel in: No. 3 Void (two [2] tanks) No. 6 Void (two [2] tanks)
Fill and Sounding:	Raised steel pipe fill with containment on main deck. Raised pipe vents with ball checks.
Supply Lines & Shutoff:	Steel pipe supply and return lines through strainer and filters to engine with flexible lines and shutoff valves at engines
Components:	Dual gang primary filters, secondary filters on auxiliary and main engines

TANKS (Cont)
FUEL OIL (Cont)

Ventilation: Natural to containment

Fresh Water

Capacity & Tanks: 275 U.S. Gallons

Material & Location: One [1] independent galvanized mild steel tank located in pilothouse void

Fill and Sounding: Standpipes

Supply Lines & Shutoff: Galvanized steel piping with in-line filters/strainers

Components: One electric driven Jabsco Pump, 4.2 GPM diaphragm pump.

Ventilation: Natural

Lubricating Oil

Capacity & Tanks: Pail Storage

Hydraulic Oil

Capacity & Tanks: Pail Storage

Waste Lubricating Oil

Capacity & Tanks: Portable 5-gallon pails, transferred ashore

Gray Water/Slop Holding
None

Black Water Treating

Capacity & Tanks: No toilet facilities onboard

VENTILATION	Location:	Accommodation Areas
	Type:	Natural and mechanical
	Location:	Engine Compartment
	Type:	Natural through vent openings

DECK MACHINERY
The vessel is outfitted with one hydraulically powered anchor winch located forward of the passenger lounge on the No. 1 end foredeck. Anchoring gear consists of One [1] 400 lb. Danforth type anchor and ground tackle of 5/8" x 300' wire rope.

FIRE FIGHTING & LIFE SAVING EQUIPMENT

The "M/V Guemes" is protected from fire by a combination of portable fire extinguishers, remote fuel and machinery shutoffs and fire pump.

Fire Detection
The owner has installed Detect-A-Fire sensors in engine compartments

Fire Hose
The vessel is equipped with two [2] fire stations each with 50' of 1-1/2" fire hose and nozzle stowed on deck, No. 1 and No. 2 ends pressurized by an electrically driven pump Void No. 7 and engine mounted hydraulic pump.

Portable Fire Extinguishers
Portable fire extinguishers are reportedly of the following types and sizes are located as indicated:

Number	Type	Location
One [1]	Halon B-1	Wheelhouse
One [1]	Halon B-1	Ladder
Three [3]	Halon B-II	Crew Day Room
Two [2]	Dry Chemical B-II	Crew Day Room
Three [3]	Sodium B-III	Car Deck
One [1]	Dry Chemical B-III	Car Deck
Three [3]	Dry Chemical B-II	Passenger Lounge

All fire extinguishers serviced January 2019.

Fire Axe
The vessel is equipped with one fire axe mounted in pilothouse.

General Alarm
The vessel is not equipped with a general alarm—not required.

Alarms and Monitoring System
A Murphy Electric monitoring bilge level system panel with a visual and audio alarm is located in the pilothouse. Main engine oil pressure and temperature audible and visual alarms for the

FIRE FIGHTING & LIFE SAVING EQUIPMENT (Cont)

Emergency Lighting
Emergency lighting consists of battery powered navy style emergency lights mounted in the pilothouse and crew day room.

LIFESAVING EQUIPMENT

Life Rings	Quantity:	Three [3] Total. One [1] with light, one [1] with line
Life Raft	Number:	None required for this route
Life Jackets	Quantity:	One hundred three [103] adult/ forty-six [46] Child
	Manufacturer:	Various
	Type:	Type 1
	Where Stowed:	01-Deck Lockers and passenger lounge
Man Overboard Retrieval	Quantity:	Two [2]
	Type:	Rescue lines, one swimmer's suite with harness and tether, one [1] marker buoy
First Aid Equipment	Quantity:	One [1]
	Type:	Industrial First Aid Kit
	Where Stowed:	Crew Day Room
	Quantity:	One [1]
	Type:	Eye Wash Station
	Where Stowed:	Crew Day Room
	Quantity:	Two [2]
	Type:	Fire Blankets
	Where Stowed:	Crew Day Room
	Quantity:	One [1]
	Type:	AED
	Where Stowed:	Crew Day Room

LIFESAVING EQUIPMENT (Cont)

Flares (Reportedly)	Number:	Fourteen [14]
	Type:	Six [6] smoke
		Four [4] handheld
		Four [4] rocket
	Expiry:	Note not sighted or inspected

EXTERNAL INSPECTION

Hull

Butts and seams appeared satisfactory with no significant wastage. Hull plating found fair with light washboarding between frames, particularly in areas that are subject to wheelwash from the Z-drive propulsion---No. 1 end port, No. 2 end starboard. Coatings and zincs renewed (reference dry-docking report).

It should be noted that the hull condition was found satisfactory by attending USCG Inspectors for Certificate of Inspection dry-dock exam.

Main Deck

Butts and seams appeared satisfactory with no significant wastage. Approximately 50" of wasted deck plate on each end apron were being cropped and renewed at the time of survey. This area was identified on the 2019 gauging report and is subject to normal heavy wear due to ramp and traffic loads. Deck coatings and non-skid were in the process of being renewed at the time of survey (Reference dry-docking report)

INTERNAL INSPECTION

Internal tanks and voids were open for inspection. All tanks excepting No. 1 Void were entered or viewed by the undersigned surveyor. Visible areas were well coated and free of significant structural deformities.

It should be noted that the hull condition was found satisfactory by attending USCG Inspectors for Certificate of Inspection internal structural exam.

DRY-DOCKING

The "M/V Guemes was dry-docked March 2019 at Foss Shipyard, Seattle Washington. The following work was reportedly completed during dry-docking:

Sea Valves/Sea Chests

- Remove two [2] 3" sea chest gate valves
- Inspect and reinstall sea chest valves

Propellers

- Inspect propellers
- No. 1 propeller removed and replaced.
- No. 1 propeller seal replaced
- No. 2 propeller seal replaced

Keel Coolers

- Channel Coolers
- Pressure tested to 20 psi
- Replace discharge butterfly valves on No. 1 and No. 2 engines

Anodes

- Thirty [30] 23# zinc anodes installed on hull
- Twelve total [12], six [6] each, zinc anodes installed on Z-drive lower leg
- Two [2] ZHS-26 zinc anodes installed on generator grid cooler

Gauging

- Vessel was gauged while in dry-dock. Wasted areas renewed at drydocking
- Report attached

Voids

- Open and clean voids

Fire Pumps

- Remove and replace fire pumps
    - One [1] Electric Motor Driven Barnes Series 25CCE
    - Two [2] Hydraulic Pumps—one [1] in void No. 2 and one [1] in No. 2 Engine room

Fuel Tanks

- Strip and clean

DRY-DOCKING (Cont)

Steel Renewals

- Crop and renew four [4] wasted fuel tank sounding tubes.
- Crop and renew 5' 8" x 12' 6" x 1/2" plate in main deck apron in way of No. 1 and No. 2 car ramp areas
- No. 1 and No. 2 Z-drive hull mounting brackets found with fractures-v-out and reweld.

Machinery Repairs

- No. 1 and No. 2 Reduction gears removed, overhauled by 3rd party and reinstalled
- Auxiliary Generator removed, overhauled by 3rd party and reinstalled
    - New head gasket
    - New oil cooler
- Main Engines
    - Flush cooling system with fresh water
    - Engine No. 1
        - Replace FW pump and drive
        - Clean and replace aftercooler core
        - Replace fuel pump
    - Engine No. 2
        - Replace all heads
        - Replace turbocharger
        - Clean and replace aftercooler core
        - Replace fuel pump
        - Replace FW pump

Coatings

- Keel to Waterline
    - Low pressure wash and prepare to SP-6 or similar standard
    - Spot coat Amercoat 240 Epoxy Buff
    - Spot coat Amercoat 240 Gray
    - One [1] full coat ABC #3 AF Black
    - One [1] full coat ABC #3 AF Red

- Freeboard (Waterline to top of Guard Rail)
    - Low pressure wash and prepare to SP-6 or similar standard
    - Spot coat Amercoat 240 Epoxy Buff
    - Spot coat Amercoat 240 Gray
    - One [1] full coat Amershield Urethane Black
    - One [1] full coat Amershield Urethane White (Boot Stripe)

DRY-DOCKING (Cont)
COATINGS (Cont)

- Freeboard (Waterline to top of Guard Rail)
  - Low pressure wash and prepare to SP-6 or similar standard
  - Spot coat Amercoat 240 Epoxy Buff
  - Spot coat Amercoat 240 Gray
  - One [1] full coat Amershield Urethane Black
  - One [1] full coat Amershield Urethane White (Boot Stripe)

- Car Deck
  - Low pressure wash and prepare to SP-6 or similar standard
  - Track blast to remove existing deck coatings
  - One [1] full coat 302 Zinc Rich Epoxy Green
  - One [1] full coat Amercoat 240 Epoxy Dark Gray
  - One [1] full coat Amercoat 138 heavy Duty Non-Skid Epoxy Dark Gray

GENERAL CONDITION
The vessel was dry-docked March 2019 for inspection, maintenance and renewal of coatings (Reference dry-docking section in this report for details). The hull was found satisfactory with widely scattered light to moderate washboarding between side shell frames which are considered normal wear and tear for a vessel of this age. Exterior hull surfaces are newly painted and the deckhouse are satisfactorily coated and generally well maintained. Decks have suitable non-skid and coatings are in satisfactory condition. The hull has satisfactory cathodic protection with paint and anodes.

The vessel is forty [40] years old and in active service as passenger/car ferry. The hull was recently gauged and found with minimal wastage with the exception of the car deck in way of car ramp. This area was cropped and renewed in March 2019. The vessel's machinery, equipment, electrical systems, lifesaving and firefighting equipment meet regulatory requirements for compliance with a USCG Certificate of Inspection for inspected passenger service. The remaining useful life of the hull structure is estimated at 20-years. However, the machinery and equipment, although well maintained, is approaching technological obsolescence with regard to propulsion, air emission, noise, and environmental standards.

Interior surfaces are satisfactorily preserved by paint.

SURVEYORS NOTES

A. Underwater portions of hull and bottom plating and outboard fittings and zinc anodes were examined as the vessel was in dry-dock at time of survey.

SURVEYORS NOTES (Cont)

B. Propellers and Z-drive propulsion units were examined visually at the time of survey.

C. Wasted steel on the main deck in way of the car ramps was cropped and renewed. repairs were in process at the time of survey.

D. Owner provided written documentation and photographs of new installed equipment and machinery and steel repairs.

E. Internal tanks and voids were inspected at the time of survey as tanks and voids were open and certified as safe for entry.

F. Vessel systems including main engines, diesel generator, electric motors, pumps and valves were not operated for the purposes of this survey.

REGULATORY REFERENCES

The following regulatory and industry standards were referenced in this survey and in the construction, maintenance and repair of the vessel. Relevant sections of:

33 CFR 26, 81, 130, 155, 156 & 173; 46 CFR 25, 26, 28 & 105; 47 CFR 80; 46 USC 4505, 8103, 11101, 10601 & 10602

RECOMMENDATIONS

- **Certification-** Vessel to be maintained in compliance with USCG Certificate of Inspection.
- **Regulatory Compliance**--Vessel to be maintained in compliance with the rules, regulations and certifications required for its intended service.
- **Housekeeping-** Vessel is noted as being disheveled at time of survey due to shipyard maintenance and repair activities. Clean and re-stow safety, lifesaving, firefighting and critical equipment in orderly, organized fashion.
- **Z-drive Mounts-**Continue to monitor Z-drive mounting brackets and bolts for fractures and disturbed or deformed mounting hardware.
- **Qualifications-** All recommendations to be carried out by qualified technicians to best marine practice standards.
- **Lifesaving and Firefighting Equipment**- To be inspected and certified to the satisfaction of the attending USCG Certificate of Inspection Inspectors.

VALUATION

Definitions
DEFINITIONS:
The following definitions are from the American Society of Appraisers Machinery & Technical Specialties Committee.

- **Fair Market Value** is the estimated amount, expressed in terms of money that may be reasonably expected for a property in an exchange between a willing buyer and a willing seller, with equity to both, neither under any compulsion to buy or sell, and both fully aware of all relevant facts, as of a specific date.
- **Replacement Cost** is the current cost of a similar new property having the nearest equivalent utility as the property being appraised.
- **Economic Life** is the estimated number of years that a new property may be profitably used for the purpose for which it was intended.
- **Normal Economic Life**
  The designed life of an income producing asset.
- **Remaining Economic Life**
  The time an asset can continue to be used to earn income in its original design and purpose.
- **Normal Useful Life**
  The estimated number of years that a new asset can be operated before it becomes unusable as to physical condition, usually used with non-income producing assets.
- **Remaining Useful Life**
  The estimated number of years that an asset in use can continue to be operated before it becomes unusable due to physical condition.
- **Highest and Best Use**
  A use for the purpose to which the vessel was designed

Highest and Best Use
The highest and best use of the subject vessel is a car and foot passenger ferry on short routes in protected waters.

Methodology
The appraisal process that is applied to most vessels is designed to evaluate all factors, which influence value. A detailed description of the subject vessel is an important component of this process. The characteristics of the subject vessel establish its utility and desirability.
The as-is market value of the 100% ownership interest in the subject vessel is reported in this

VALUATION (Cont)

appraisal. The three standard approaches to value (Cost, Income, and Sales Comparison Approaches) have been considered in this analysis. The definitions of these approaches to value are as follows:

Cost Approach - this approach is based upon the principle that the value of the vessel is significantly related to its physical characteristics, and that a prudent buyer will not pay more for an asset than the cost of acquiring a substitute property of equivalent utility. In this approach the replacement cost of the asset is estimated and the value is adjusted for depreciation caused by physical deterioration, functional obsolescence, and economic obsolescence.

Income Approach - this approach estimates value by calculating the present value of the future economic benefits of owning the asset.

Sales Comparison Approach - this approach estimates value through the analysis of recent sales or offering prices of property that is similar to the subject property. If the comparables are not exactly like the asset being appraised, adjustments are made to the selling prices of the com parables to equate them to the characteristics of the asset being appraised.

The three generally accepted methods of valuation (Cost, Income, and Sales Comparison) were all considered for the purposes of this analysis.

We were not provided the information necessary to perform an Income Approach analysis. We were unable to locate a sufficient number of sales/sales listings of comparable sales/sales listing data for similar vessels. Buyers of vessels this age tend to look at the usable life remaining, any additional cost to make the vessel suitable for the buyers intended service; the condition, history of maintenance and renewals and the cost of a new like-in-kind vessel.

For this reason the Cost Approach was used with adjustments made for capital investments that extend the life of the vessel and major maintenance or renewal due within the next 5-years.

We were provided information by Skagit County relating to the recent upgrades and capital expenditures made to the subject vessel. This information has been incorporated into the following analysis. The vessel is 40-years old. However, its age is offset by the recent maintenance, refurbishment and renewals completed by the owner. Generally, an asset of this type may be expected to have a 40-year life span. However, the service life can go beyond this average with upgrades and renewals. The recent maintenance and renewals completed by the

VALUATION (Cont)

current owner has added approximately 10 years to the vessel's serviceable life in its current condition.

Industry sources indicate the current replacement cost for the subject vessel was approximately $10,000,000 in 2012 for a new built, in-kind vessel, constructed at a Pacific Northwest Shipyard. The Bureau of Labor Statistics Producer's Price Index for Shipyards indicates a 9.8% rise in costs since that time resulting in an estimated 2019 $10,980,000.00 replacement cost.

The designed life-span of this type of vessel is 40-years which would indicate that this vessel is at the end of its useful life. However, it is estimated that the owner's capital investments have extended the vessel useful life. Based upon the information provided it is the undersigned's opinion with continued timely and professional maintenance the subject vessel should have ten [10] years remaining useful life. We utilized a scrap value of $40,000 and a remaining useful life of ten [10] years.

The following factors and assumptions were considered in estimating the fair market value of the "M/V Guemes":

- $10,980,000.00 estimated replacement cost
- 10-year remaining useful life
- $40,000 Scrap Value
- 2019 Dry-docking maintenance and repair
- 2019 Gauging Report
- Vessel to hold a valid USCG Certificate of Inspection

Using this information, the cost approach to valuation yielded the following valuation estimates based on the previously detailed premises of value. These values are statements of opinion. No guarantee can be given that these opinions of value will be sustained or that they will be realized in an actual transaction.

Replacement Cost	$10,980,000.00
Salvage Value	($40,000.00)
Replacement Cost Adjusted	$10,940,000.00
40-year straight line depreciation	$10,940,000/40 = $273,500/year
10-year remaining useful life	$2,735,000.00
Salvage Value	$40,000.00
2019 Certificate of Inspection Dry-dock and ISE	$200,000.00
Fair Market Value	**$2,975,000.00**

VALUATION (Cont)

Surveyor Notes:

It should be noted that the above values are estimates for value of the physical asset only in the condition as found on the day of the survey with no consideration for future economic factors such as required equipment upgrades, replacement or economic obsolescence.

Projected 5-year and 10-year Valuation

NARRATIVE
The future value of the M/V Guemes is inextricably tied to its value as an income producing asset. The M/V Guemes is a special purpose vessel—double ended passenger/car ferry with limited range and operating in protected waters. These types of vessels can be sold to be repurposed but at significantly lower values than in its highest and best use. Any private or public buyer of this asset in the future must also consider the cost of the shoreside infrastructure required to accommodate a passenger/car ferry.

The vessel's future value is dependent on it remaining suitable for its highest and best use and retaining the certifications and equipment required to retain its Certificate of Inspection as a passenger/car ferry vessel.

Additional factors to consider are the future investments required to accommodate growth on the M/V Guemes current route, noise and air emission standards, equipment upgrades and the ongoing "cost to cure" to keep the M/V "Guemes" in service. Cost to cure is the cost to remedy a depreciation factor such as physical depreciation, obsolescence or class, load line or Certificate of Inspection Renewal.

We were provided information by Skagit County that included current and legacy documents of maintenance & repair costs (Reference list of Documents Reviewed). It is estimated that the average of future annual maintenance and repair costs is approximately $750,000/year.

From a physical condition standpoint the hull plating and internal structure are in sound condition and with continued diligent maintenance can be expected to remain structurally sound for another 20-years. However, critical machinery and equipment will require regularly scheduled replacement or overhaul. It is estimated the vessel operates approximately 6,000 to 7,000 hours per year. Scheduled engine overhauls are required every 15,000-20,000 hours and Z-drive overhauls at 40,000-hour intervals. It is estimated that main engine overhauls run approximately $125,000 per engine and Z-drive overhauls run approximately $250,000.00 per overhaul. Based on the current hours of installed machinery the following machinery maintenance costs are anticipated in the five [5] and ten [10] year period.

VALUATION (Cont)

Item	2-year outlook	5-year cost outlook	10-year cost outlook
Main Engines	$250,000.00	$500,000.00	$1,000,000.00
Z-drives	$250,000.00	$600,000.00	$1,200.000.00

Additional economic factors affecting future value of the M/V Guemes are:

- Capacity limitations
- Noise abatement Standards
- Underwater noise abatement standards
- Environmental Stewardship
- Air Emission Standards
- Technological advancement (e.g. LNG/Hybrid/Electric Propulsion)

The cost to cure for the M/V Guemes will rise over the next 5 to 10 years while the depreciated value decreases. In essence the M/V Guemes is on an economic voyage in which the hull is sound but the technology is aging toward obsolescence.

A conservative estimate of the cost to cure for the M/V Guemes is $1,500,000.00 for 2-years, $3,750,000.00 for five years and $12,600,000.00 for ten years. The two and five-year estimate is the average annual maintenance and repair (5 x $750,000) inclusive of the above noted propulsion machinery overhauls. The ten-year cost includes average annual maintenance and repair (10 x $750,000) plus a major refit and extension of the vessel with a 20' mid-body ($5,100,000.00 in 2024) required to accommodate projected population and commercial growth demands. The following factors and assumptions were considered in estimating the future fair market value of the "M/V Guemes":

- $10,980,000.00 estimated replacement cost (2019)
- Use of Economic Useful Life (instead of remaining useful life)
- 5-year remaining Economic Useful life in present condition (Terminal date 2024)
- $273,500.00 depreciation per annum until 2024
- $750,000 cost to cure per annum pre-upgrade
- Upgrade with addition of mid-body extension in 2024
- $5,100,000.00 cost of 2024 upgrade[1]
  (Does not include cost of leased vessel for replacement service)
- $4,700,000.00 FMV in 2024 after upgrade
- 15-year extended economic useful life from date of upgrade (2024)
  (Terminal date 2039)

[1] M/V Guemes, O.N. 601686: Ferry Replacement Plan, Elliott Bay Design Group, Reference No. 13039-001-043-3, Rev. B, 22 November 2013.
Adjusted to 2019 Estimated Cost

VALUATION (Cont)

- $314,000 depreciation per annum after upgrade
- $300,000 cost to cure per annum post upgrade
- $40,000 Scrap Value
- Vessel to hold a valid USCG Certificate of Inspection

2-year Projection
The estimated costs/values of the M/V Guemes in two [2]-years (2021) is as follows:

Fair Market Value	$2,188,000.00
Cumulative Cost to Cure	$1,500,000.00
Difference of between cost and FMV	$688,000.00

5-year Projection
The estimated costs/values of the M/V Guemes in five [5] years (2024) is as follows:

Fair Market Value	$1,367,500.00
Cumulative Cost to Cure	$3,750,000.00
Difference of between cost and FMV	($2,383,500.00)

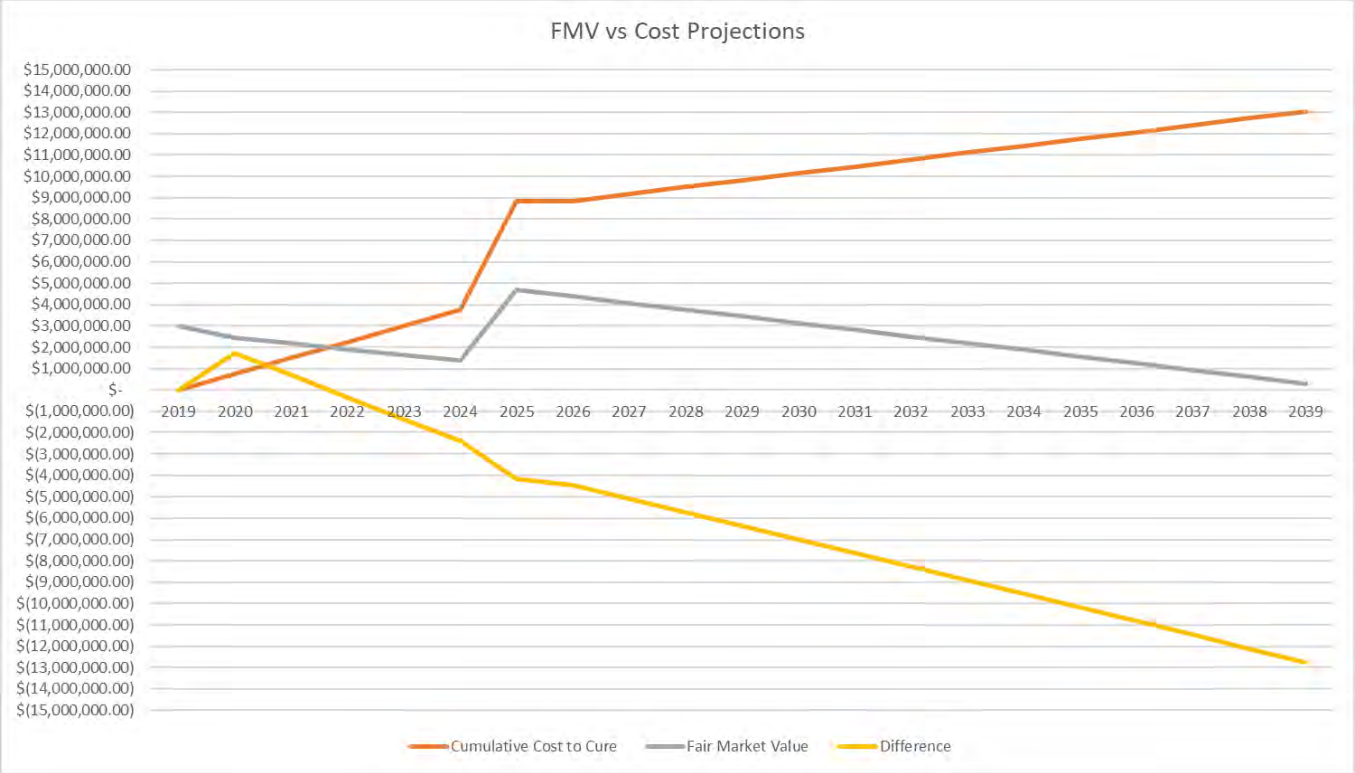
10-year Projection
The estimated costs/values of the M/V Guemes in ten [10] years (2029) is as follows:

Fair Market Value	$3,444,000.00
Cumulative Cost to Cure	$9,818,322.00
Difference of between cost and FMV	$(6,374,322.00)

Note that the increase in FMV from 5-years to 10-years is due to the extensive renewal, betterments and upgrade during year 2024. The estimated $5,100,000.00 cost to lengthen and refurbish the vessel creates a new depreciation schedule and revised cost to cure.

It should be noted that the above estimates are for costs and value of the physical assets with no adjustment for income/revenue to offset cost to cure. Income/revenue data was not available to the undersigned surveyor.

VALUATION (Cont)



It should be noted the above graph captures the total projected costs and associated FMV with maintaining and extending the Guemes life to 2039 including the 2024 upgrade. In other words it is estimated that by the end of 2039 the owner would have spent a cumulative $13,043,322 for maintenance and upgrades and own a vessel valued at $304,000.

REFERENCES

- Guemes Island Ferry Replacement Project, Skagit County Public Works
- M/V Guemes, O.N. 601686: Ferry Replacement Plan, Elliott Bay Design Group, Reference No. 13039-001-043-3, Rev. B, 22 November 2013.
- Guemes 2019 Shipyard Contract Value, Skagit County Public Works
- Cummins Engine Repair/Overhaul Invoice No. 01-29583
- ZF Marine Propulsion Invoice No. RO-51382
- ZF Marine Propulsion Invoice No. RO-51381
- Plansk_SKA-182-01 Rev A., Art Anderson Associates
- M/V Guemes Work Orders 2019, Foss Shipyard
- S3603 MV Guemes Final Report, International Inspection (Gauging) March 2019
- 2017-CMS Guemes Condition and Value Survey
- 4086 CMS_2015 Condition and Value Survey

REFERENCES (Cont)

- 77083-01-3 Rev A Deck Arrangements Plans, Nickum and Spaulding
- 15-01164 Guemes-Schedule
- 770083-0102 Rev A Inboard Profile and Hold Plan, Nickum and Spaulding
- 2019 Work Package Spec
- Operational Cost Estimate, 28-Car Electric Ferry, Glosten and Associates
- Foss Shipyard Invoice 92312612, April 27, 2017
- Foss Shipyard Invoice 92284334, March 23, 2017
- Foss Shipyard Invoice 92734671, October 30, 2018
- Foss Shipyard Invoice 91590714, September 24, 2014
- Foss Shipyard Invoice 92734671, October 30, 2018
- Lake Union Drydock Company Invoice 47813, December 28, 2015
- Dakota Creek Industries Invoice 30283, September 12, 2018

LIMITATIONS

I certify that, to the best of my knowledge and belief the statements of fact contained in this report are true and correct. The reported analyses, opinions, and conclusions are limited only by the reported assumptions and limiting conditions, and are my personal, unbiased professional analyses, opinions, and conclusions.

1. This survey is intended for the purpose of assessing condition and valuation only and is not intended to influence the purchase or non-purchase of the vessel. This survey is based on the facts presented and discovered, based on my opinion with no warranty either specified or implied. It is a statement of the condition of the vessel at the time of survey only. Any observations by the undersigned are strictly in the nature of opinion and should not be acted upon without verification
2. We have no present or prospective interest in the property that is the subject of this report and no personal interest with respect to the parties involved.
3. Our engagement in this assignment was not contingent upon delivering or reporting predetermined results.
4. We are currently unaware of ever having previously provided any professional services involving this marine asset within the last three years. While we attempt to follow owner and name changes, many are not recorded, or not recorded in a manner that provides reasonable transparency.

LIMITATIONS (Cont)

5. The undersigned surveyor made a personal inspection of the property that is a subject of this report.
6. The undersigned surveyor conducted the Survey that is contained in this report.
7. Unless our representative indicates otherwise, the issuance of our condition and valuation survey report will be based upon:
    a. external conditions observed by our representative without opening machinery or spaces normally closed and
    b. upon information provided to him including documents and photos provided by subcontractors, regulatory agencies and owners.
    c. Information supplied by others that was considered and utilized in constructing this report is from sources believed to be reliable and no further responsibility is assumed for its accuracy.
    d. If our representative is provided misleading or erroneous information, our damage survey report shall be deemed withdrawn.
8. This examination has been made without making removals or opening parts normally concealed or testing for tightness or trying out machinery; only provided maintenance and other data has been recorded. Further, no determination of intact or damaged stability or inherent structural integrity has been made.
9. Equipment descriptions are included in the report for purposes of identification and classification. Descriptions are intended for informational purposes only but are not intended to detail all conditions or list all features associated with each item described.
10. The subject vessel was examined by the undersigned and the conditions of the underwater hull and appurtenances are known in the context of this survey. Further, the internal sections of the vessel tanks were examined during the subject survey and the specific condition is known in the context of this survey.
11. The values given in this appraisal are for the stated valuation dates only, and only for the stated purpose.
12. The vessel was appraised under the assumption that there was responsible ownership and management, competent crewing, and ongoing maintenance.

LIMITATIONS (Cont)

13. The vessel was appraised on the premise that it was free and clear of all encumbrances, mortgage debt, and special liens.
14. Value is considered to be in cash. Contracts or charters, if any, are not considered in reaching the value.

As far as may be ascertained from a general examination of this vessel in dry-dock at Foss Shipyard on March 4, 2019 and subsequent dates the vessel was found to be capable of being used for its intended purpose.

The document is not a certificate of seaworthiness but a statement of opinion given WITHOUT PREJUDICE, that with the recommendation contained in the survey and submitted to owners being complied with, and the voyage and/or transportation contemplated represents no specific hazards beyond such as are normally accepted by the Underwriters.

Survey made without prejudice.

ATTENDING

Bob Martin	Chief Engineer, M/V Guemes
Captain Rachel Rowe	Ferry Operations Division Manager, Skagit County Public Works
Captain Jeff Slesinger	Marine Surveyor, Delphi Maritime, LLC

PDF-Certified Digital Signature) Signed: July 31, 2019

Jeff Slesinger, Surveyor
SAMS® Surveyor Associate
Delphi Maritime, LLC

Attachments:

- Gauging Report
- Photographs

INTERNATIONAL INSPECTION

Specialists in Nondestructive Examination

M/V GUEMES

Ultrasonic Gauging Survey

MARCH 2019

Ultrasonic thickness measurements were obtained for Art Anderson and Associates on the vessel M/V GUEMES on February 28th, 2019 through March 2nd, 2019 and on March 12th, 2019 at the Foss Ship Yard in Seattle, Washington. The owners were represented by Mr. Connor Shannon and Mrs. Rachel Rowe. The survey was conducted by International Inspection personnel.

EXTENT OF SURVEY

The following items were ultrasonically gauged:

- Main Deck Plating.
- No.1 End Voids:
  - Void 1 Internals.
  - Void 2 Internals.
  - Void 3 Internals.
  - Void 4 Internals:
  - No.1 End Ballast Water Tank Internals.
- No.2 End Voids:
  - No.2 End Ballast Water Tank Internals.
  - Void 5 Internals.
  - Void 6 Internals.
  - Void 7 Internals.
  - Void 8 Internals.
- Side & Bottom Shell Plating.

RESULTS OF SURVEY

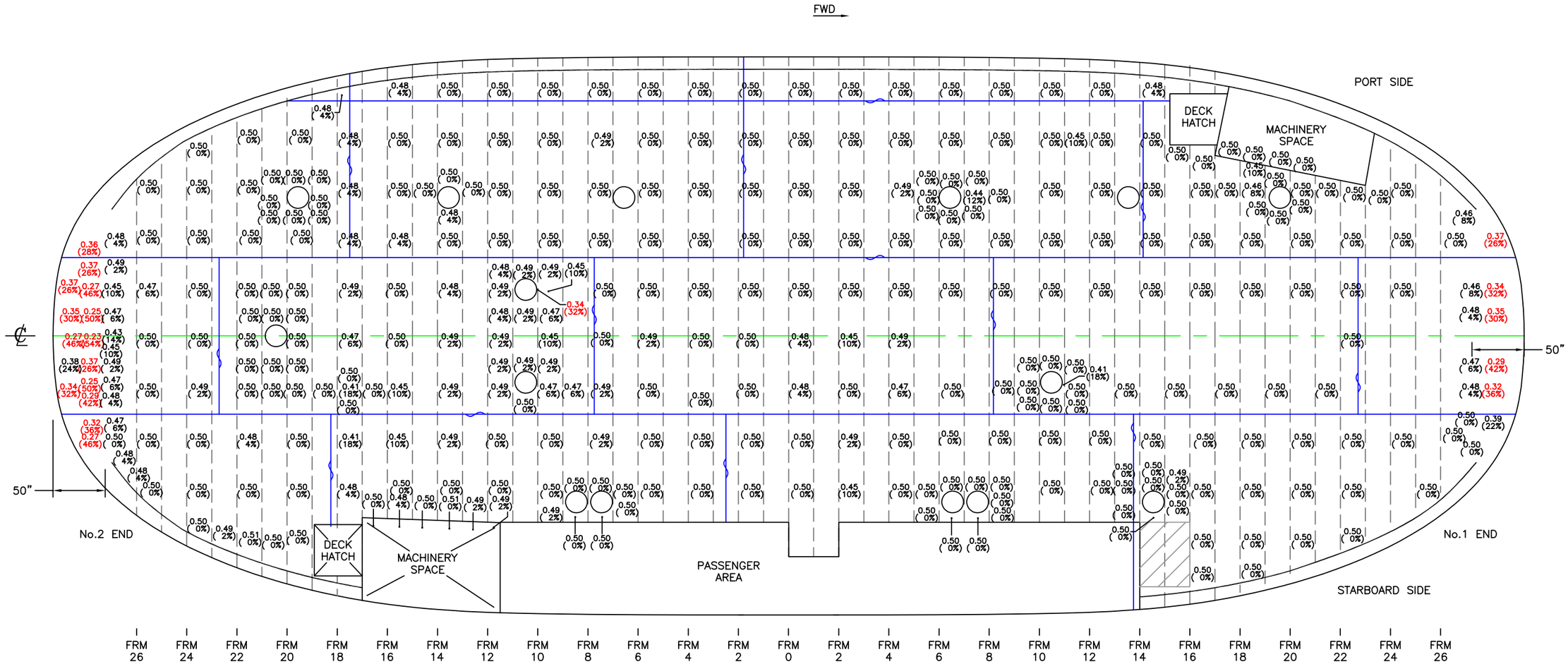
The results are shown within the following report.

Respectfully submitted,

INTERNATIONAL INSPECTION, Inc.

Gabe Graham
Senior Field Supervisor
S3603

MAIN DECK PLATING



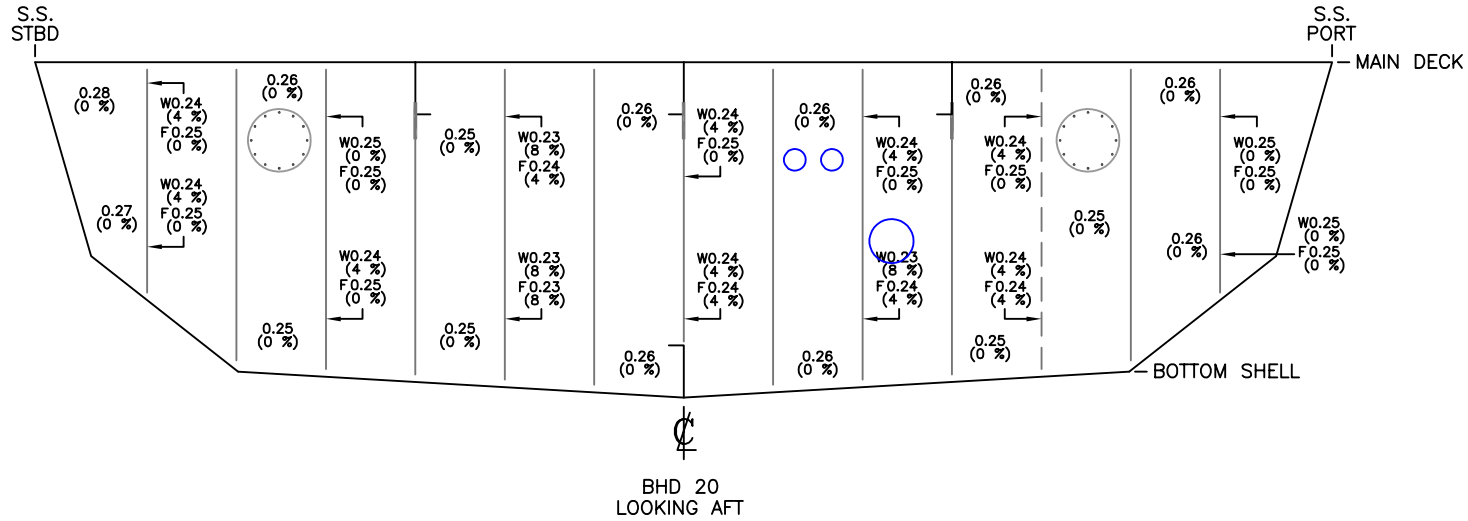
NOTE:
MAIN DECK PLATING .50"
RED = EXCESSIVE WASTAGE (25% AND GREATER).
▨ = RAMP.

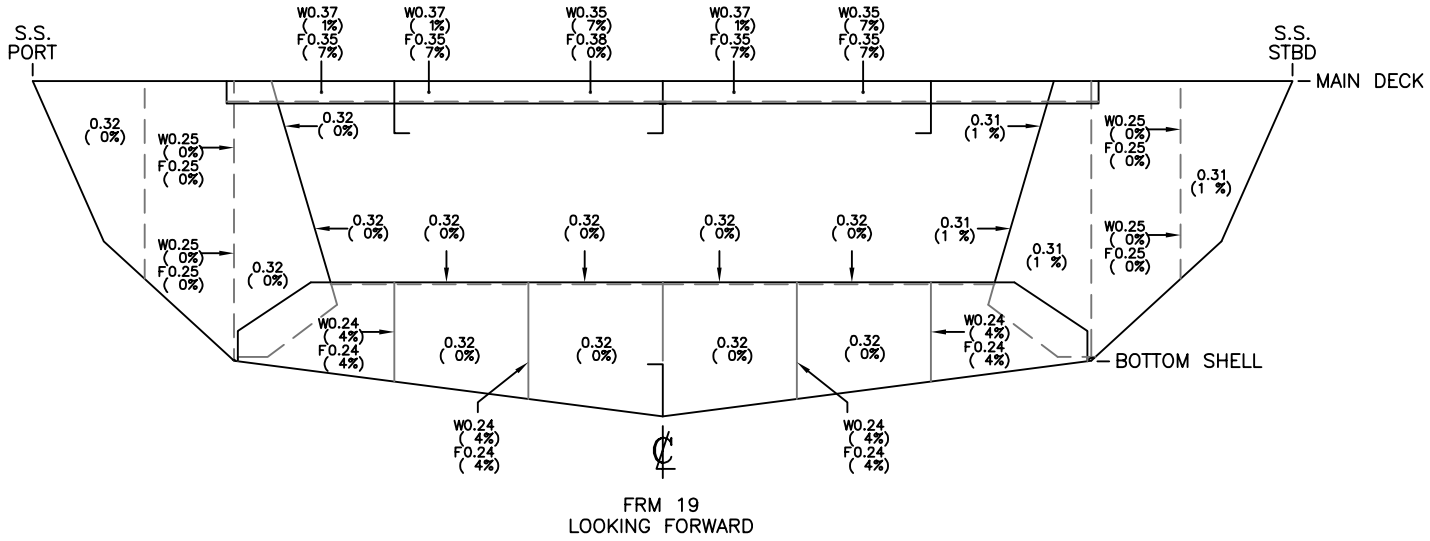
PROJECT: M/V GUEMES		MAIN DECK PLATING DESCRIPTION: PLAN VIEW	
DRAWN BY: G. GRAHAM	JOB # S3603	DWG # MnDk v1.1	DATE: MARCH 2019

INTERNATIONAL INSPECTION

Specialists in Nondestructive Examination

No.1 VOID INTERNALS





NOTE:
- BULKHEAD 20 PLATING .25".
- BULKHEAD 20 VERTICAL STIFFENERS L5" x 3" x .25".
- FRAME 19 TRANSVERSE UNDER DECK FRAME L6" x 3.5 x .375".
- FRAME 19 SIDE SHELL FRAME .3125" PLATE W/ 4" FLANGE.
- FRAME 19 SIDE SHELL FRAME STIFFENERS L3" x 2" x .25".
- FRAME 19 TRANSVERSE BOTTOM FRAME 36" x 4"FlgPlt x .3125" C/F.
- FRAME 19 TRANSVERSE BOTTOM FRAME STIFFENERS L3" x 2.5" x .25".

W = WEB / F = FLANGE.

VESSEL: M/V GUEMES

DESCRIPTION: No.1 VOID - BULKHEAD 20 VIEWED AS NOTED

DRAWN BY: G. GRAHAM

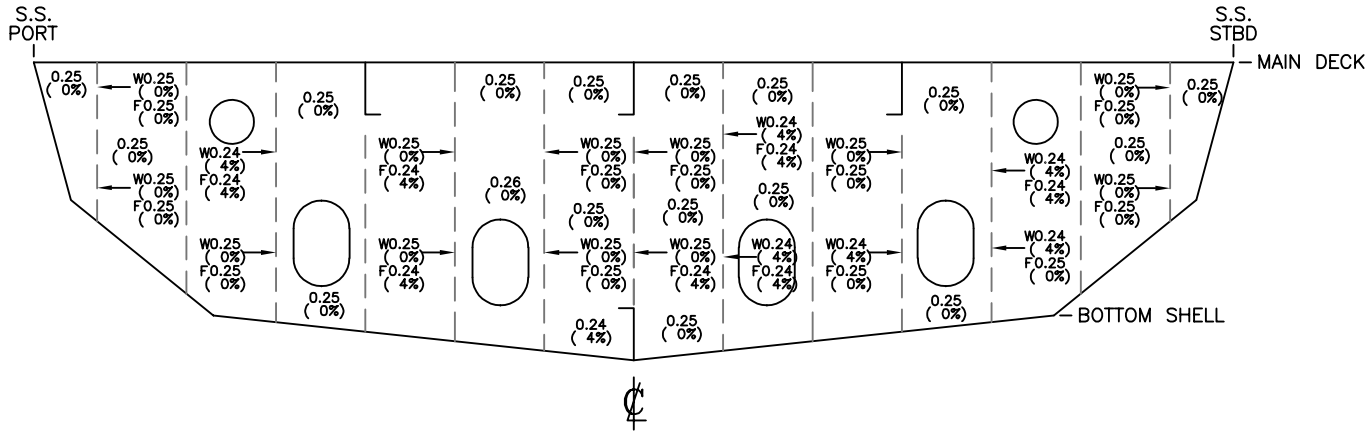
JOB # S3603

DWG # No1 BHD 20

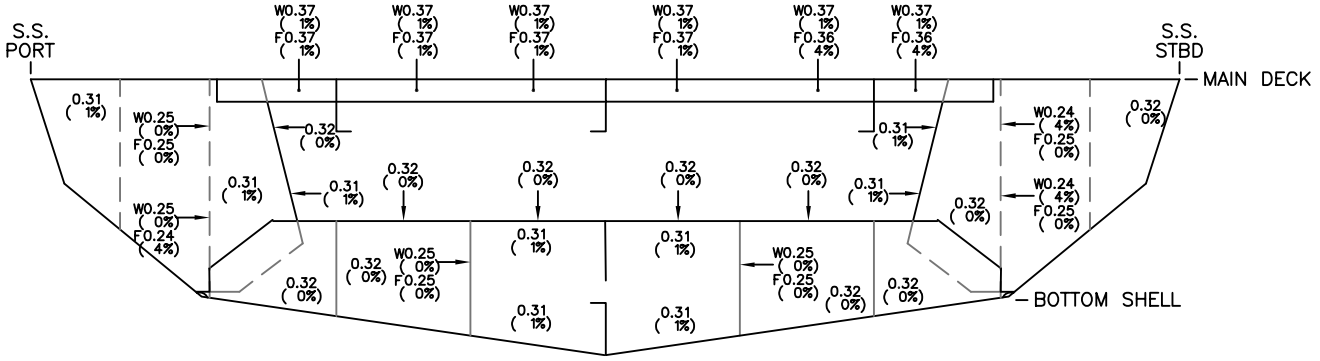
v1.1

DATE: MARCH 2019

INTERNATIONAL INSPECTION, INC.



FRAME 22



FRAME 23

NOTE:
- SWASH FRAME PLATING .25"
- SWASH FRAME STIFFENING L3" x 2.5" x .25".
- TRANSVERSE UNDER DECK FRAME L6" x 3.5 x .375".
- SIDE SHELL FRAME .3125" PLATE W/ 4" FLANGE.
- SIDE SHELL FRAME STIFFENERS L3" x 2" x .25".
- TRANSVERSE BOTTOM FRAME 36" x 4"FlgPlt x .3125" C/F.
- TRANSVERSE BOTTOM FRAME STIFFENERS L3" x 2.5" x .25".

W = WEB / F = FLANGE.

VESSEL: M/V GUEMES

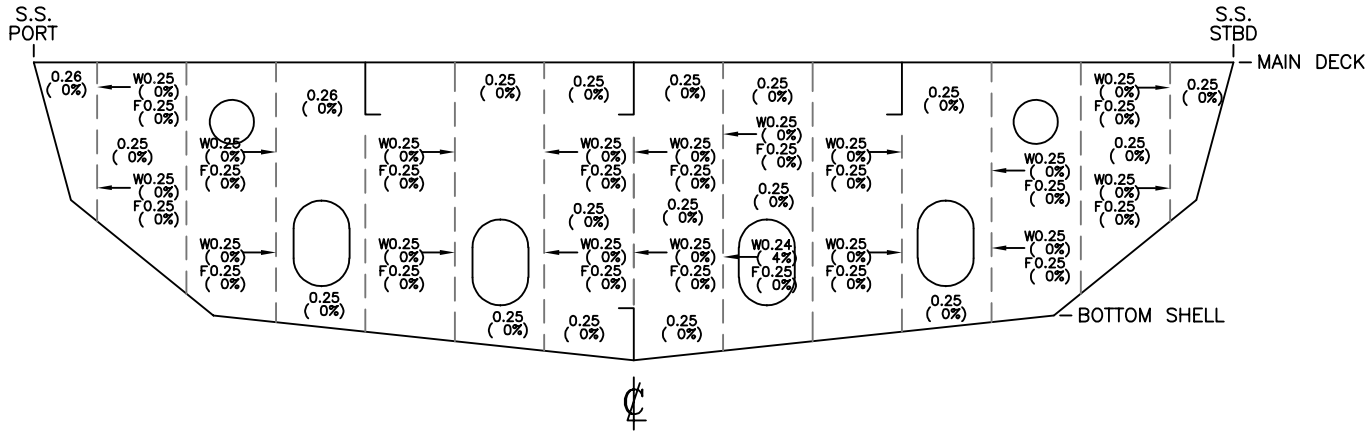
DESCRIPTION: No.1 VOID - FRAMES 22 & 23 LOOKING FORWARD

DRAWN BY: G. GRAHAM

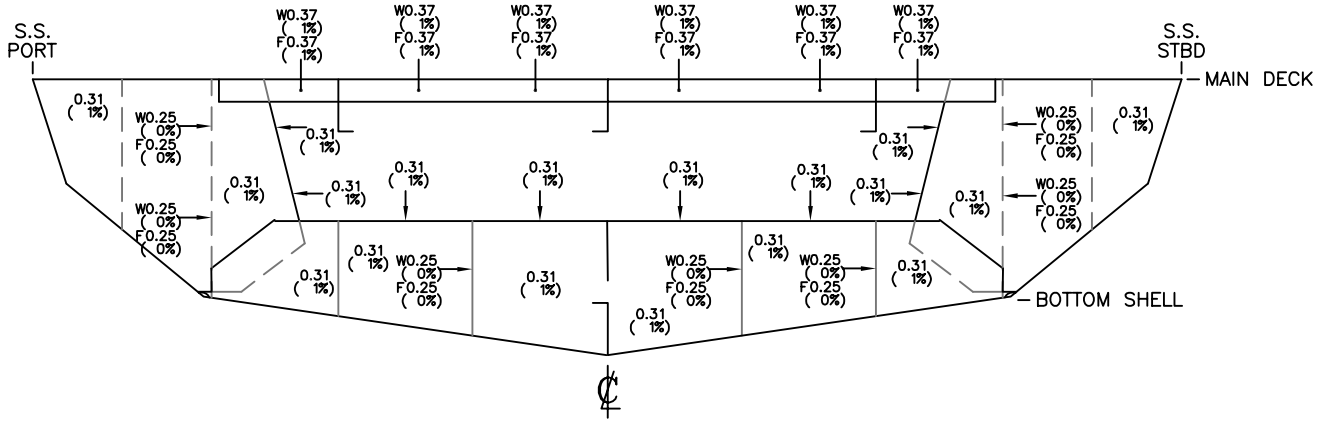
JOB # S3603

DWG # No1 FRM 22 23 v1.1

DATE: MARCH 2019



FRM 24



FRM 25

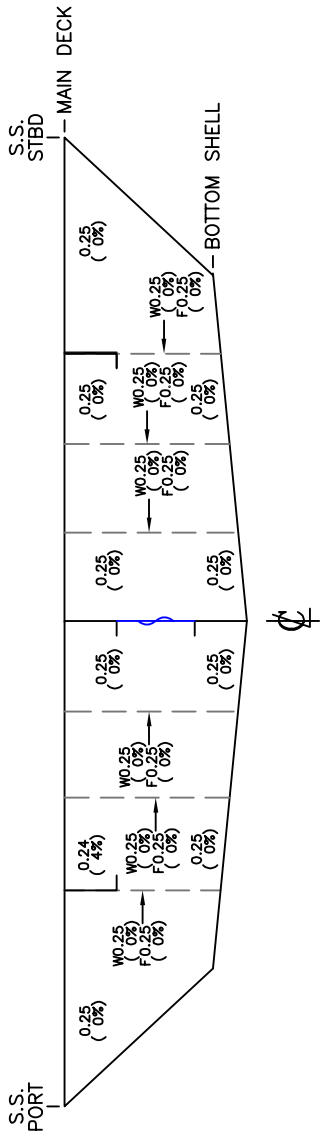
NOTE:
- SWASH FRAME PLATING .25"
- SWASH FRAME STIFFENING L3" x 2.5" x .25".
- TRANSVERSE UNDER DECK FRAME L6" x 3.5 x .375".
- SIDE SHELL FRAME .3125" PLATE W/ 4" FLANGE.
- SIDE SHELL FRAME STIFFENERS L3" x 2" x .25".
- TRANSVERSE BOTTOM FRAME 36" x 4"FlgPlt x .3125" C/F.
- TRANSVERSE BOTTOM FRAME STIFFENERS L3" x 2.5" x .25".

W = WEB / F = FLANGE.

VESSEL: M/V GUEMES

DESCRIPTION: No.1 VOID - FRAMES 24 & 25 LOOKING FORWARD

DRAWN BY: G. GRAHAM | JOB # S3603 | DWG # No1 FRM 24 25 v1.1 | DATE: MARCH 2019



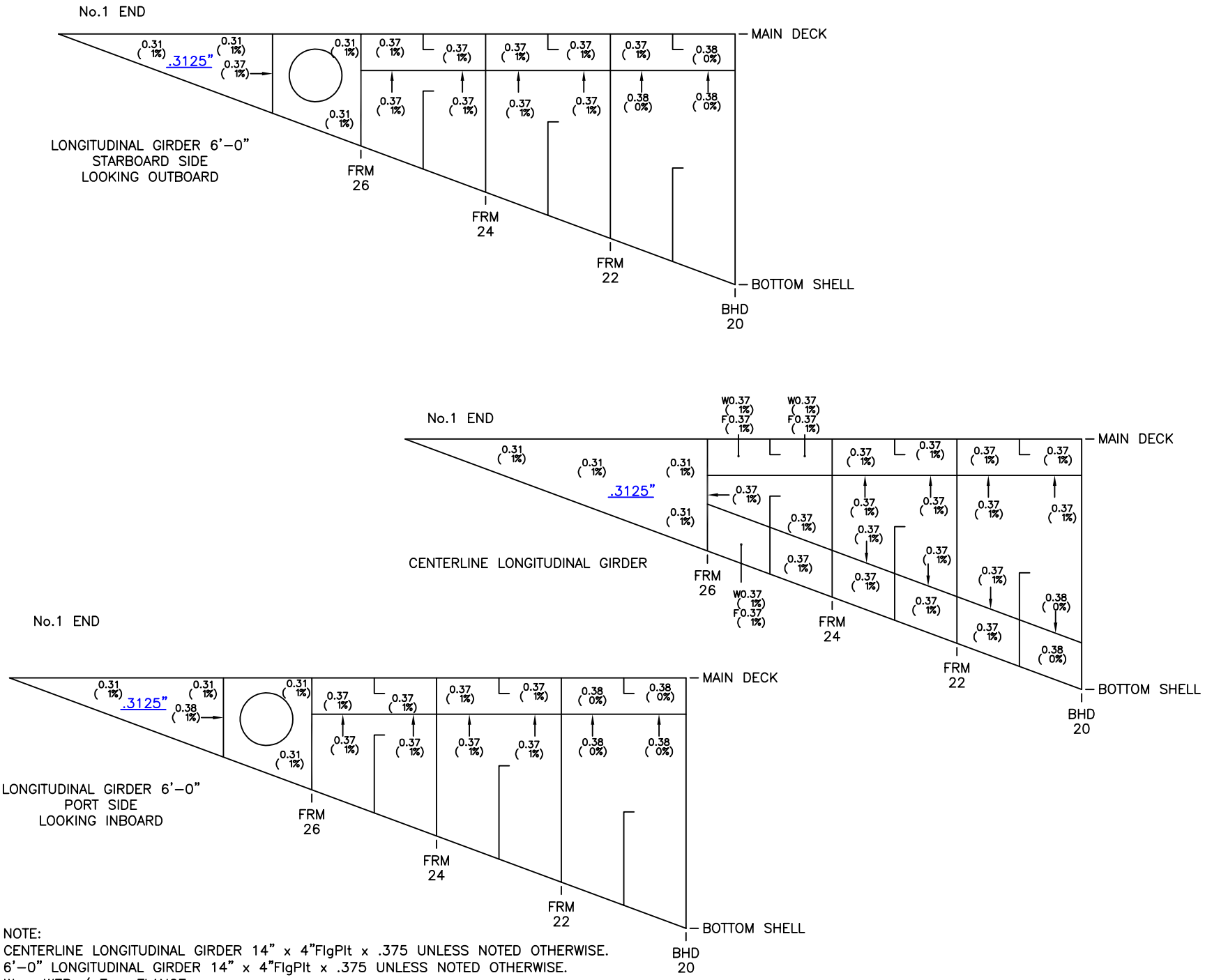
NOTE:
FRAME 26 PLATING .25".
FRAME 26 STIFFENING .25".
W = WEB / F = FLANGE.

VESSEL: M/V GUEMES		DESCRIPTION: No.1 VOID - FRAME 26 LOOKING FORWARD	
DRAWN BY: G. GRAHAM	JOB # S3603	DWG # No1 FRM 26 v1.1	DATE: MARCH 2019

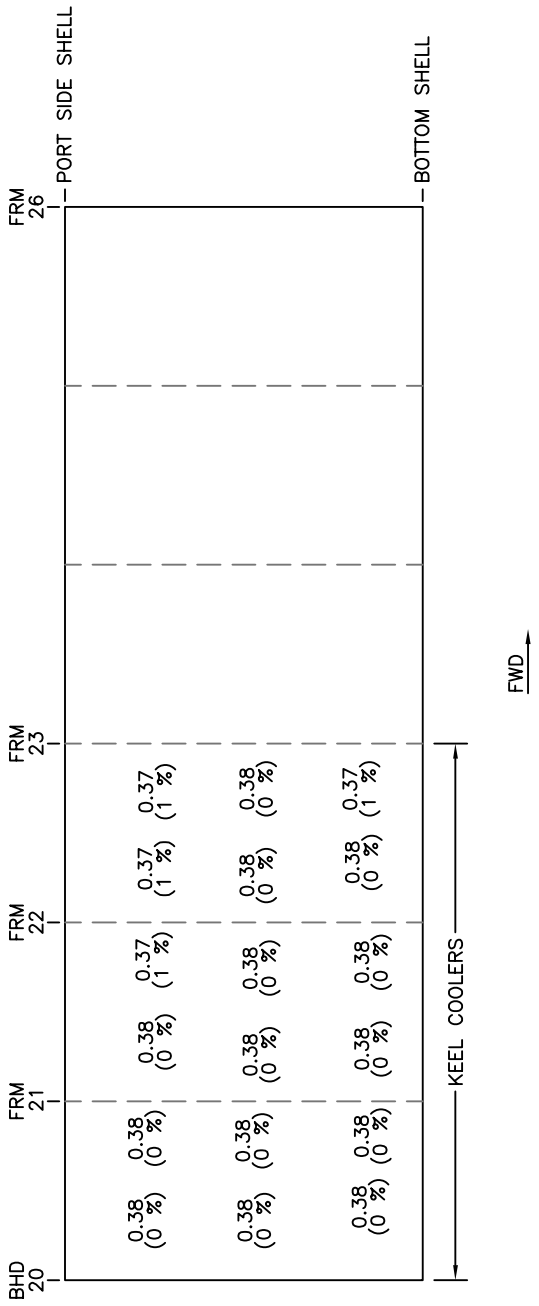
VESSEL: M/V GUEMES

DESCRIPTION: No.1 VOID - LONGITUDINAL GIRDERS VIEWED AS NOTED

DRAWN BY: G. GRAHAM | JOB # S3603 | DWG # No1 LGIR v1.1 | DATE: MARCH 2019



NOTE:
CENTERLINE LONGITUDINAL GIRDER 14" x 4"FlgPlt x .375 UNLESS NOTED OTHERWISE.
6'-0" LONGITUDINAL GIRDER 14" x 4"FlgPlt x .375 UNLESS NOTED OTHERWISE.
W = WEB / F = FLANGE.



NOTE:
NO ORIGINAL SCANTLINGS AVAILABLE AT TIME OF SURVEY.
NOMINAL THICKNESS MEASUREMENTS OBTAINED TO DETERMINE PERCENT WASTAGE.

NOMINAL THICKNESS USED:
– TURN OF BILGE PLATING .375"

VESSEL: M/V GUEMES	DESCRIPTION: No.1 VOID - PLATING IWO KEEL COOLERS PORT SIDE - PLAN VIEW
DRAWN BY: G. GRAHAM / JOB # S3603	DWG # No2 VOID BTM PLT v1.1 / DATE: MARCH 2019

INTERNATIONAL INSPECTION

Specialists in Nondestructive Examination

No.2 VOID INTERNALS

VESSEL: M/V GUEMES

DRAWN BY: G. GRAHAM

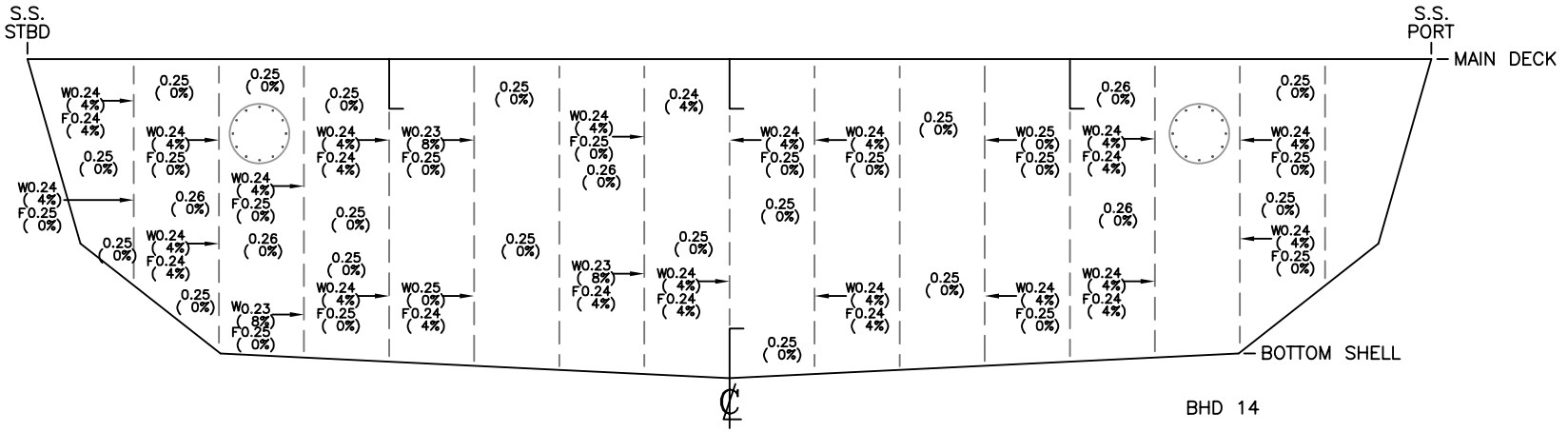
JOB # S3603

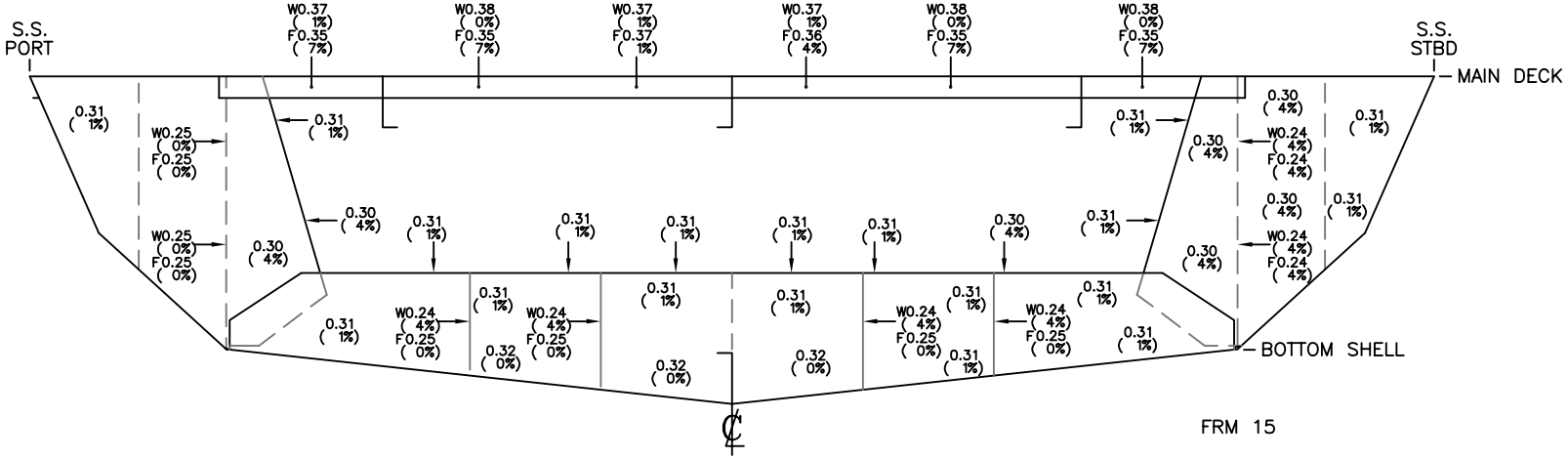
DWG # No2 BHD 14 FRM 15

v1.1

DESCRIPTION: No.2 VOID - BULKHEAD 14 & FRAME 15 LOOKING FORWARD

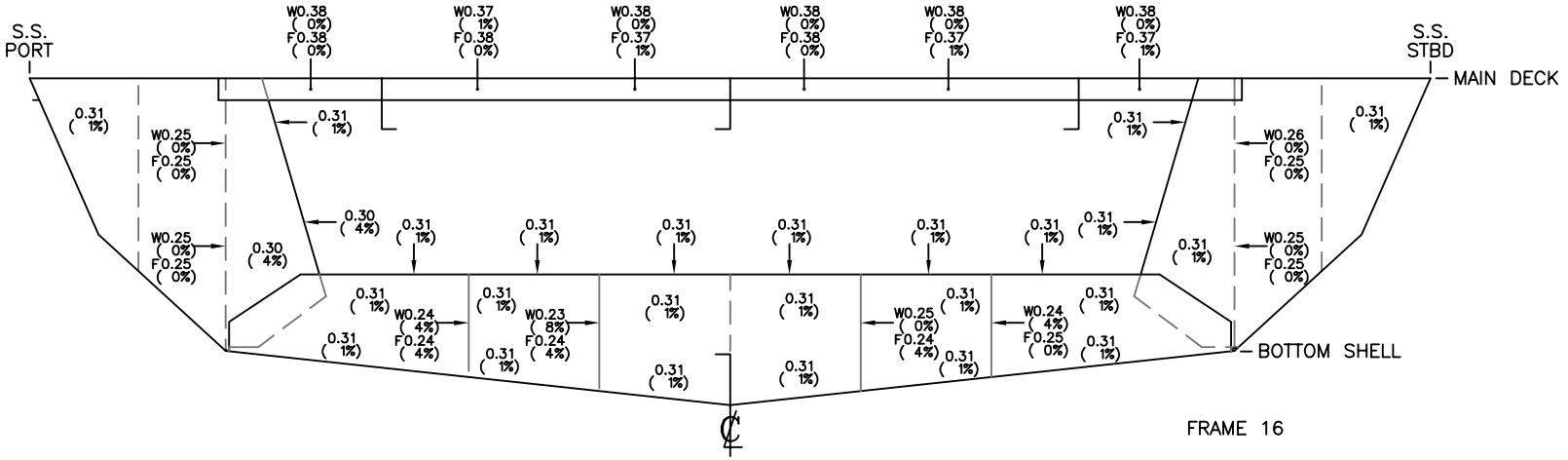
DATE: MARCH 2019



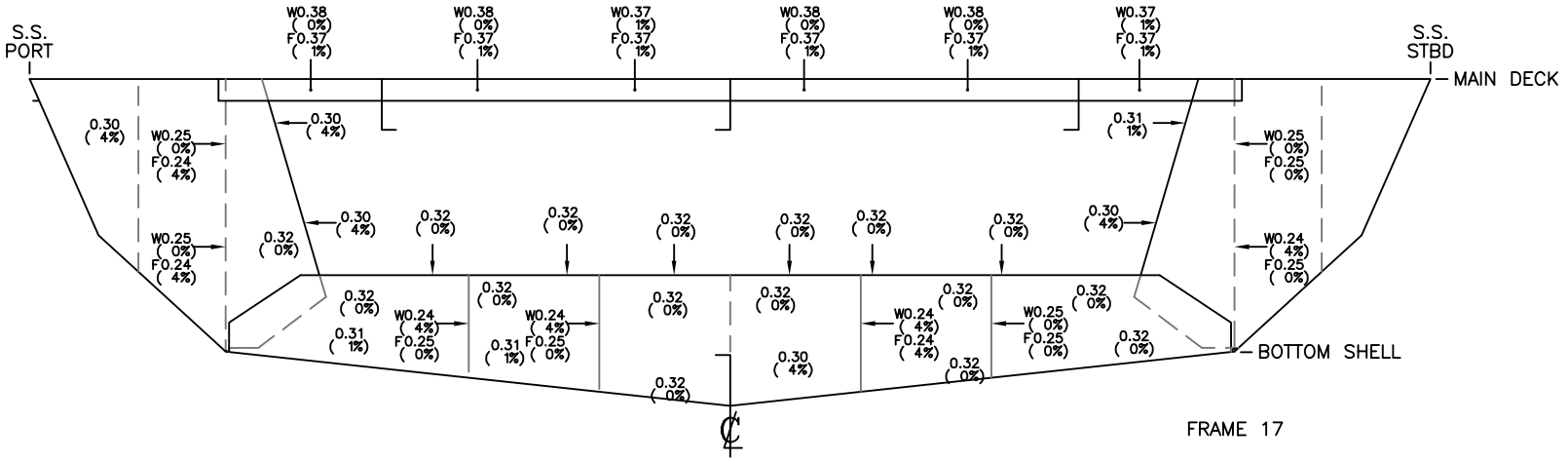


NOTE:
- BULKHEAD 14 PLATING .25".
- BULKHEAD 14 VERTICAL STIFFENERS L5" x 3" x .25".
- FRAME 15 TRANSVERSE UNDER DECK FRAME L6" x 3.5 x .375".
- FRAME 15 SIDE SHELL FRAME .3125" PLATE W/ 4" FLANGE.
- FRAME 15 SIDE SHELL FRAME STIFFENERS L3" x 2" x .25".
- FRAME 15 TRANSVERSE BOTTOM FRAME 36" x 4"FlgPlt x .3125" C/F.
- FRAME 15 TRANSVERSE BOTTOM FRAME STIFFENERS L3" x 2.5" x .25".

W = WEB / F = FLANGE.



FRAME 16



FRAME 17

NOTE:
- TRANSVERSE UNDER DECK FRAME L6" x 3.5 x .375".
- SIDE SHELL FRAME .3125" PLATE W/ 4" FLANGE.
- SIDE SHELL FRAME STIFFENERS L3" x 2" x .25".
- TRANSVERSE BOTTOM FRAME 36" x 4"FlgPlt x .3125" C/F.
- TRANSVERSE BOTTOM FRAME STIFFENERS L3" x 2.5" x .25".

W = WEB / F = FLANGE.

VESSEL: M/V GUEMES

DESCRIPTION: No.2 VOID - FRAME 16 & 17 LOOKING FORWARD

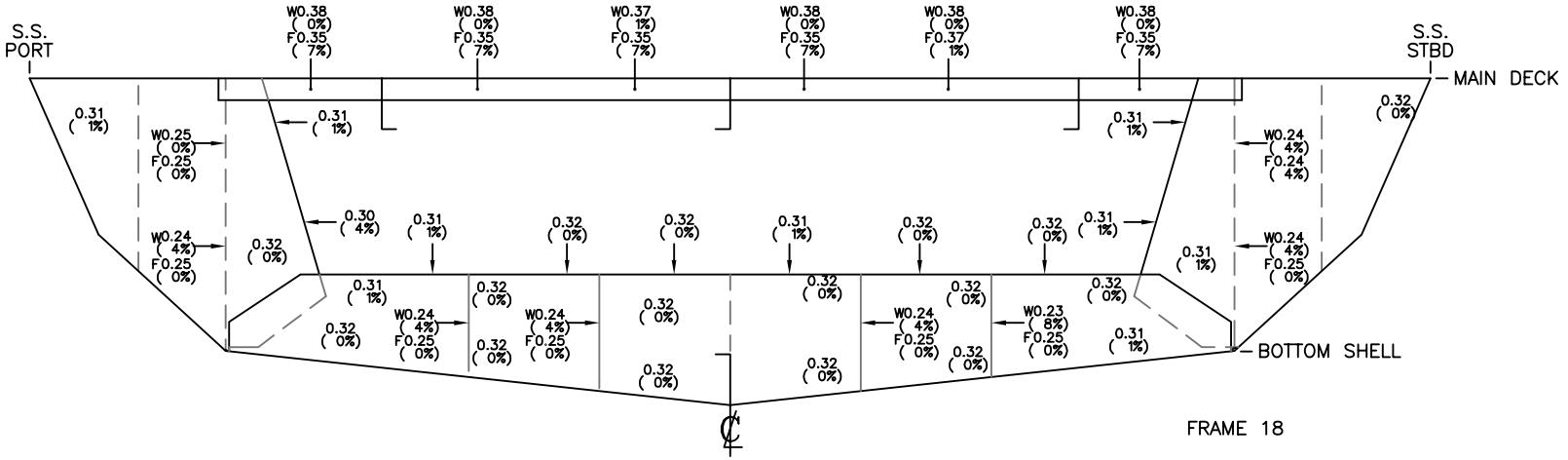
DRAWN BY: G. GRAHAM

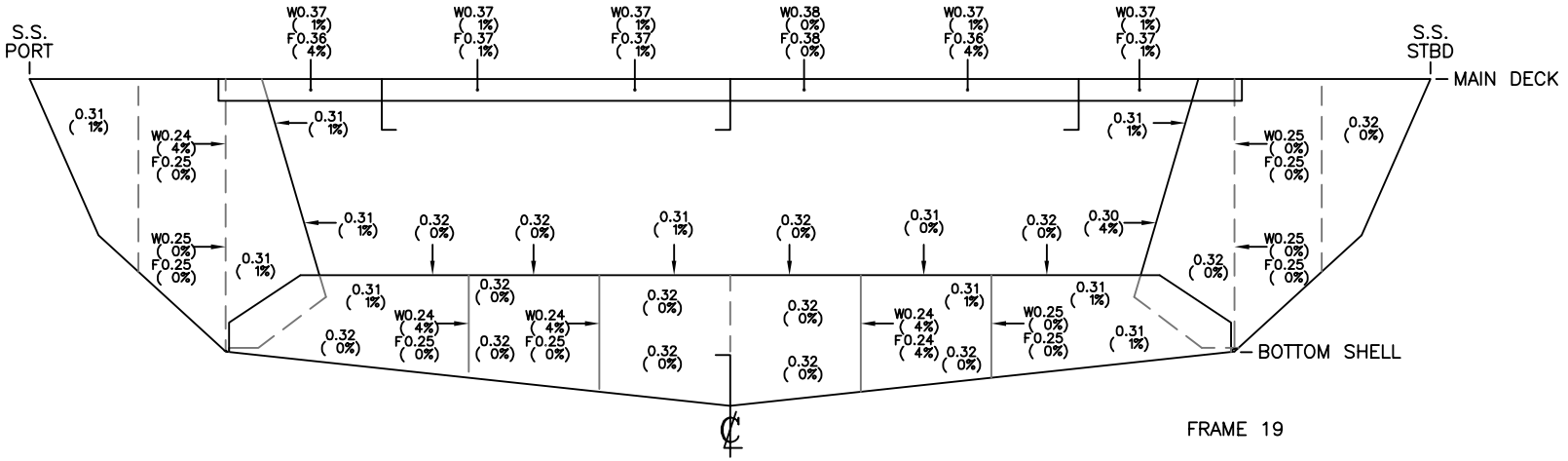
JOB # S3603

DWG # No2 FRM 16 17 v1.1

DATE: MARCH 2019

INTERNATIONAL INSPECTION, INC.





NOTE:
- SWASH FRAME PLATING .25"
- SWASH FRAME STIFFENING L3" x 2.5" x .25".
- TRANSVERSE UNDER DECK FRAME L6" x 3.5 x .375".
- SIDE SHELL FRAME .3125" PLATE W/ 4" FLANGE.
- SIDE SHELL FRAME STIFFENERS L3" x 2" x .25".
- TRANSVERSE BOTTOM FRAME 36" x 4"FlgPlt x .3125" C/F.
- TRANSVERSE BOTTOM FRAME STIFFENERS L3" x 2.5" x .25".

W = WEB / F = FLANGE.

VESSEL: M/V GUEMES

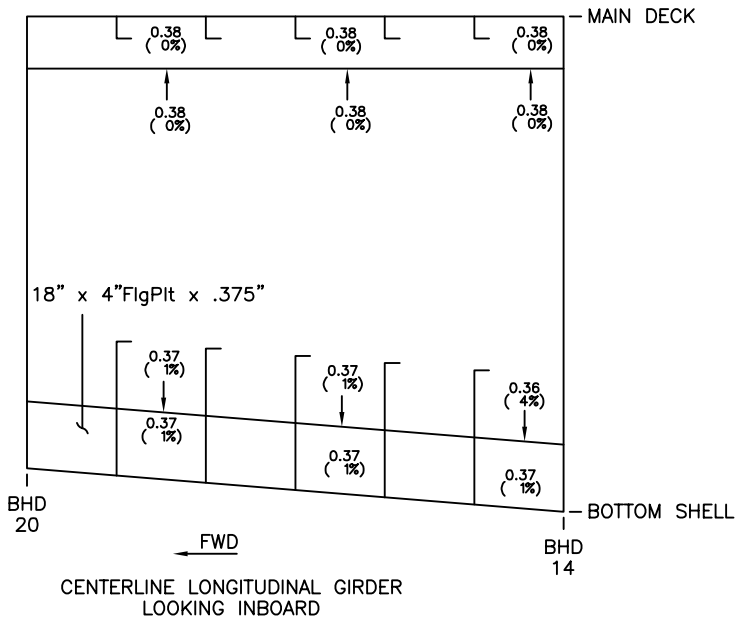
DESCRIPTION: No.2 VOID - FRAME 18 & 19 LOOKING FORWARD

DRAWN BY: G. GRAHAM

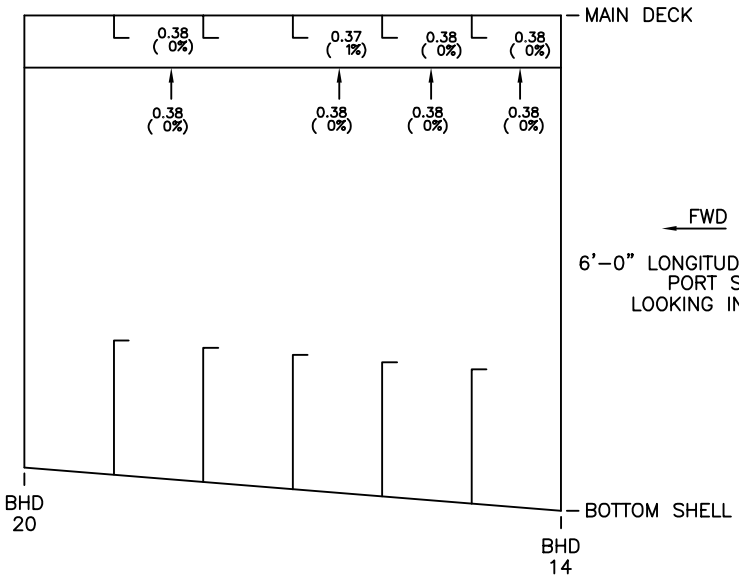
JOB # S3603

DWG # No2 FRM 16 17 v1.1

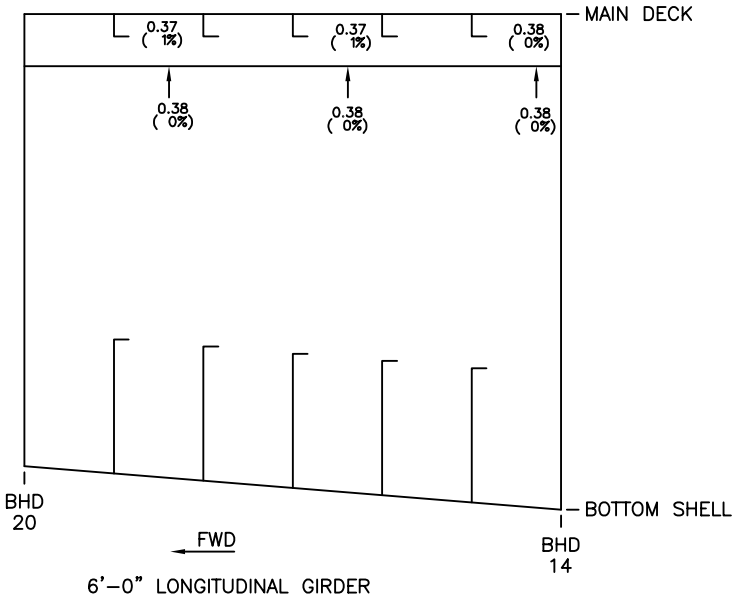
DATE: MARCH 2019



CENTERLINE LONGITUDINAL GIRDER
LOOKING INBOARD



6'–0" LONGITUDINAL GIRDER
PORT SIDE
LOOKING INBOARD



6'–0" LONGITUDINAL GIRDER
STARBOARD SIDE
LOOKING INBOARD

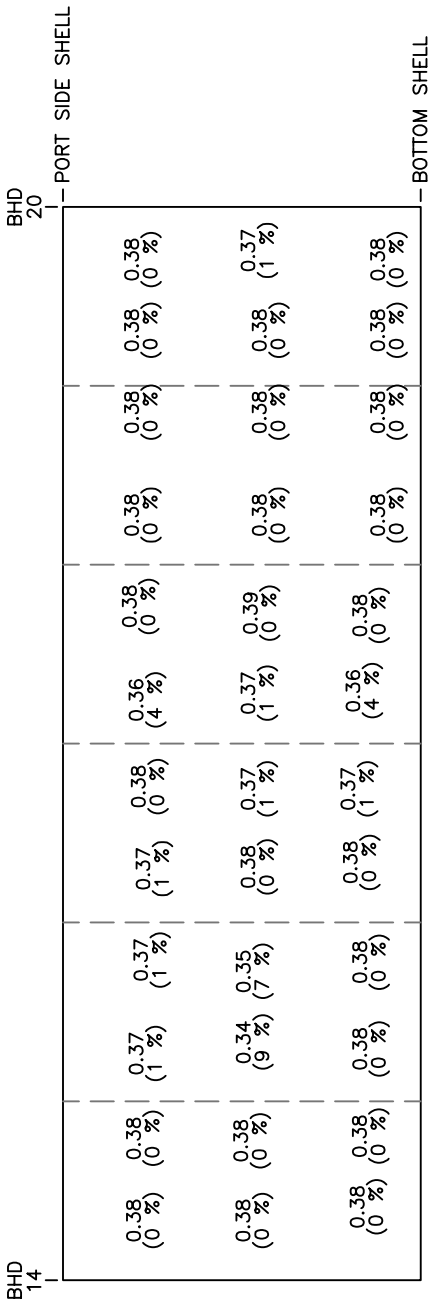
NOTE:
CENTERLINE LONGITUDINAL GIRDER 14" x 4"FlgPlt x .375 UNLESS NOTED OTHERWISE.
6'–0" LONGITUDINAL GIRDER 14" x 4"FlgPlt x .375 UNLESS NOTED OTHERWISE.
W = WEB / F = FLANGE.

VESSEL: M/V GUEMES

DESCRIPTION: No.2 VOID - LONGITUDINAL GIRDERS
VIEWED AS NOTED

DRAWN BY: G. GRAHAM
JOB # S3603
DWG # No2 LGIR
v1.1
DATE: MARCH 2019

INTERNATIONAL INSPECTION, INC.



NOTE:
NO ORIGINAL SCANTLINGS AVAILABLE AT TIME OF SURVEY.
NOMINAL THICKNESS MEASUREMENTS OBTAINED TO DETERMINE PERCENT WASTAGE.

NOMINAL THICKNESS USED:
– TURN OF BILGE PLATING .375"

VESSEL: M/V GUEMES		DESCRIPTION: No.2 VOID - PLATING IWO KEEL COOLERS PORT SIDE - PLAN VIEW	
DRAWN BY: G. GRAHAM	JOB # S3603	DWG # No2 VOID BTM PLT v1.1	DATE: MARCH 2019

INTERNATIONAL INSPECTION

Specialists in Nondestructive Examination

No.3 VOID INTERNALS

VESSEL: M/V GUEMES

DRAWN BY: T.HENSON

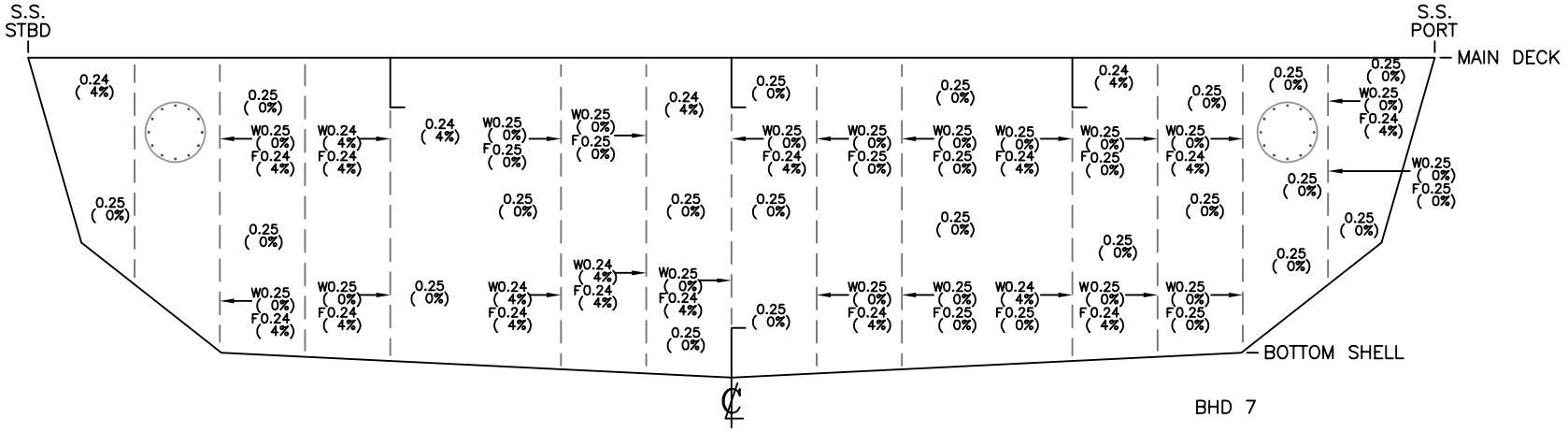
JOB # S3603

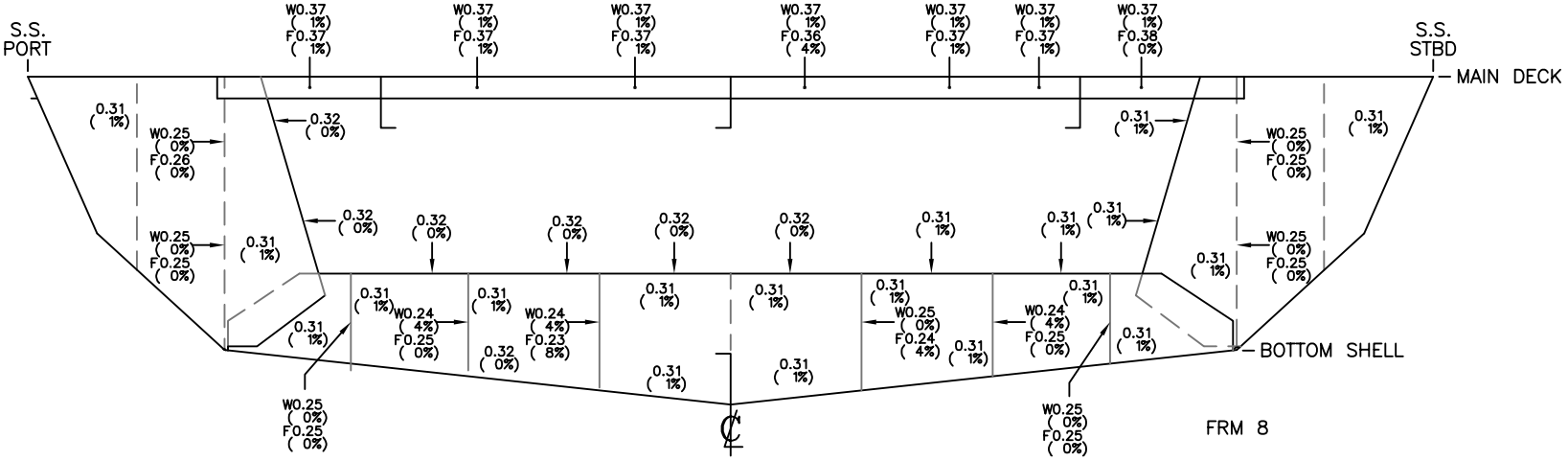
DWG # No33 BHD 7 FRM 8

v1.1

DATE: MARCH 2019

DESCRIPTION: No.3 VOID - BHD7 & FRAME 8 LOOKING FORWARD





NOTE:
- BULKHEAD 7 PLATING .25".
- BULKHEAD 7 VERTICAL STIFFENERS L5" x 3" x .25".
- FRAME 8 TRANSVERSE UNDER DECK FRAME L6" x 3.5 x .375".
- FRAME 8 SIDE SHELL FRAME .3125" PLATE W/ 4" FLANGE.
- FRAME 8 SIDE SHELL FRAME STIFFENERS L3" x 2" x .25".
- FRAME 8 TRANSVERSE BOTTOM FRAME 36" x 4"FlgPlt x .3125" C/F.
- FRAME 8 TRANSVERSE BOTTOM FRAME STIFFENERS L3" x 2.5" x .25".

W = WEB / F = FLANGE.

VESSEL: M/V GUEMES

DESCRIPTION: No.3 VOID - FRAME 9 & 10
LOOKING FORWARD

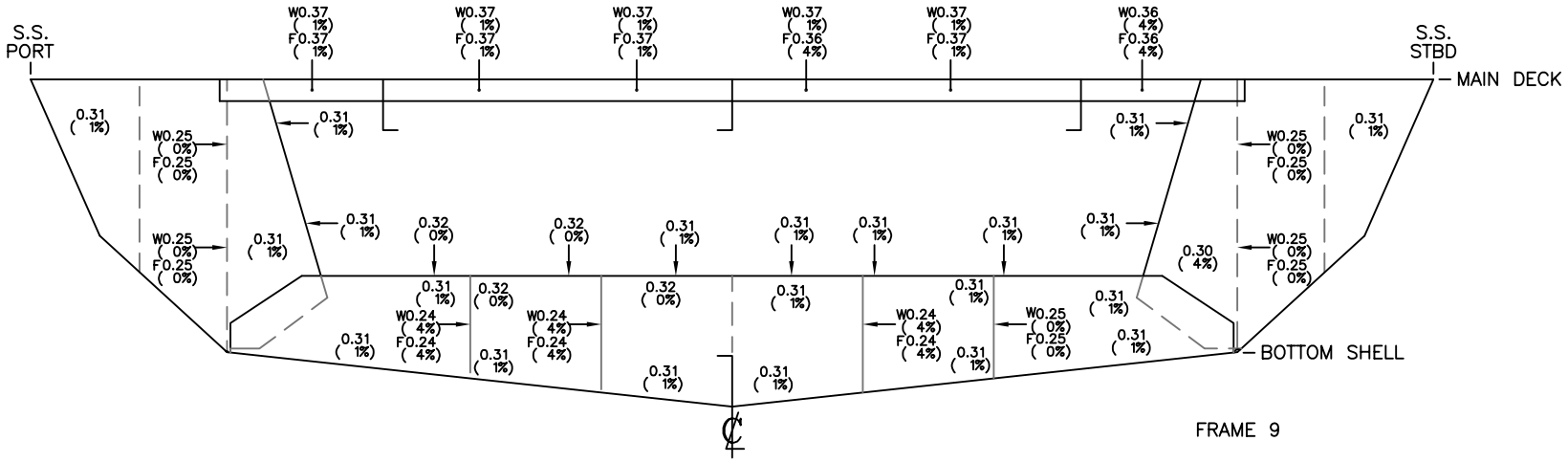
DRAWN BY: T.HENSON

JOB # S3603

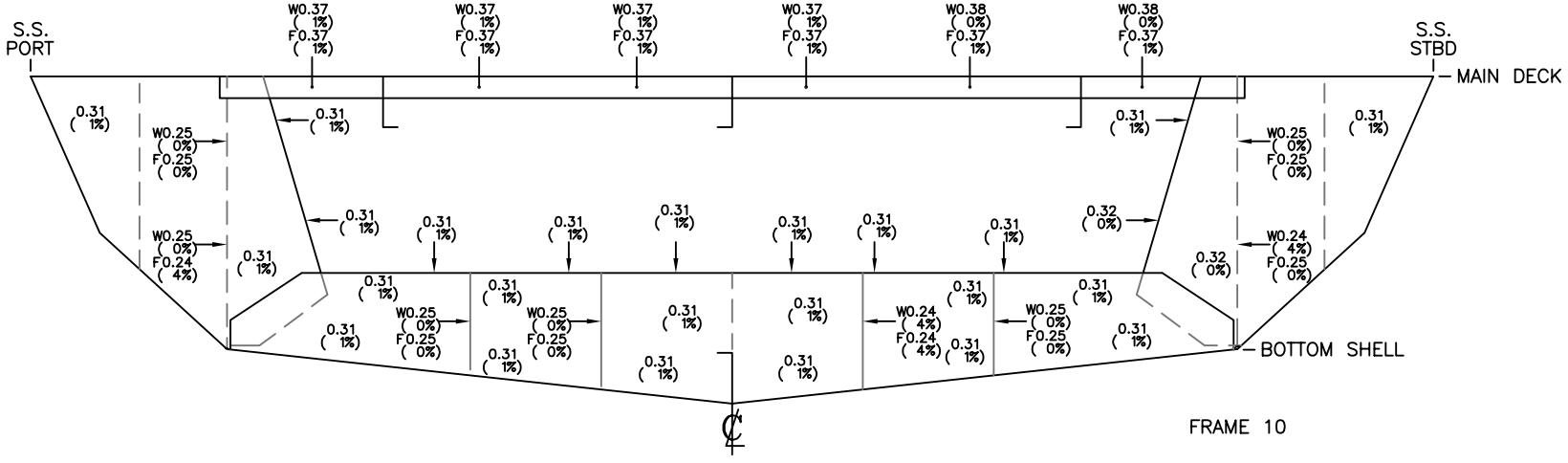
DWG # No3 FRM 9 10

v1.1

DATE: MARCH 2019



FRAME 9



FRAME 10

NOTE:
- TRANSVERSE UNDER DECK FRAME L6" x 3.5 x .375".
- SIDE SHELL FRAME .3125" PLATE W/ 4" FLANGE.
- SIDE SHELL FRAME STIFFENERS L3" x 2" x .25".
- TRANSVERSE BOTTOM FRAME 36" x 4"FlgPlt x .3125" C/F.
- TRANSVERSE BOTTOM FRAME STIFFENERS L3" x 2.5" x .25".

W = WEB / F = FLANGE.

VESSEL: M/V GUEMES

DESCRIPTION: No.3 VOID - FRAME 11 & 12
LOOKING FORWARD

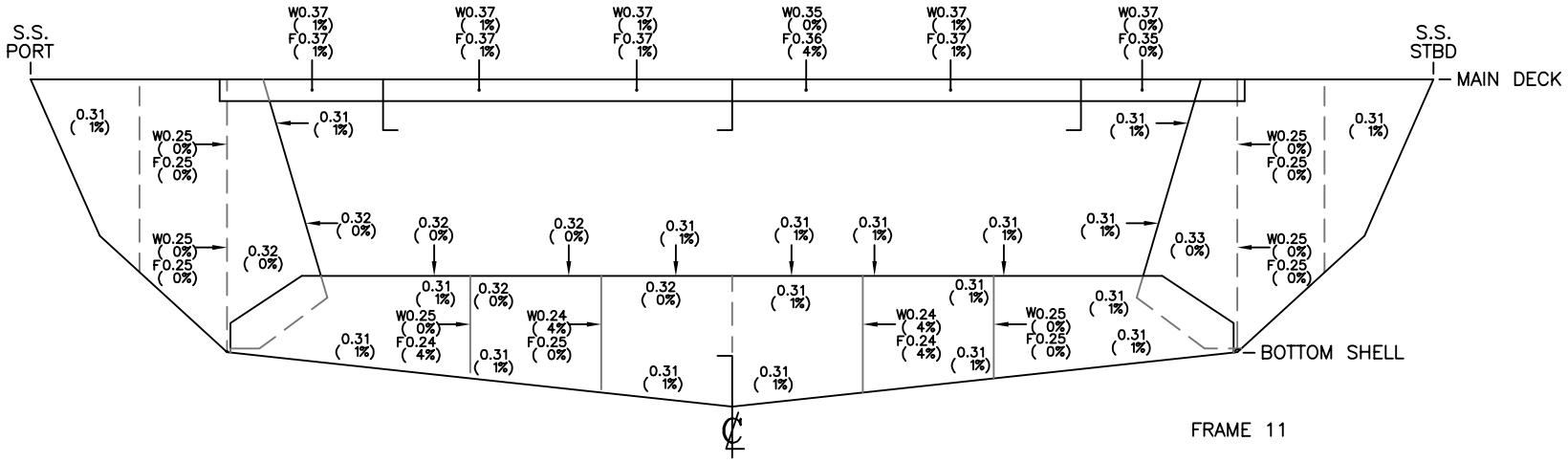
DRAWN BY: T.HENSON

JOB # S3603

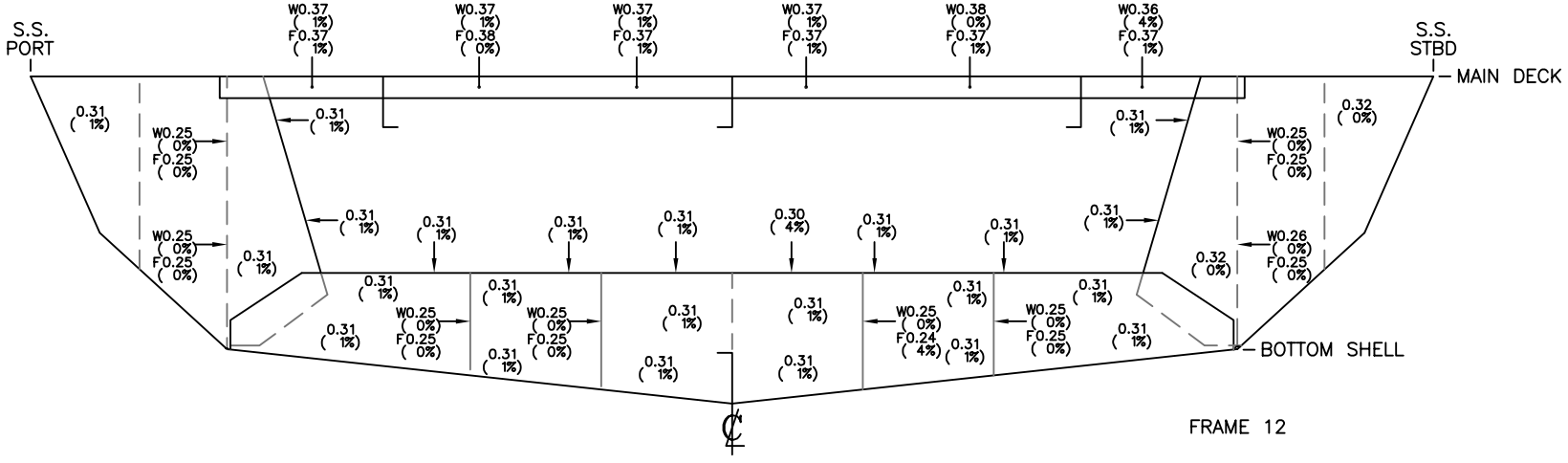
DWG # No3 FRM 11 12

v1.1

DATE: MARCH 2019



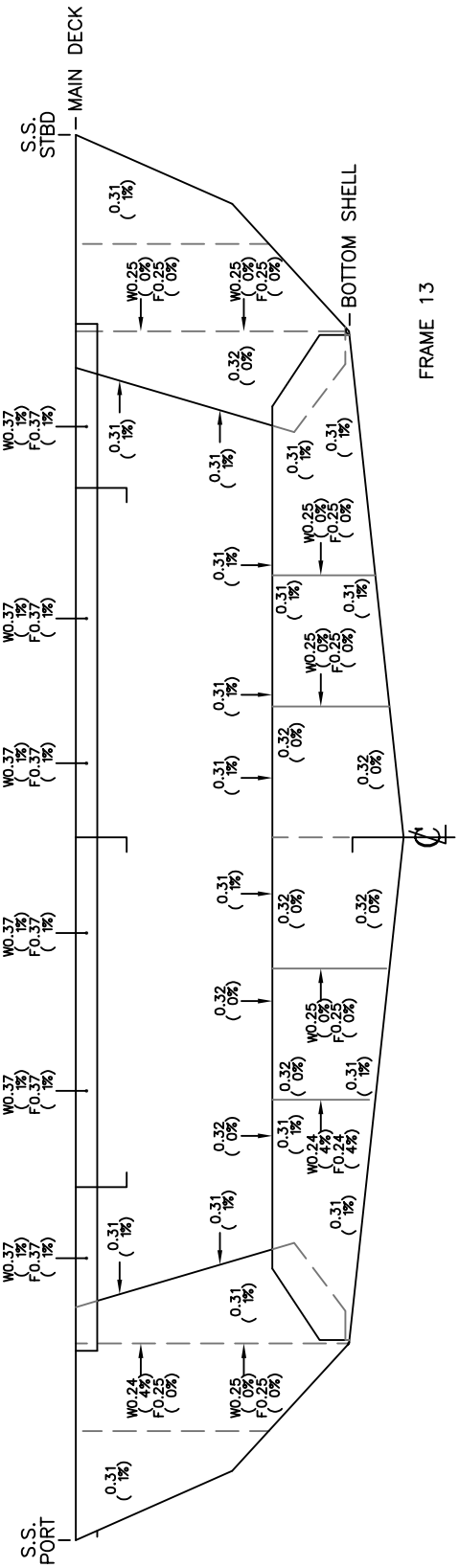
FRAME 11



FRAME 12

NOTE:
- TRANSVERSE UNDER DECK FRAME L6" x 3.5 x .375".
- SIDE SHELL FRAME .3125" PLATE W/ 4" FLANGE.
- SIDE SHELL FRAME STIFFENERS L3" x 2" x .25".
- TRANSVERSE BOTTOM FRAME 36" x 4"FlgPlt x .3125" C/F.
- TRANSVERSE BOTTOM FRAME STIFFENERS L3" x 2.5" x .25".

W = WEB / F = FLANGE.



NOTE:
- TRANSVERSE UNDER DECK FRAME L6" x 3.5 x .375".
- SIDE SHELL FRAME .3125" PLATE W/ 4" FLANGE.
- SIDE SHELL FRAME STIFFENERS L3" x 2" x .25".
- TRANSVERSE BOTTOM FRAME 36" x 4"FlgPlt x .3125" C/F.
- TRANSVERSE BOTTOM FRAME STIFFENERS L3" x 2.5" x .25".

W = WEB / F = FLANGE.

VESSEL: M/V GUEMES		No.3 VOID - FRAME 13 DESCRIPTION: LOOKING FORWARD	
DRAWN BY: T.HENSON	JOB # S3603	DWG # No3 FRM 13 v1.1	DATE: MARCH 2019

CENTERLINE LONGITUDINAL GIRDER
LOOKING INBOARD

6'–0" LONGITUDINAL GIRDER
PORT SIDE
LOOKING INBOARD

6'–0" LONGITUDINAL GIRDER
STARBOARD SIDE
LOOKING INBOARD

NOTE:
CENTERLINE LONGITUDINAL GIRDER 14" x 4"FlgPlt x .375 UNLESS NOTED OTHERWISE.
6'–0" LONGITUDINAL GIRDER 14" x 4"FlgPlt x .375 UNLESS NOTED OTHERWISE.
W = WEB / F = FLANGE.

VESSEL: M/V GUEMES

DESCRIPTION: No.3 VOID - LONGITUDINAL GIRDERS
VIEWED AS NOTED

DRAWN BY: G. GRAHAM

JOB # S3603

DWG # No3 LGIR

v1.1

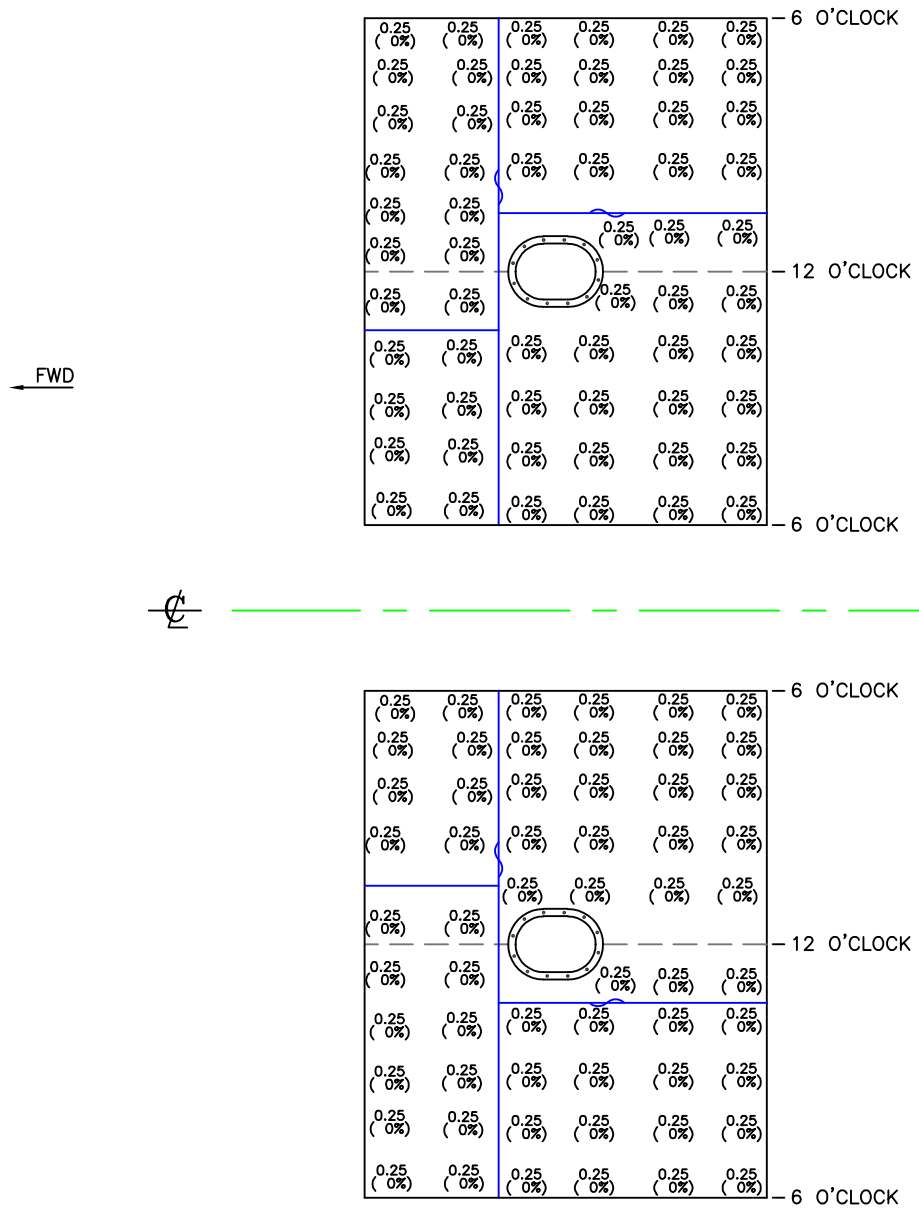
DATE: MARCH 2019

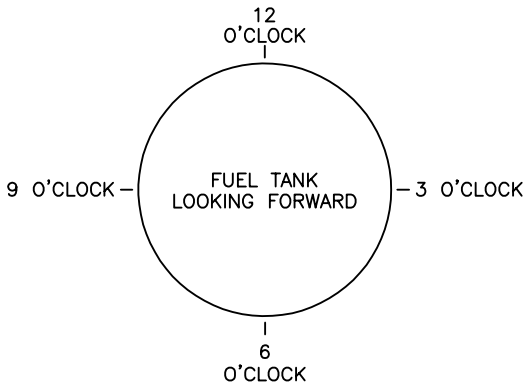
INTERNATIONAL INSPECTION, INC.

VESSEL: M/V GUEMES

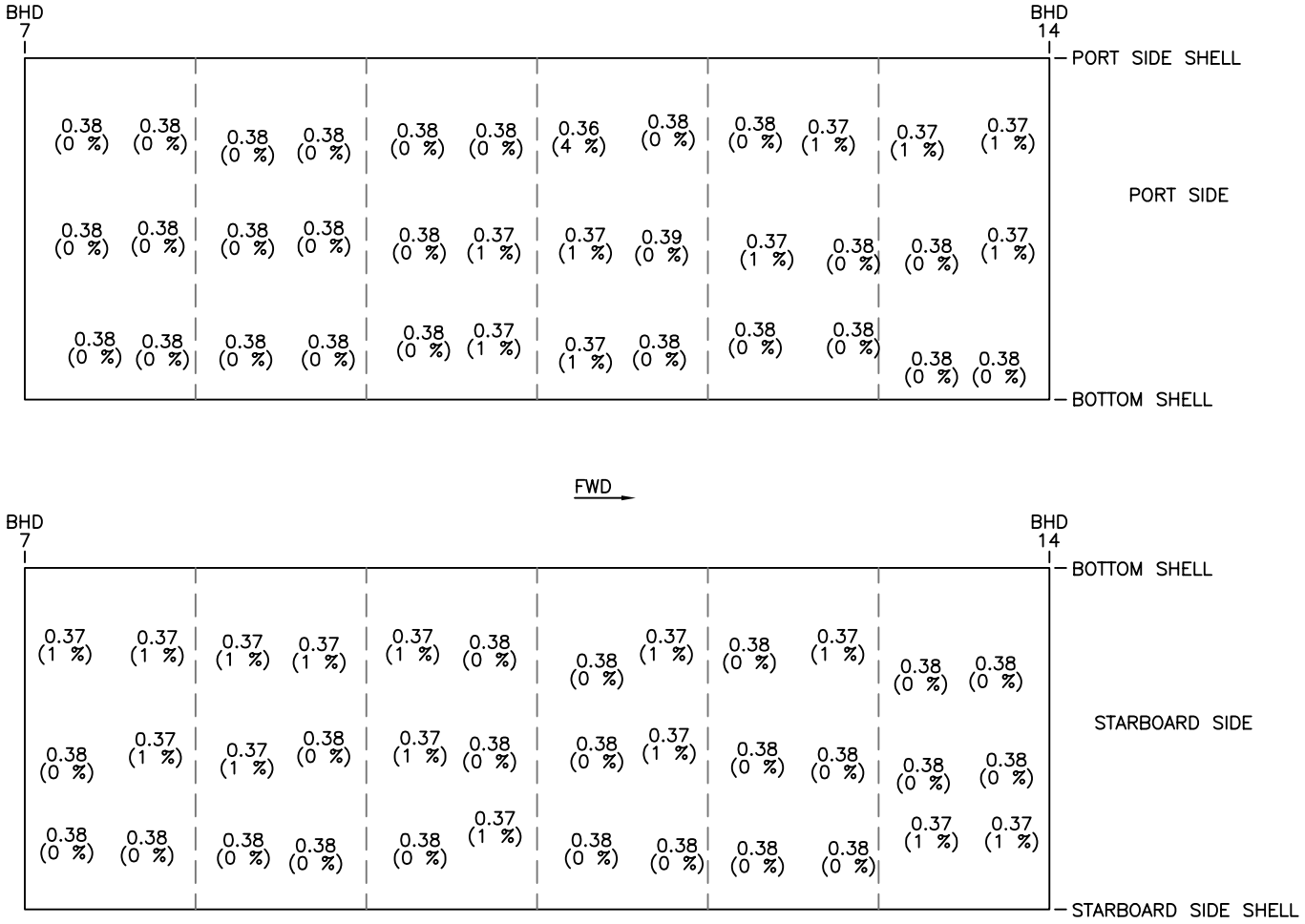
DESCRIPTION: No.3 VOID - FUEL OIL TANKS
VIEWED AS NOTED

DRAWN BY: G. GRAHAM | JOB # S3603 | DWG # No3 FOT v1.1 | DATE: MARCH 2019





NOTE:
FUEL TANK PLATING .25".



NOTE:
NO ORIGINAL SCANTLINGS AVAILABLE AT TIME OF SURVEY.
NOMINAL THICKNESS MEASUREMENTS OBTAINED TO DETERMINE PERCENT WASTAGE.

NOMINAL THICKNESS USED:
– TURN OF BILGE PLATING .375"

VESSEL: M/V GUEMES

DESCRIPTION: No.3 VOID - PLATING IWO KEEL COOLERS
PLAN VIEW

DRAWN BY: G. GRAHAM

JOB # S3603

DWG # No3 VOID BTM PLT

v1.1

DATE: MARCH 2019

INTERNATIONAL INSPECTION, INC.

INTERNATIONAL INSPECTION

Specialists in Nondestructive Examination

No.4 VOID INTERNALS

VESSEL: M/V GUEMES

DESCRIPTION: No.4 VOID - FRAME 1 & 2 LOOKING FORWARD

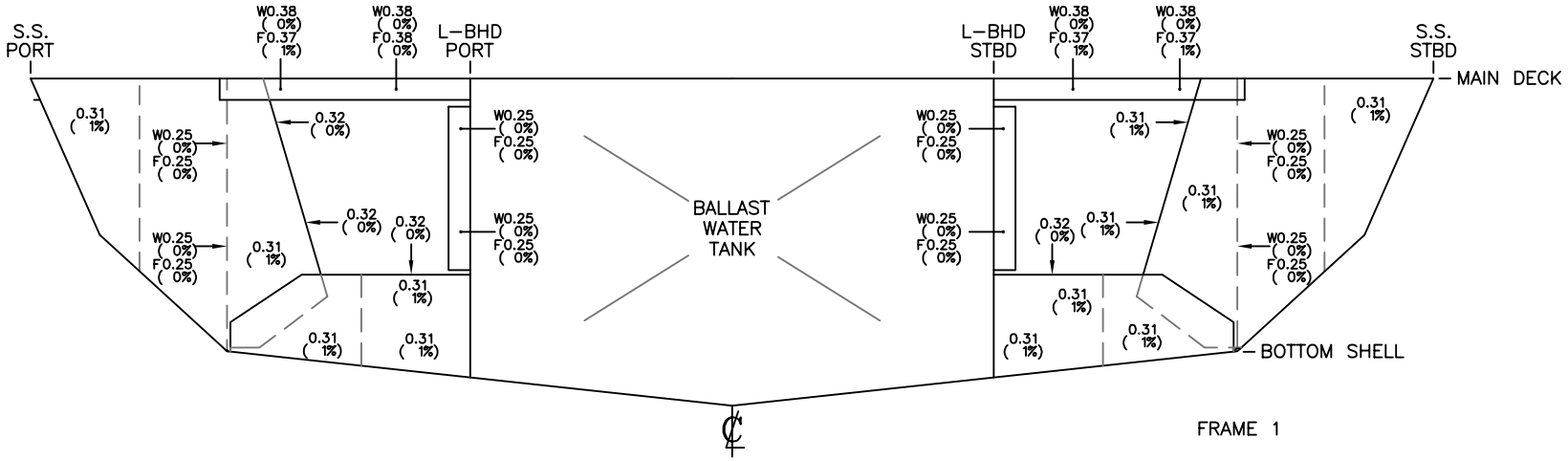
DRAWN BY: T.HENSON

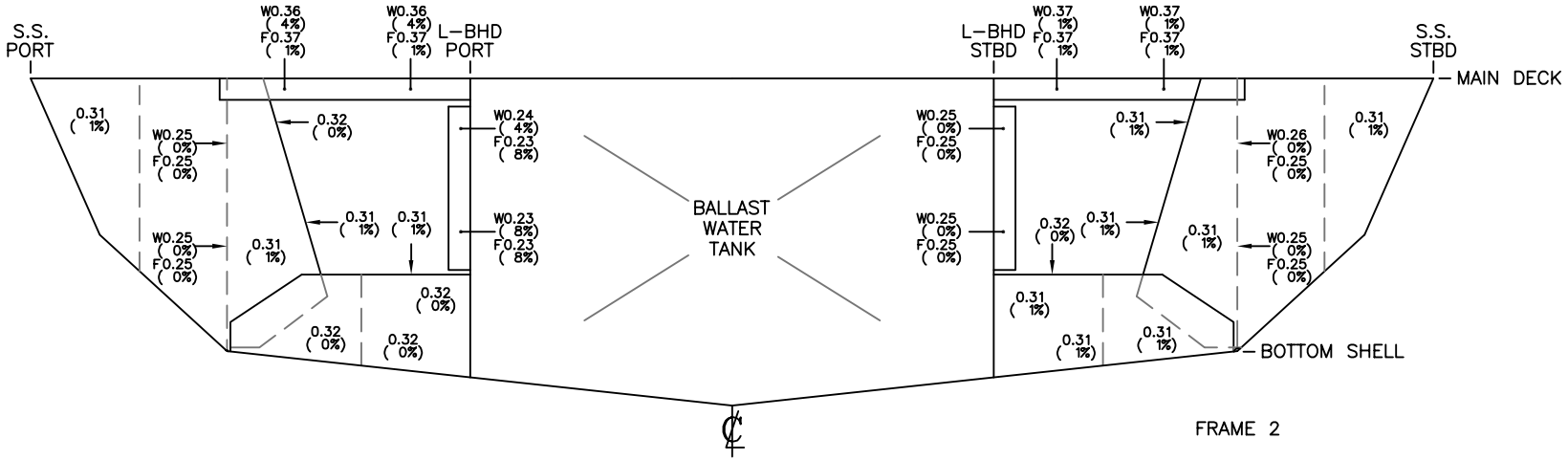
JOB # S3603

DWG # No4 FRM 1 2

v1.1

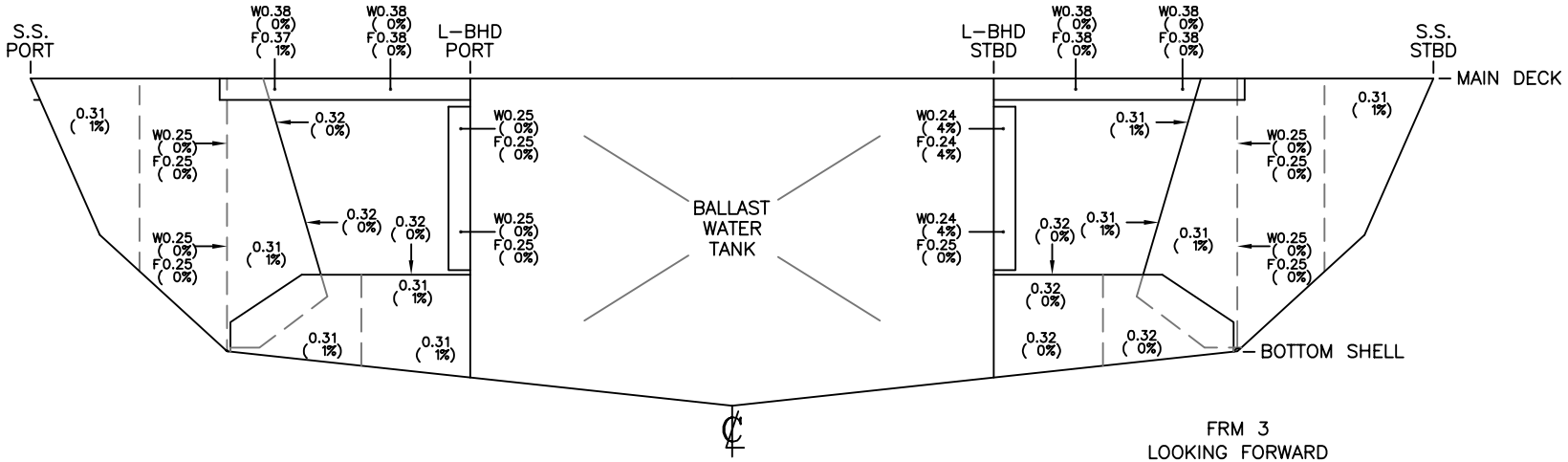
DATE: MARCH 2019

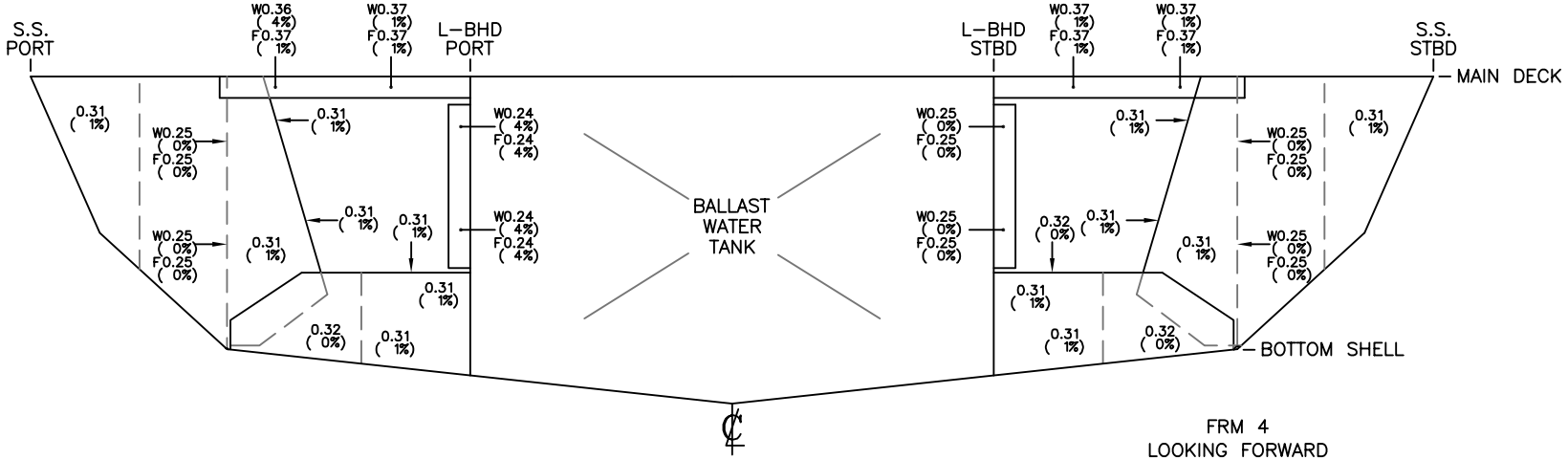




NOTE:
- TRANSVERSE UNDER DECK FRAME L6" x 3.5 x .375".
- LONGITUDINAL BULKHEAD STIFFENERS L5" x 3" x .25".
- SIDE SHELL FRAME .3125" PLATE W/ 4" FLANGE.
- SIDE SHELL FRAME STIFFENERS L3" x 2" x .25".
- TRANSVERSE BOTTOM FRAME 36" x 4"FlgPlt x .3125" C/F.

W = WEB / F = FLANGE.





NOTE:
- TRANSVERSE UNDER DECK FRAME L6" x 3.5 x .375".
- LONGITUDINAL BULKHEAD STIFFENERS L5" x 3" x .25".
- SIDE SHELL FRAME .3125" PLATE W/ 4" FLANGE.
- SIDE SHELL FRAME STIFFENERS L3" x 2" x .25".
- TRANSVERSE BOTTOM FRAME 36" x 4"FlgPlt x .3125" C/F.

W = WEB / F = FLANGE.

VESSEL: M/V GUEMES

DESCRIPTION: No.4 VOID - FRAME 3 & 4 LOOKING FORWARD

DRAWN BY: T.HENSON

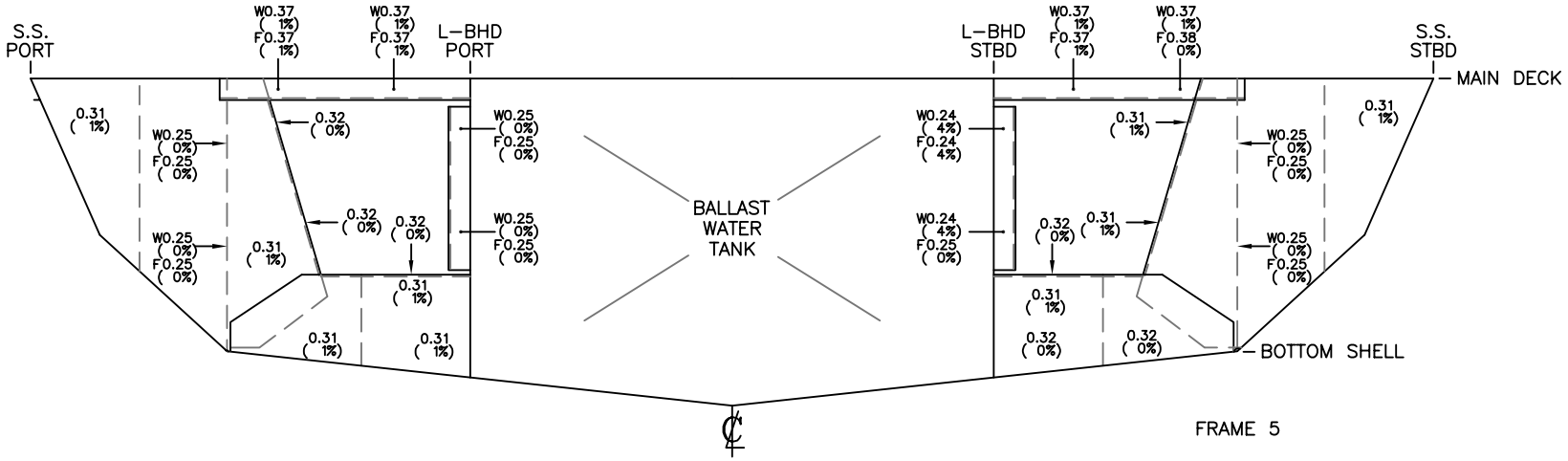
JOB # S3603

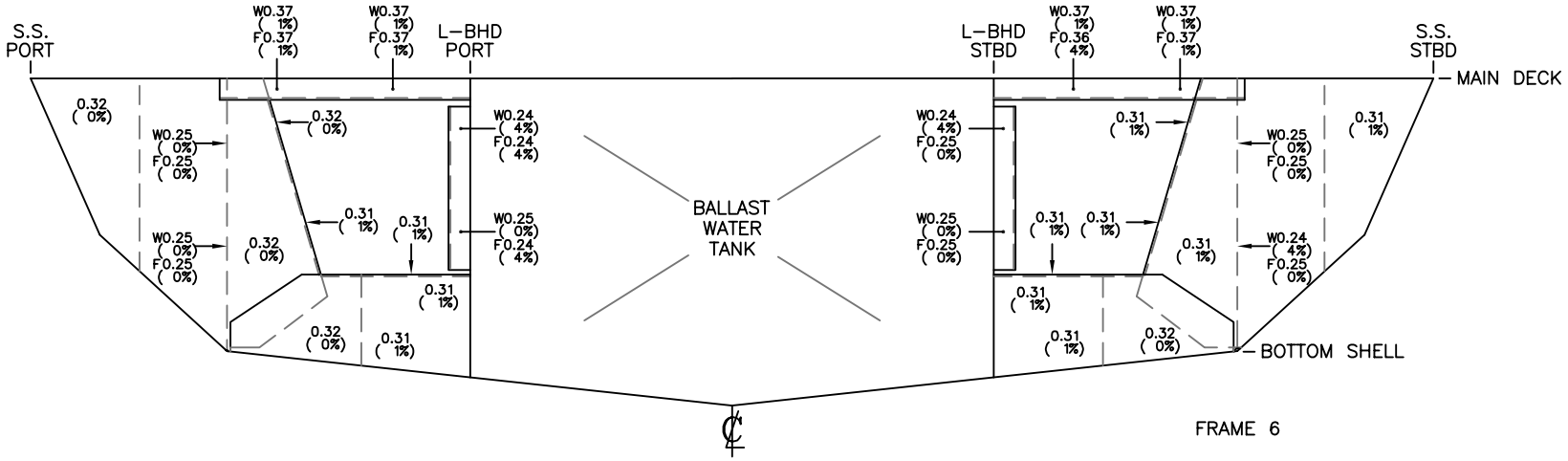
DWG # No4 FRM 3 4

v1.1

DATE: MARCH 2019

INTERNATIONAL INSPECTION, INC.





NOTE:
- TRANSVERSE UNDER DECK FRAME L6" x 3.5 x .375".
- LONGITUDINAL BULKHEAD STIFFENERS L5" x 3" x .25".
- SIDE SHELL FRAME .3125" PLATE W/ 4" FLANGE.
- SIDE SHELL FRAME STIFFENERS L3" x 2" x .25".
- TRANSVERSE BOTTOM FRAME 36" x 4"FlgPlt x .3125" C/F.

W = WEB / F = FLANGE.

VESSEL: M/V GUEMES

DESCRIPTION: No. VOID - FRAME 5 & 6 LOOKING FORWARD

DRAWN BY: T.HENSON

JOB # S3603

DWG # No4 FRM 5 6

v1.1

DATE: MARCH 2019

NOTE:
6'–0" LONGITUDINAL BULKHEAD PLATING .3125"

VESSEL: M/V GUEMES

DESCRIPTION: No.4 VOID - 6'-0" LONGITUDINAL BULKHEAD LOOKING INBOARD

DRAWN BY: G. GRAHAM

JOB # S3603

DWG # No4 VOID LBHD

v1.1

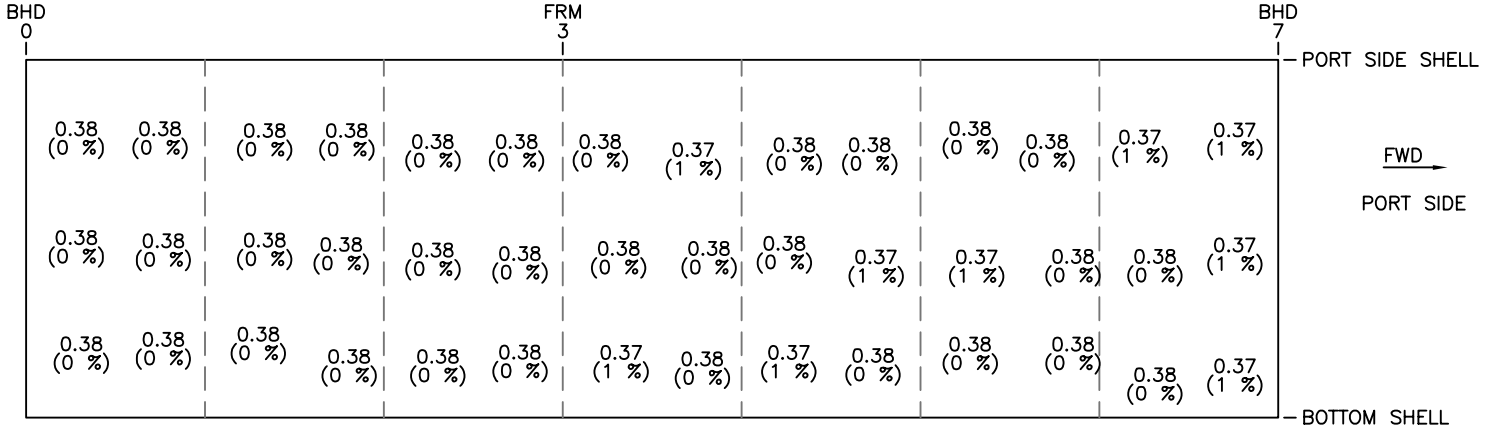
DATE: MARCH 2019

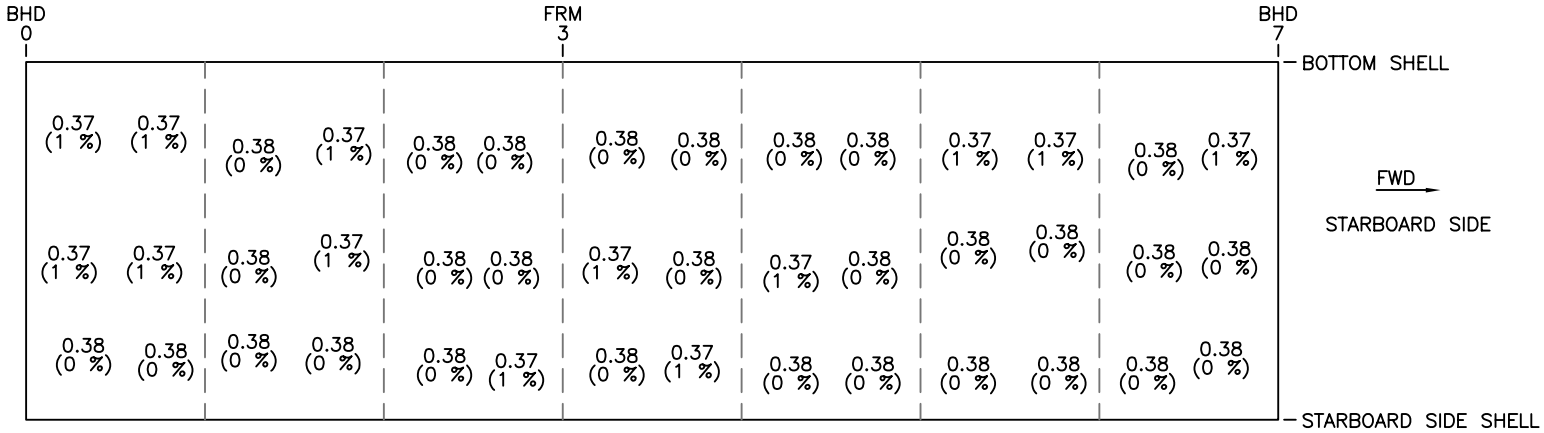
INTERNATIONAL INSPECTION, INC.

VESSEL: M/V GUEMES

DESCRIPTION: No.4 VOID - PLATING IWO KEEL COOLERS

DRAWN BY: G. GRAHAM | JOB # S3603 | DWG # No4 VOID BTM PLT v1.1 | DATE: MARCH 2019





NOTE:
NO ORIGINAL SCANTLINGS AVAILABLE AT TIME OF SURVEY.
NOMINAL THICKNESS MEASUREMENTS OBTAINED TO DETERMINE PERCENT WASTAGE.

NOMINAL THICKNESS USED:
– TURN OF BILGE PLATING .375"

INTERNATIONAL INSPECTION

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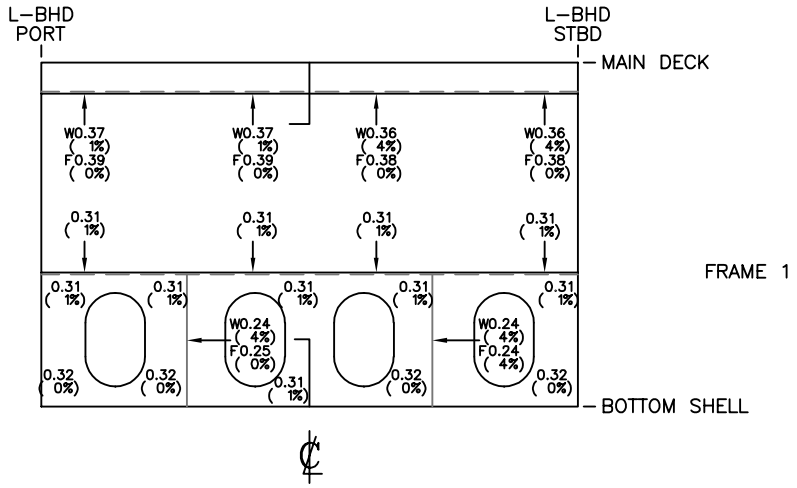
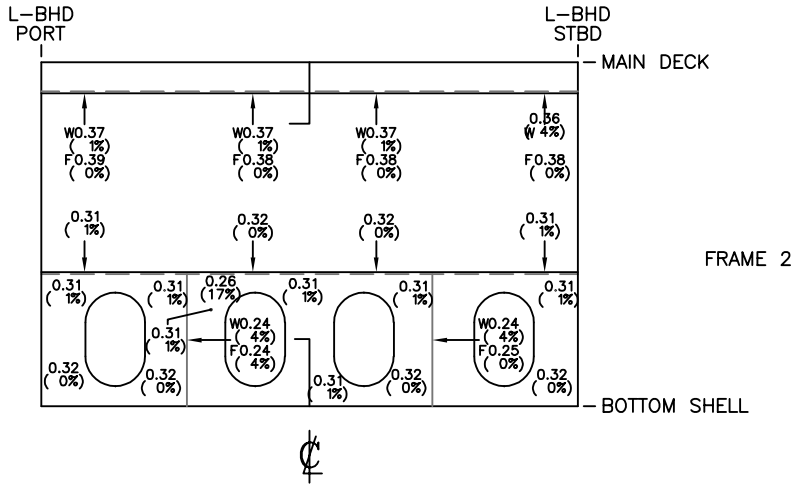
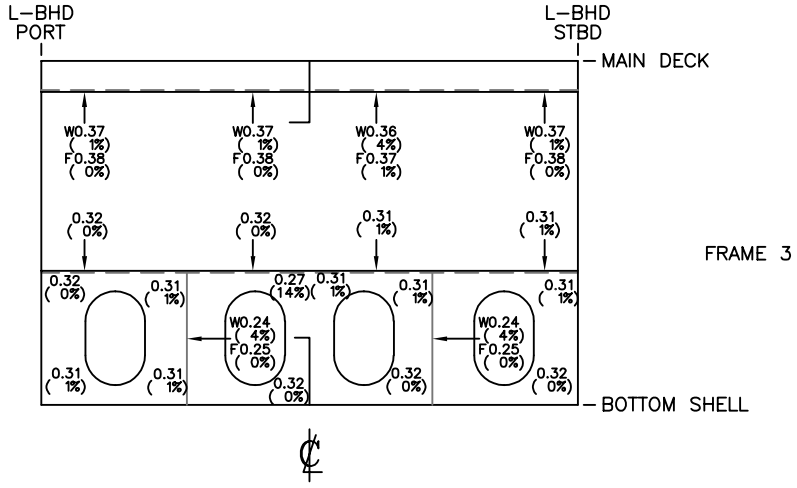
No.1 END BALLAST WATER TANK INTERNALS



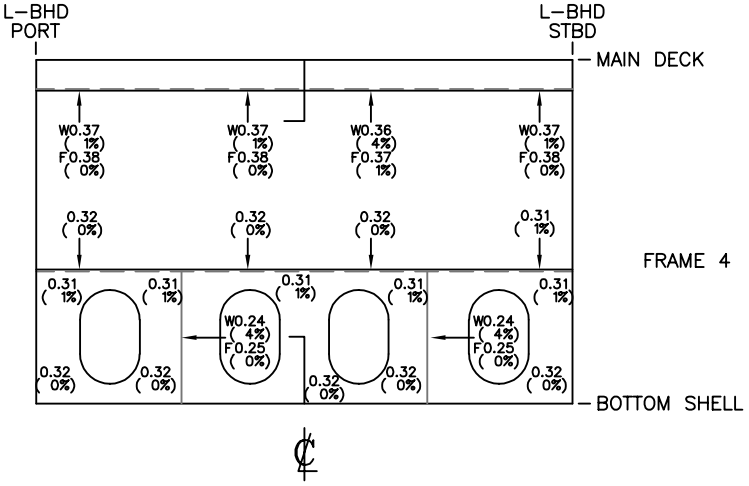


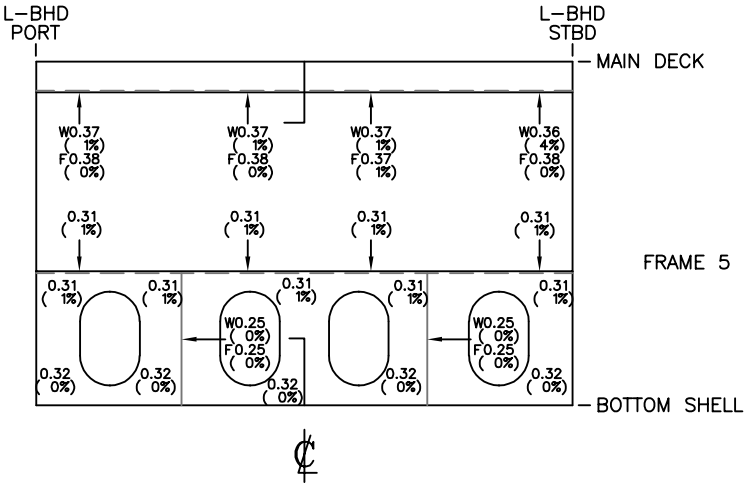


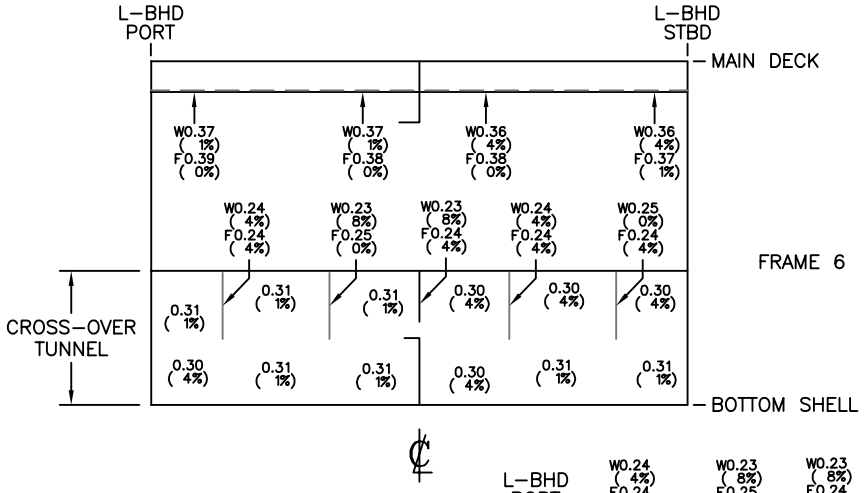
NOTE:
- UNDER DECK TRANSVERSE FRAME L6" x 3.5" x .375"
- BOTTOM TRANSVERSE FRAME 36" x 4"FlgPlt x .3125".
- FRAME VERTICAL STIFFENERS L3" x 2.5" x .25".

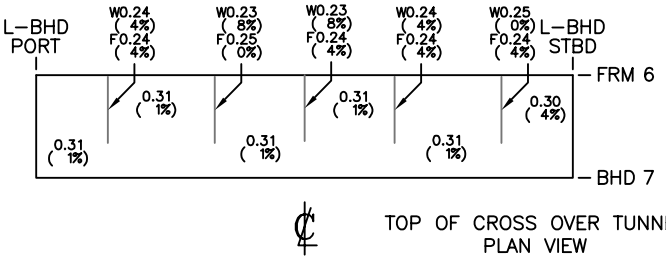
W = WEB / F = FLANGE.

VESSEL: M/V GUEMES	DESCRIPTION: No.1 END BALLAST WATER Tk - FRAMES 1-3 LOOKING FORWARD
DRAWN BY: G. GRAHAM / JOB # S3603	DWG # No1 END BWT FRMS 1 v1.1 / DATE: MARCH 2019







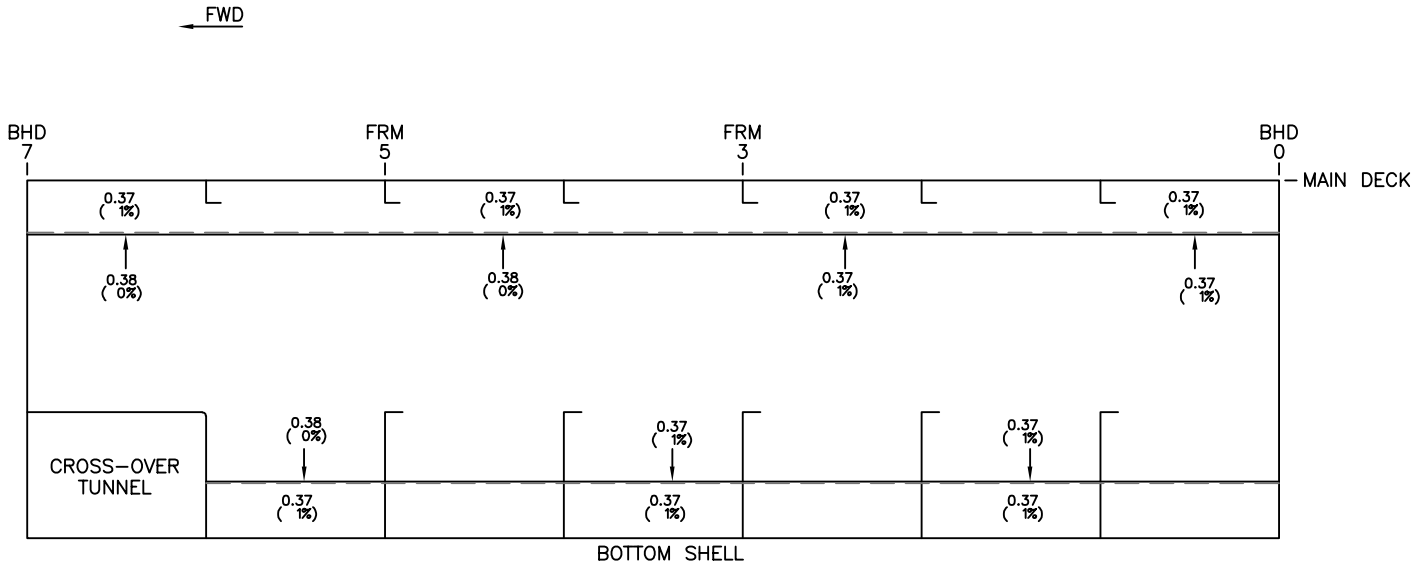


TOP OF CROSS OVER TUNNEL
PLAN VIEW

NOTE:
- UNDER DECK TRANSVERSE FRAME L6" x 3.5" x .375"
- BOTTOM TRANSVERSE FRAME 36" x 4"FlgPlt x .3125".
- TOP OF CROSS OVER TUNNEL .3125".
- FRAME VERTICAL STIFFENERS L3" x 2.5" x .25".

W = WEB / F = FLANGE.

VESSEL: M/V GUEMES	DESCRIPTION: No.1 END BALLAST WATER Tk - FRAMES 4-6 VIEWED AS NOTED
DRAWN BY: G. GRAHAM	JOB # S3603
DWG # No1 END BWT FRMS 2 v1.1	DATE: MARCH 2019



NOTE:
- UNDER DECK LONGITUDINAL GIRDER 14" x 4"FlgPlt x .375"
- BOTTOM LONGITUDINAL GIRDER 18" x 4"FlgPlt x .375".

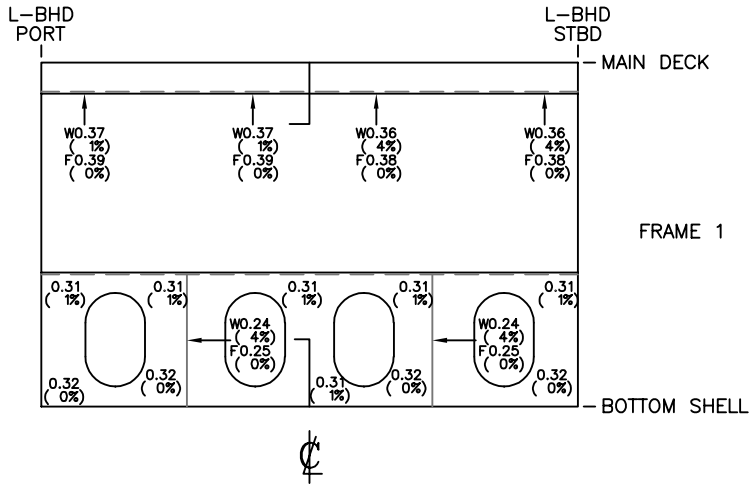
W = WEB / F = FLANGE.

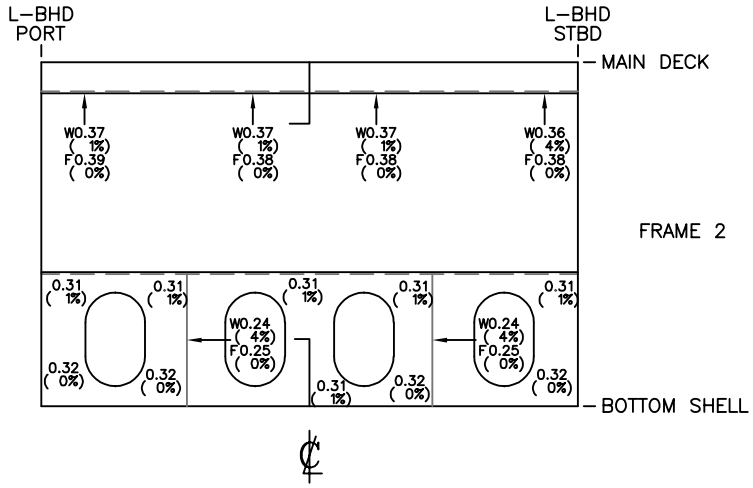
VESSEL: M/V GUEMES	DESCRIPTION: No.1 END BALLAST WATER Tk - LONG'L GIRDER LOOKING INBOARD
DRAWN BY: G. GRAHAM / JOB # S3603	DWG # No1 END BWT LGIR v1.1 / DATE: MARCH 2019

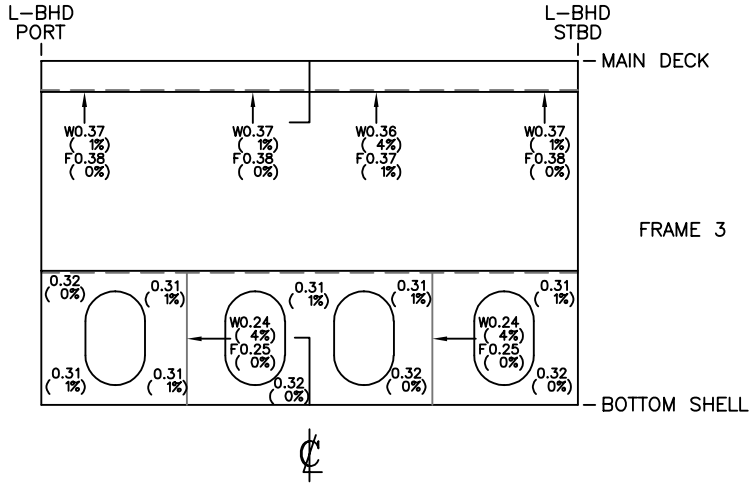
INTERNATIONAL INSPECTION

Specialists in Nondestructive Examination

No.2 END BALLAST WATER TANK INTERNALS



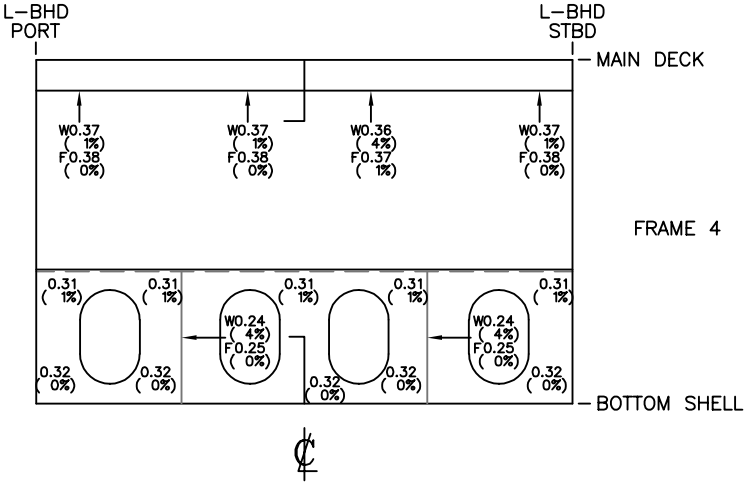


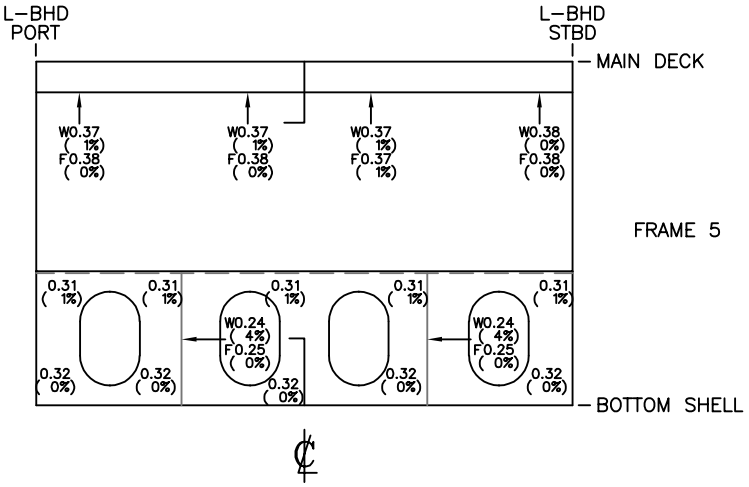


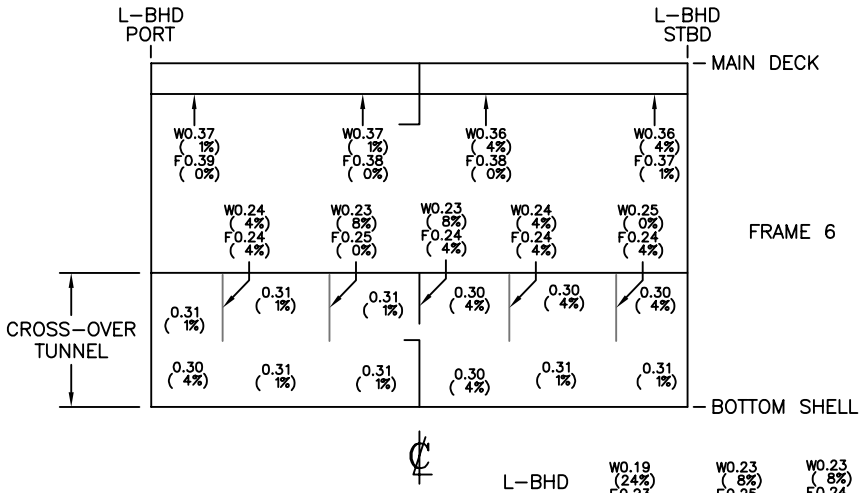
NOTE:
- UNDER DECK TRANSVERSE FRAME L6" x 3.5" x .375"
- BOTTOM TRANSVERSE FRAME 36" x 4"FlgPlt x .3125".
- FRAME VERTICAL STIFFENERS L3" x 2.5" x .25".

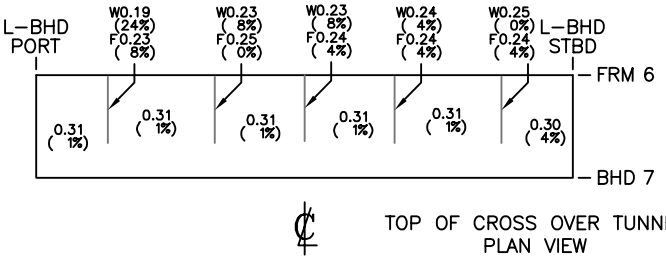
W = WEB / F = FLANGE.

VESSEL: M/V GUEMES	DESCRIPTION: No.2 END BALLAST WATER Tk - FRAMES 1-3 LOOKING FORWARD
DRAWN BY: G. GRAHAM / JOB # S3603	DWG # No2 END BWT FRMS 1 v1.1 / DATE: MARCH 2019







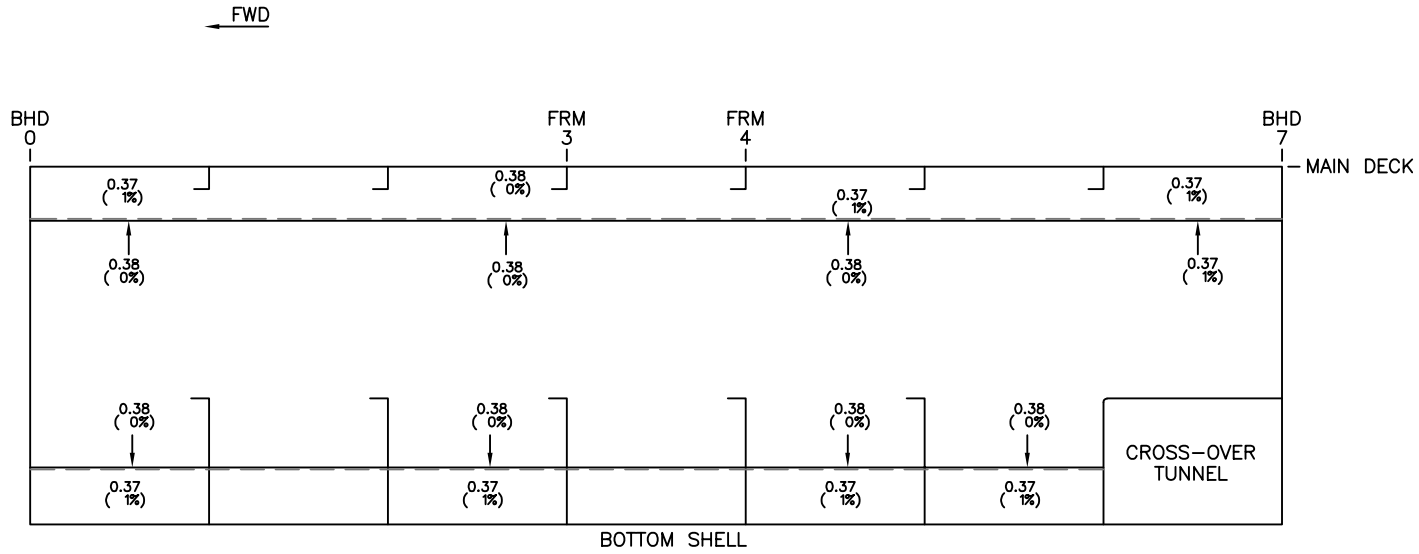


TOP OF CROSS OVER TUNNEL
PLAN VIEW

NOTE:
- UNDER DECK TRANSVERSE FRAME L6" x 3.5" x .375"
- BOTTOM TRANSVERSE FRAME 36" x 4"FlgPlt x .3125".
- FRAME VERTICAL STIFFENERS L3" x 2.5" x .25".

W = WEB / F = FLANGE.

VESSEL: M/V GUEMES		DESCRIPTION: No.2 END BALLAST WATER Tk - FRAMES 4-6 LOOKING FORWARD	
DRAWN BY: G. GRAHAM	JOB # S3603	DWG # No2 END BWT FRMS 2 v1.1	DATE: MARCH 2019



NOTE:
- UNDER DECK LONGITUDINAL GIRDER 14" x 4"FlgPlt x .375"
- BOTTOM LONGITUDINAL GIRDER 18" x 4"FlgPlt x .375".

W = WEB / F = FLANGE.

VESSEL: M/V GUEMES		DESCRIPTION: No.2 END BALLAST WATER Tk - LONG'L GIRDER LOOKING INBOARD	
DRAWN BY: G. GRAHAM	JOB # S3603	DWG # No2 END BWT LGIR v1.1	DATE: MARCH 2019

INTERNATIONAL INSPECTION

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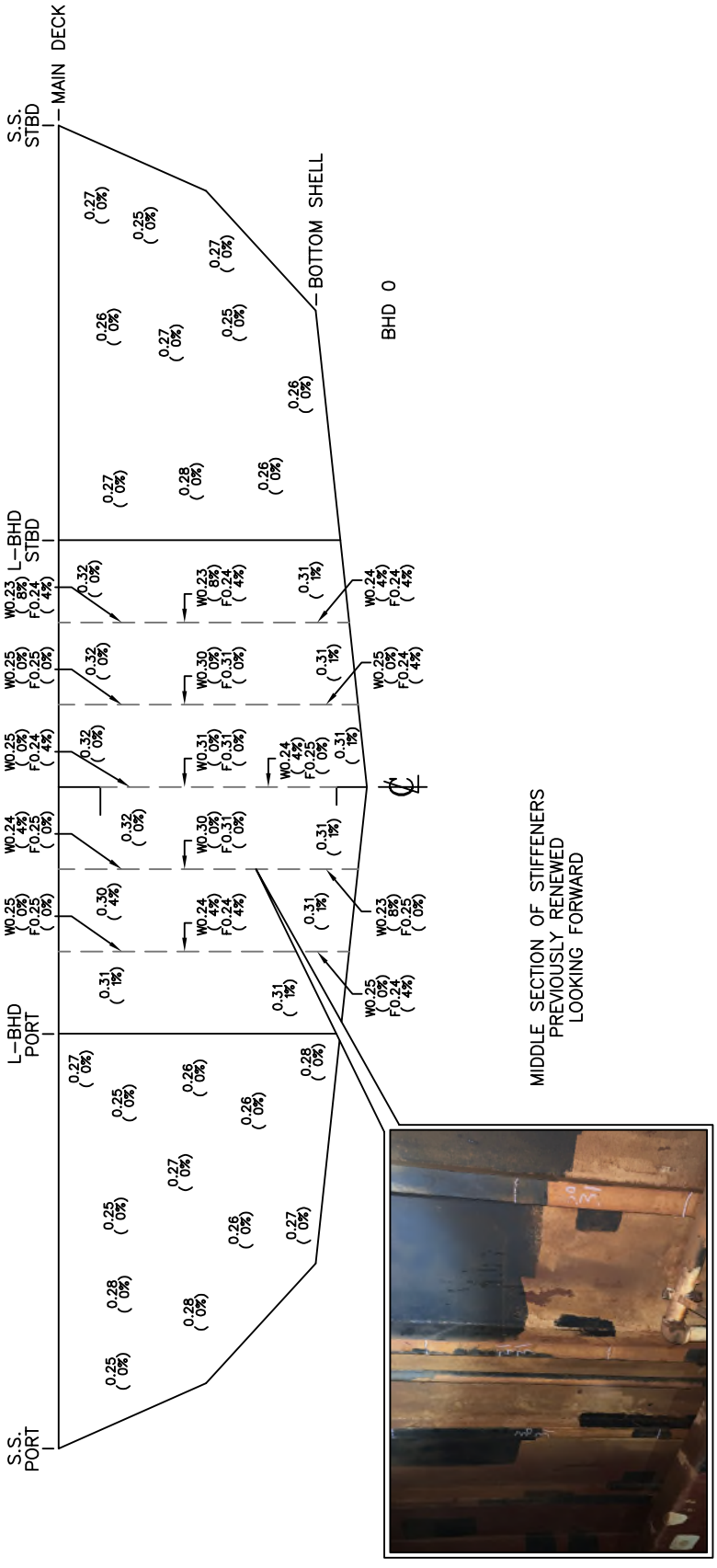
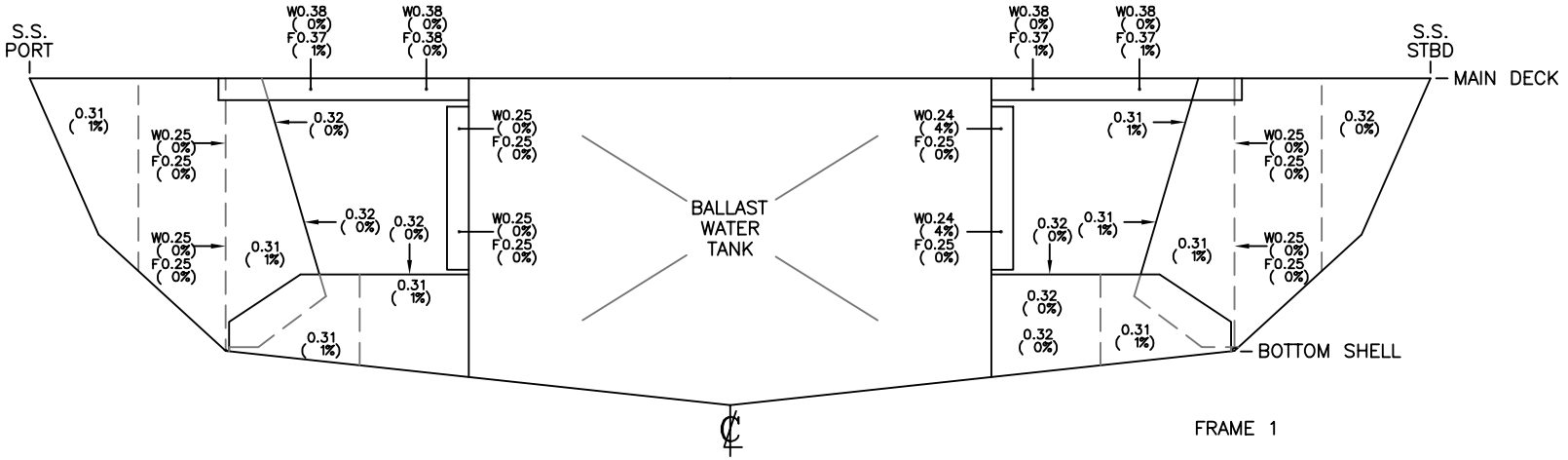
No.5 VOID INTERNALS



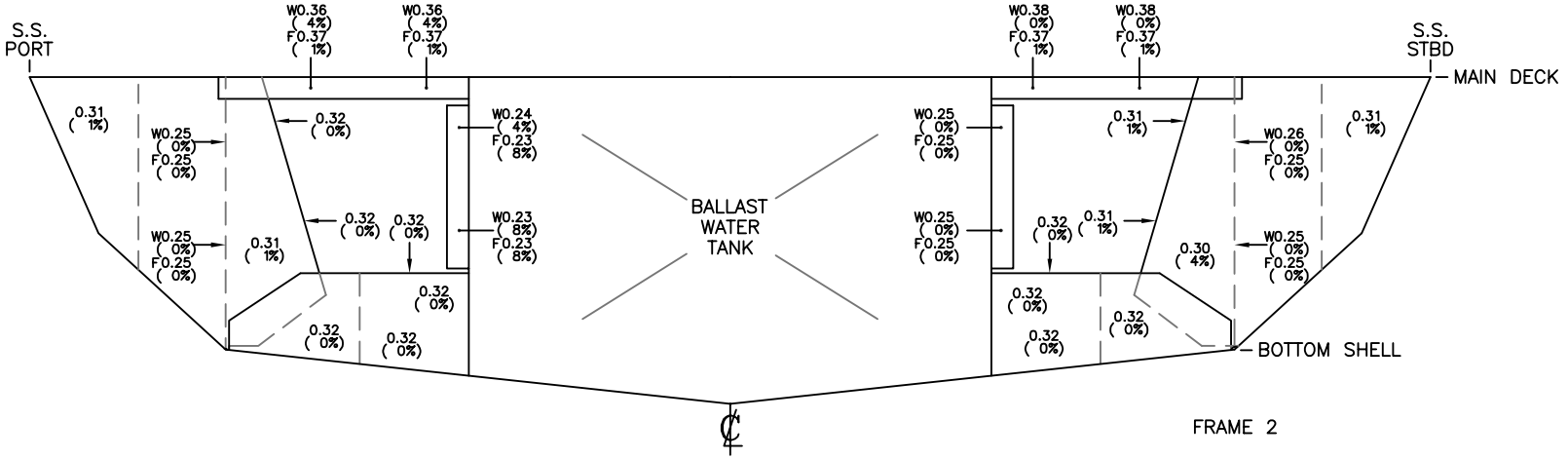
NOTE:
- BULKHEAD PLATING OUTBOARD OF LONGITUDINAL BULKHEADS .25".
- BULKHEAD PLATING INBOARD OF LONGITUDINAL BULKHEADS .3125".
- VERTICAL STIFFENERS L5" x 3" x .25".

W = WEB / F = FLANGE.

VESSEL: M/V GUEMES		No.5 VOID - BULKHEAD 0 DESCRIPTION: LOOKING FORWARD	
DRAWN BY: G. GRAHAM	JOB # S3603	DWG # No5 FBHD 0 v1.1	DATE: MARCH 2019



FRAME 1



FRAME 2

NOTE:
- TRANSVERSE UNDER DECK FRAME L6" x 3.5 x .375".
- LONGITUDINAL BULKHEAD STIFFENERS L5" x 3" x .25".
- SIDE SHELL FRAME .3125" PLATE W/ 4" FLANGE.
- SIDE SHELL FRAME STIFFENERS L3" x 2" x .25".
- TRANSVERSE BOTTOM FRAME 36" x 4"FlgPlt x .3125" C/F.

W = WEB / F = FLANGE.

VESSEL: M/V GUEMES

DESCRIPTION: No.5 VOID - FRAME 1 & 2 LOOKING FORWARD

DRAWN BY: G. GRAHAM

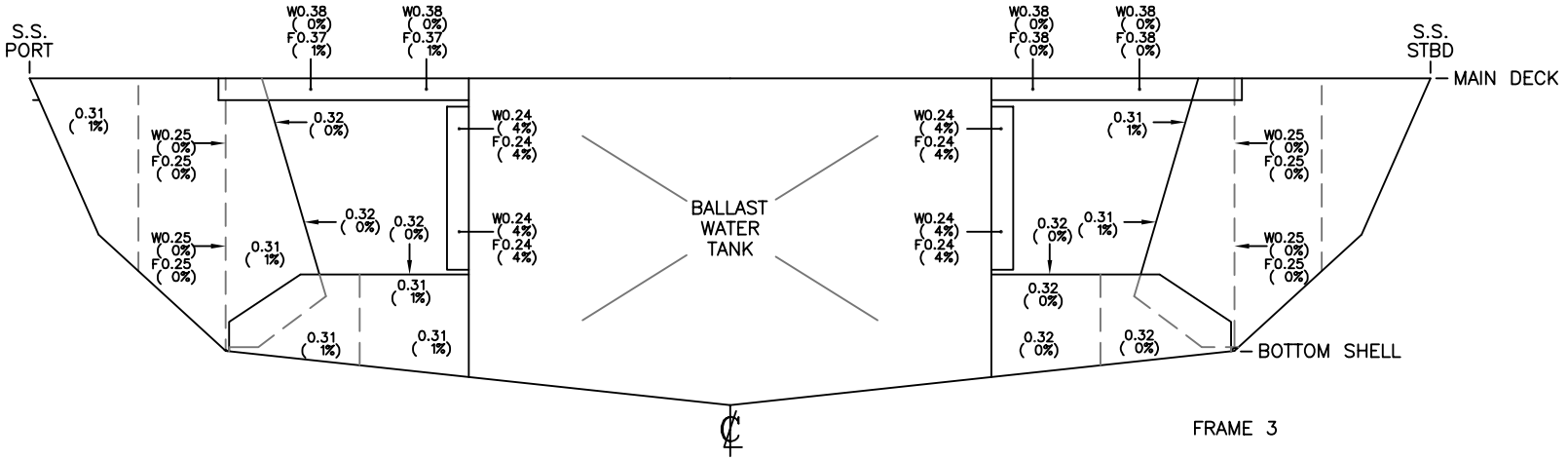
JOB # S3603

DWG # No5 FRM 1 2

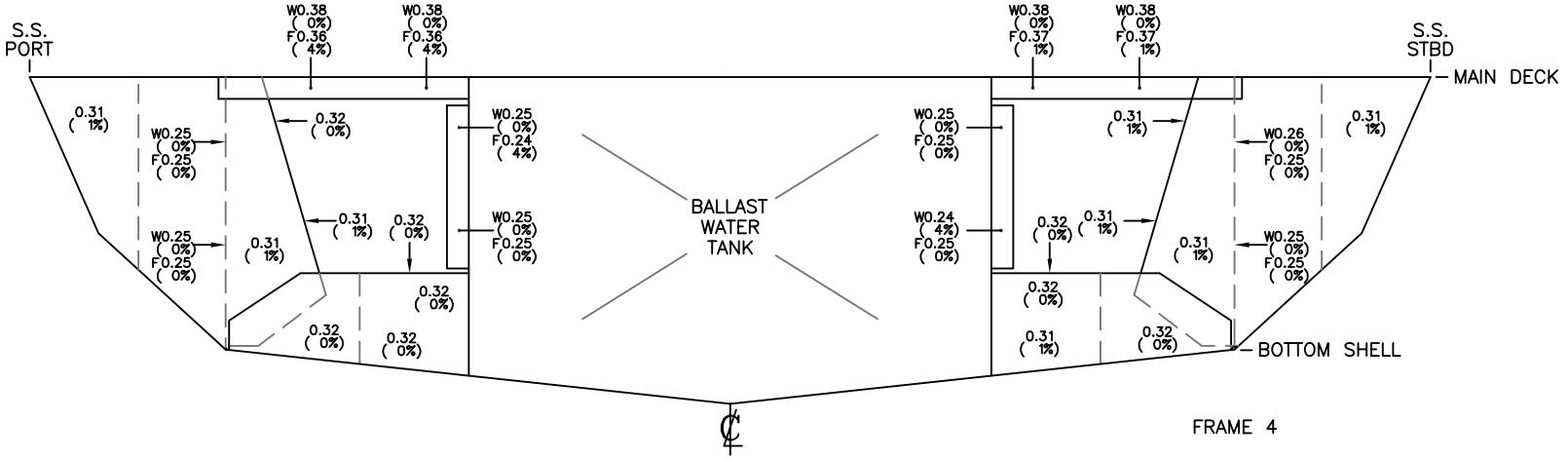
v1.1

DATE: MARCH 2019

INTERNATIONAL INSPECTION, INC.



FRAME 3



FRAME 4

NOTE:
- TRANSVERSE UNDER DECK FRAME L6" x 3.5 x .375".
- LONGITUDINAL BULKHEAD STIFFENERS L5" x 3" x .25".
- SIDE SHELL FRAME .3125" PLATE W/ 4" FLANGE.
- SIDE SHELL FRAME STIFFENERS L3" x 2" x .25".
- TRANSVERSE BOTTOM FRAME 36" x 4"FlgPlt x .3125" C/F.

W = WEB / F = FLANGE.

VESSEL: M/V GUEMES

DESCRIPTION: No.5 VOID - FRAME 3 & 4 LOOKING FORWARD

DRAWN BY: G. GRAHAM

JOB # S3603

DWG # No5 FRM 3 4

v1.1

DATE: MARCH 2019

INTERNATIONAL INSPECTION, INC.

VESSEL: M/V GUEMES

DESCRIPTION: No.5 VOID - FRAME 5 & 6 LOOKING FORWARD

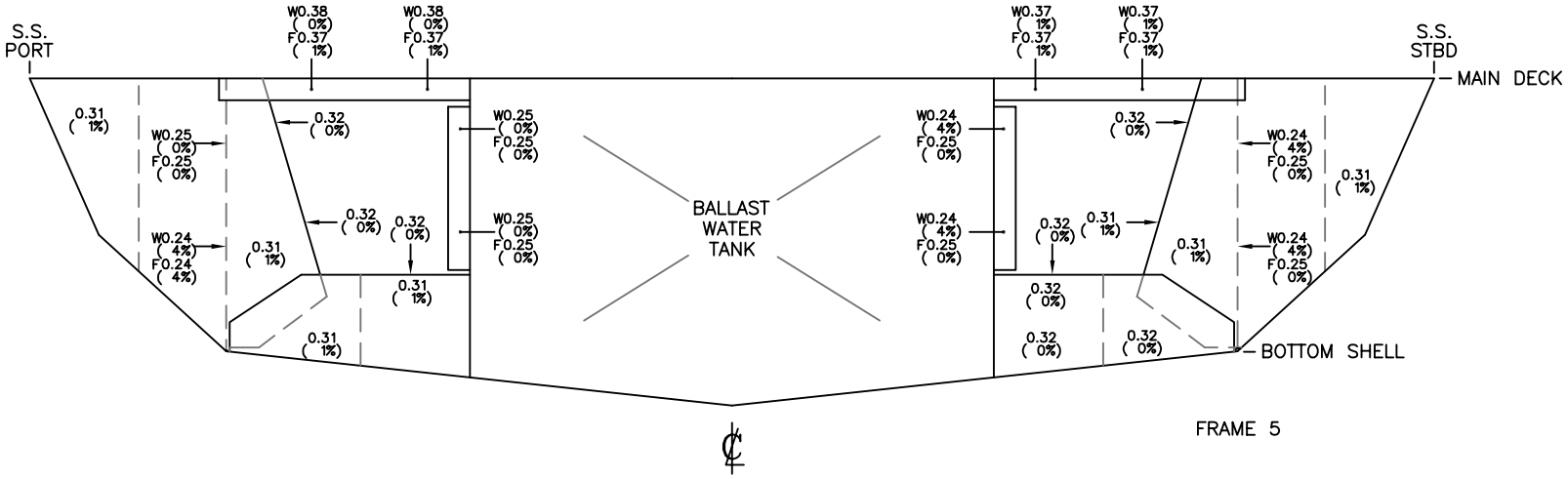
DRAWN BY: G. GRAHAM

JOB # S3603

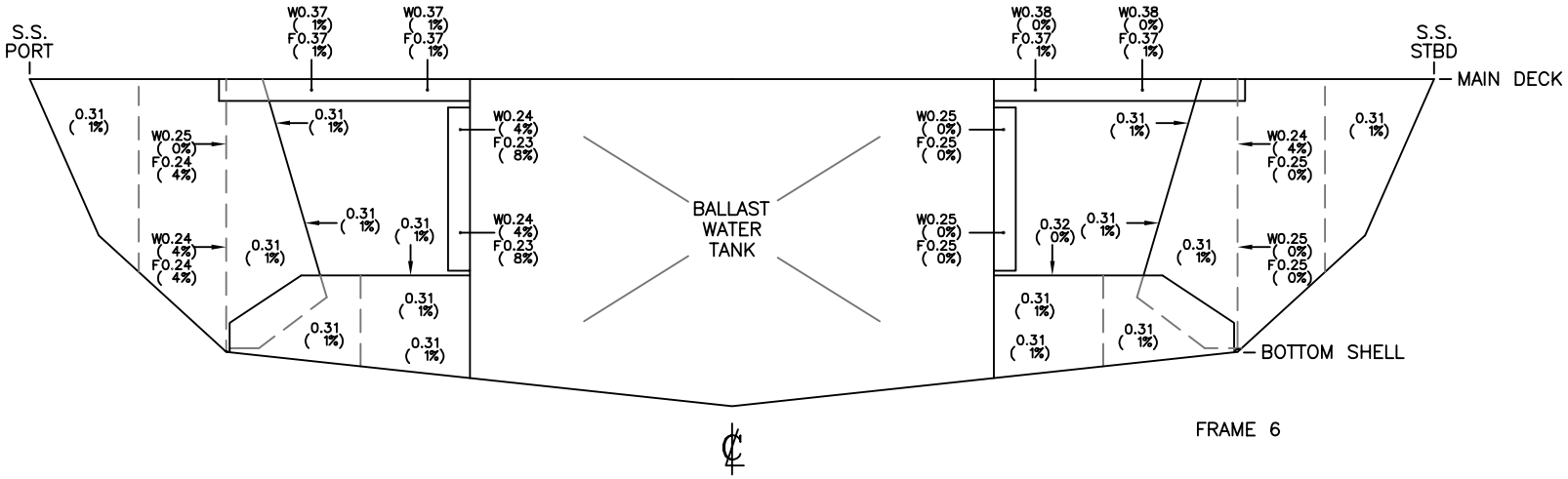
DWG # No5 FRM 5 6

v1.1

DATE: MARCH 2019



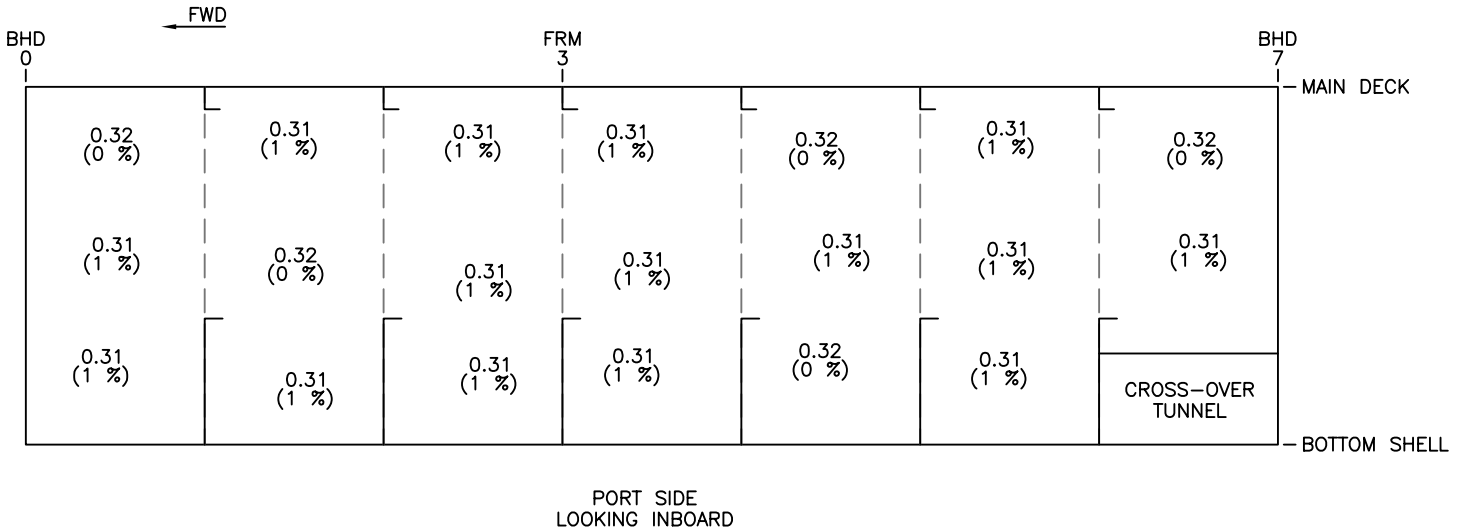
FRAME 5



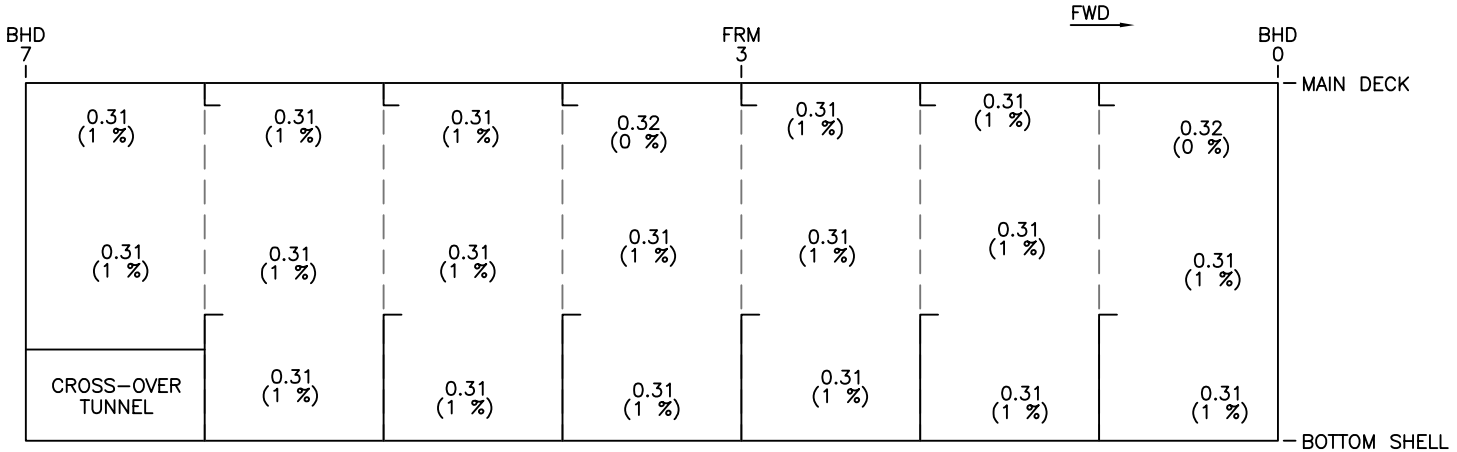
FRAME 6

NOTE:
- TRANSVERSE UNDER DECK FRAME L6" x 3.5 x .375".
- LONGITUDINAL BULKHEAD STIFFENERS L5" x 3" x .25".
- SIDE SHELL FRAME .3125" PLATE W/ 4" FLANGE.
- SIDE SHELL FRAME STIFFENERS L3" x 2" x .25".
- TRANSVERSE BOTTOM FRAME 36" x 4"FlgPlt x .3125" C/F.

W = WEB / F = FLANGE.



PORT SIDE
LOOKING INBOARD



STARBOARD SIDE
LOOKING INBOARD

NOTE:
6'–0" LONGITUDINAL BULKHEAD PLATING .3125"

VESSEL: M/V GUEMES

DESCRIPTION: No.5 VOID - 6'-0" LONGITUDINAL BULKHEAD PLAN VIEW

DRAWN BY: G. GRAHAM

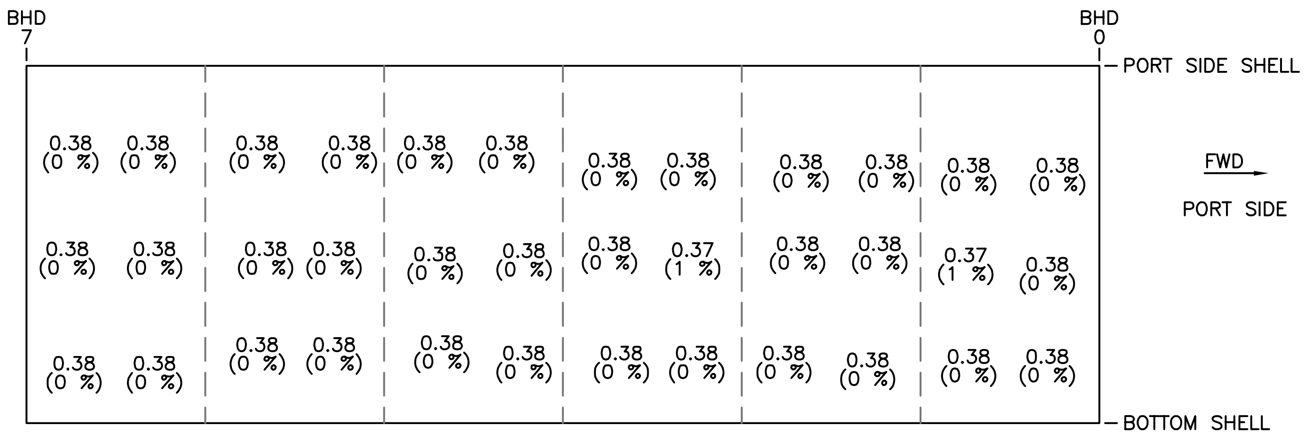
JOB # S3603

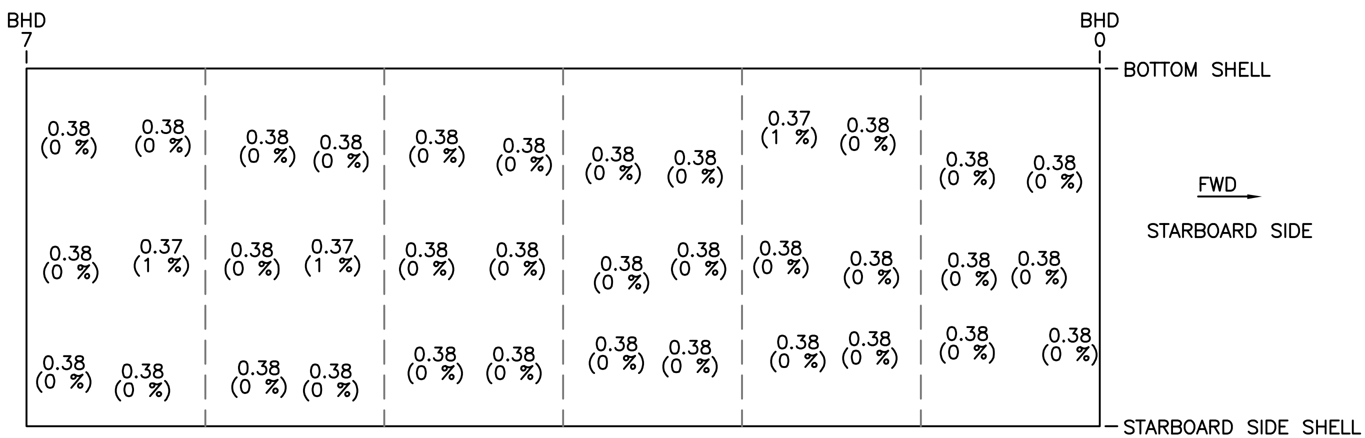
DWG # No5 LBHD

v1.1

DATE: MARCH 2019

INTERNATIONAL INSPECTION, INC.





NOTE:
NO ORIGINAL SCANTLINGS AVAILABLE AT TIME OF SURVEY.
NOMINAL THICKNESS MEASUREMENTS OBTAINED TO DETERMINE PERCENT WASTAGE.

NOMINAL THICKNESS USED:
– TURN OF BILGE PLATING .375"

INTERNATIONAL INSPECTION, INC.

VESSEL: M/V GUEMES

DESCRIPTION: PLAN VIEW
No.5 VOID - PLATING IWO KEEL COOLERS

DRAWN BY: G. GRAHAM

JOB # S3603

DWG # No5 VOID BTM PLT

v1.1

DATE: MARCH 2019

INTERNATIONAL INSPECTION

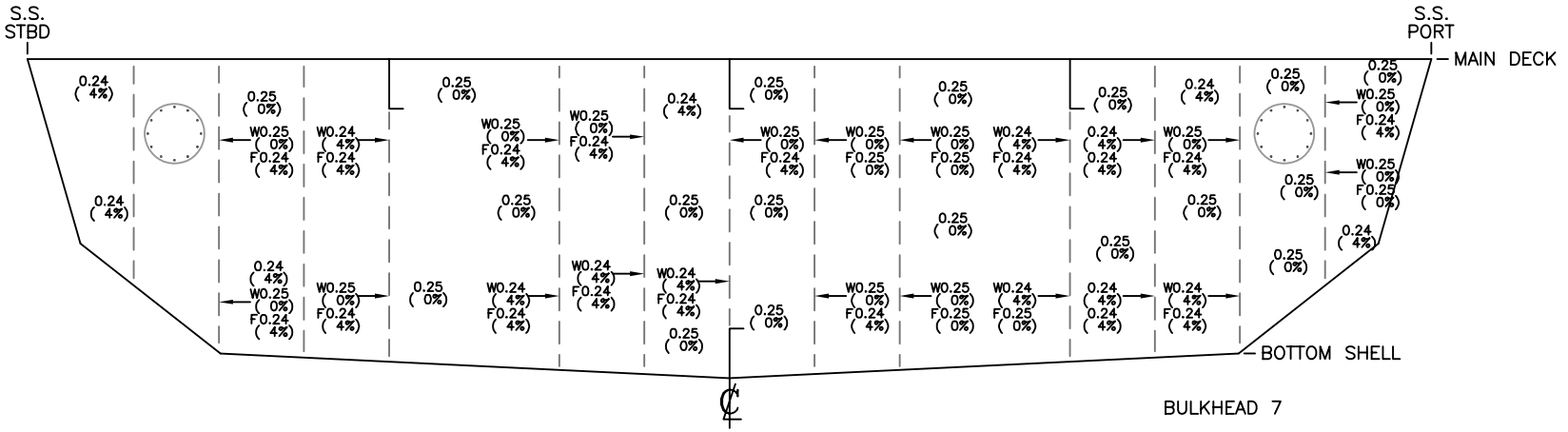
Specialists in Nondestructive Examination

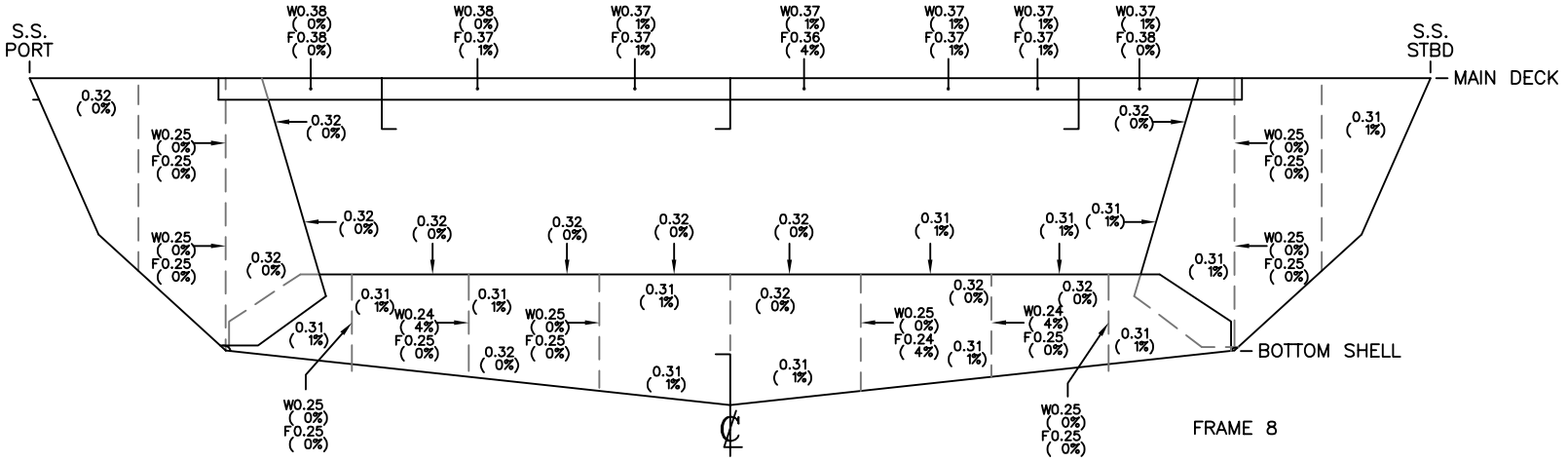
No.6 VOID INTERNALS

VESSEL: M/V GUEMES

DRAWN BY: G. GRAHAM | JOB # S3603 | DWG # No7 BHD 7 FRM 8 v1.1 | DATE: MARCH 2019

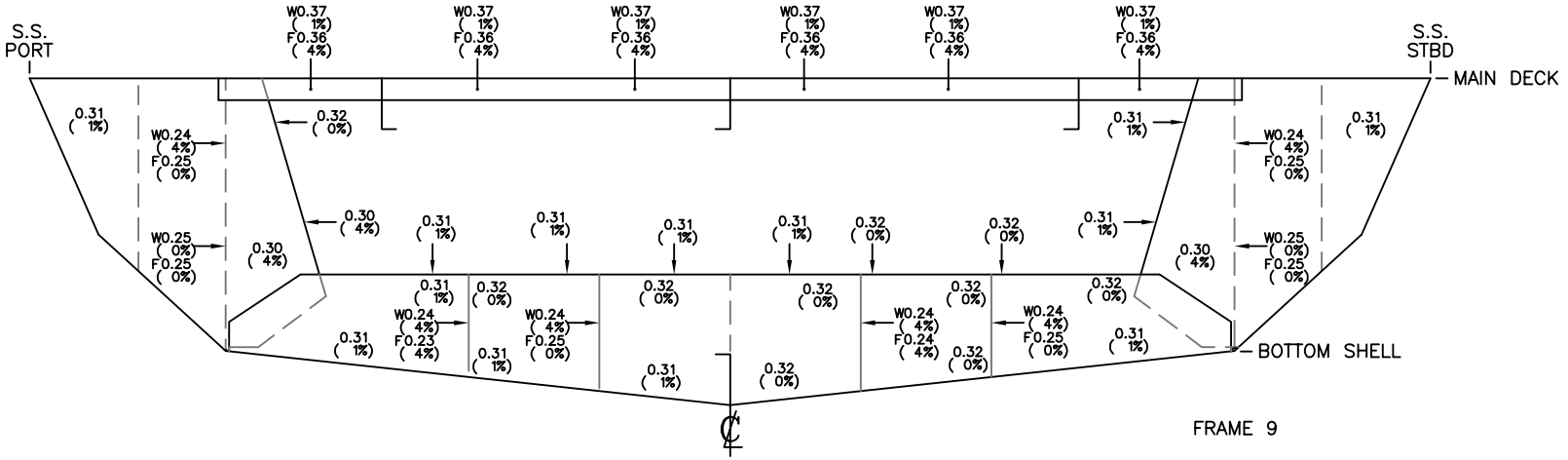
DESCRIPTION: No.6 VOID - BHD7 & FRAME 8 LOOKING FORWARD



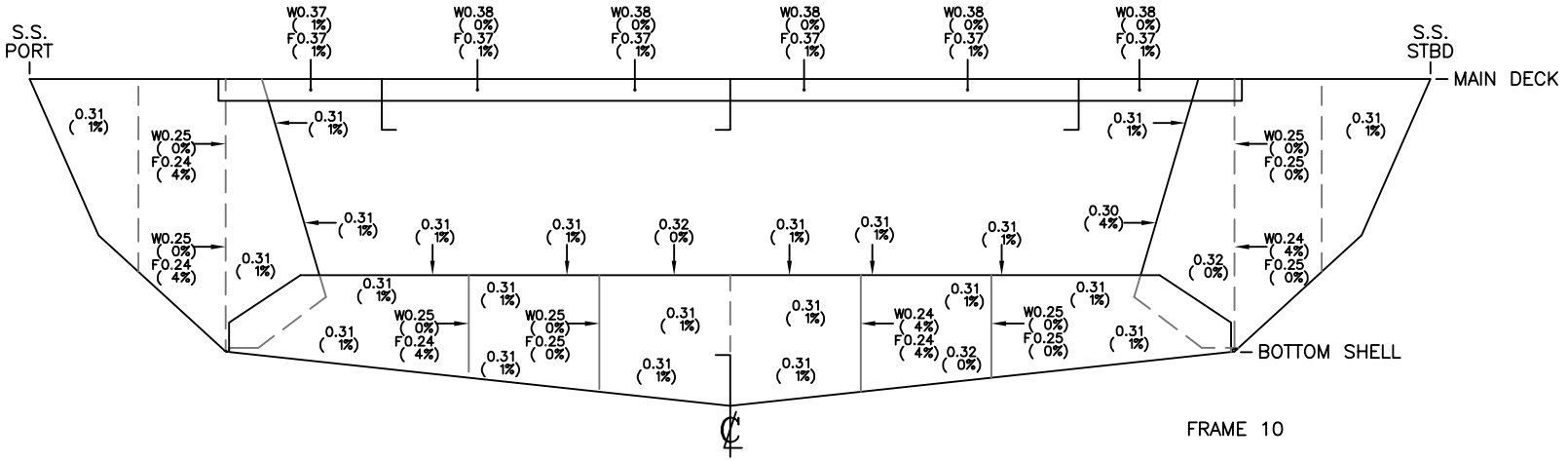


NOTE:
- BULKHEAD 7 PLATING .25".
- BULKHEAD 7 VERTICAL STIFFENERS L5" x 3" x .25".
- FRAME 8 TRANSVERSE UNDER DECK FRAME L6" x 3.5 x .375".
- FRAME 8 SIDE SHELL FRAME .3125" PLATE W/ 4" FLANGE.
- FRAME 8 SIDE SHELL FRAME STIFFENERS L3" x 2" x .25".
- FRAME 8 TRANSVERSE BOTTOM FRAME 36" x 4"FlgPlt x .3125" C/F.
- FRAME 8 TRANSVERSE BOTTOM FRAME STIFFENERS L3" x 2.5" x .25".

W = WEB / F = FLANGE.



FRAME 9



FRAME 10

NOTE:
- TRANSVERSE UNDER DECK FRAME L6" x 3.5 x .375".
- SIDE SHELL FRAME .3125" PLATE W/ 4" FLANGE.
- SIDE SHELL FRAME STIFFENERS L3" x 2" x .25".
- TRANSVERSE BOTTOM FRAME 36" x 4"FlgPlt x .3125" C/F.
- TRANSVERSE BOTTOM FRAME STIFFENERS L3" x 2.5" x .25".

W = WEB / F = FLANGE.

VESSEL: M/V GUEMES

DESCRIPTION: No.6 VOID - FRAME 9 & 10 LOOKING FORWARD

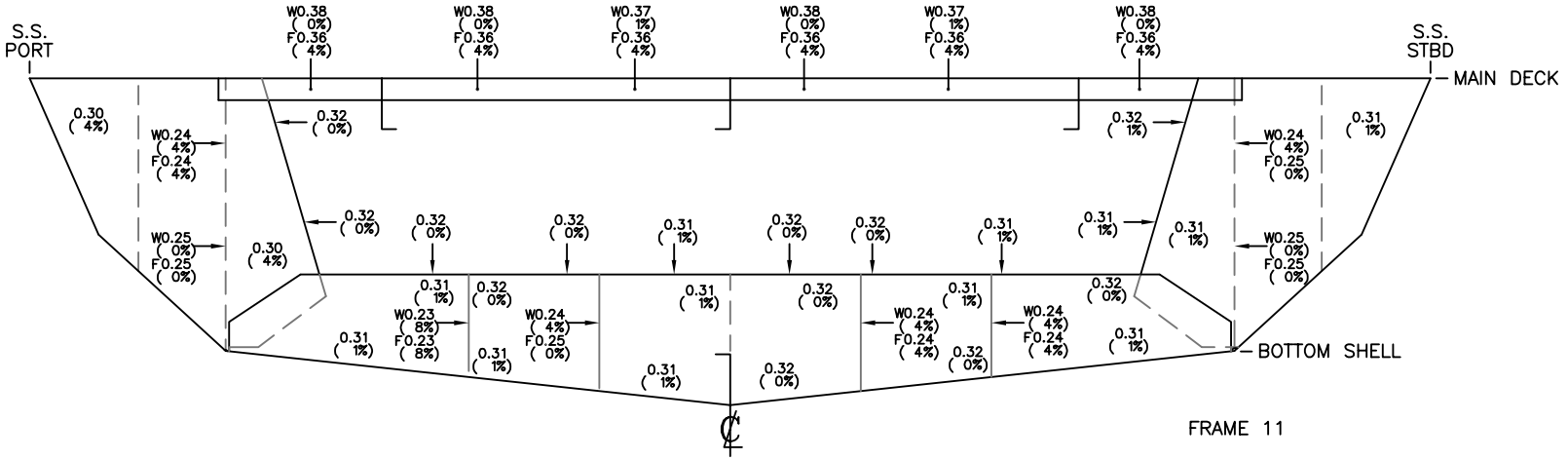
DRAWN BY: G. GRAHAM

JOB # S3603

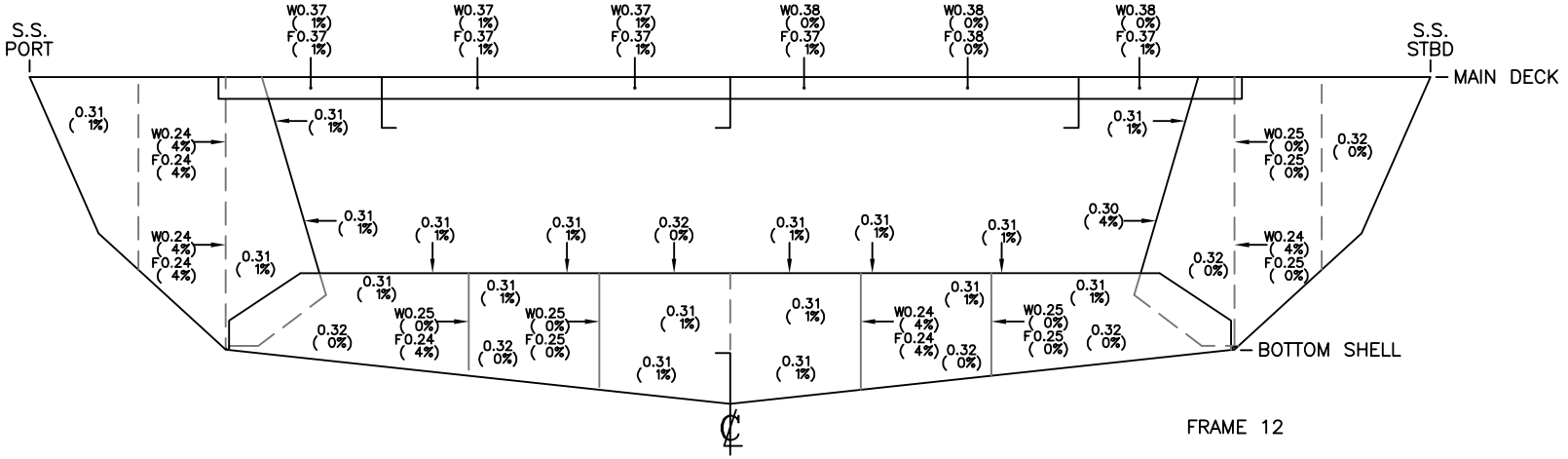
DWG # No6 FRM 9 10 v1.1

DATE: MARCH 2019

INTERNATIONAL INSPECTION, INC.



FRAME 11



FRAME 12

NOTE:
- TRANSVERSE UNDER DECK FRAME L6" x 3.5 x .375".
- SIDE SHELL FRAME .3125" PLATE W/ 4" FLANGE.
- SIDE SHELL FRAME STIFFENERS L3" x 2" x .25".
- TRANSVERSE BOTTOM FRAME 36" x 4"FlgPlt x .3125" C/F.
- TRANSVERSE BOTTOM FRAME STIFFENERS L3" x 2.5" x .25".

W = WEB / F = FLANGE.

VESSEL: M/V GUEMES

DESCRIPTION: No.6 VOID - FRAME 11 & 12 LOOKING FORWARD

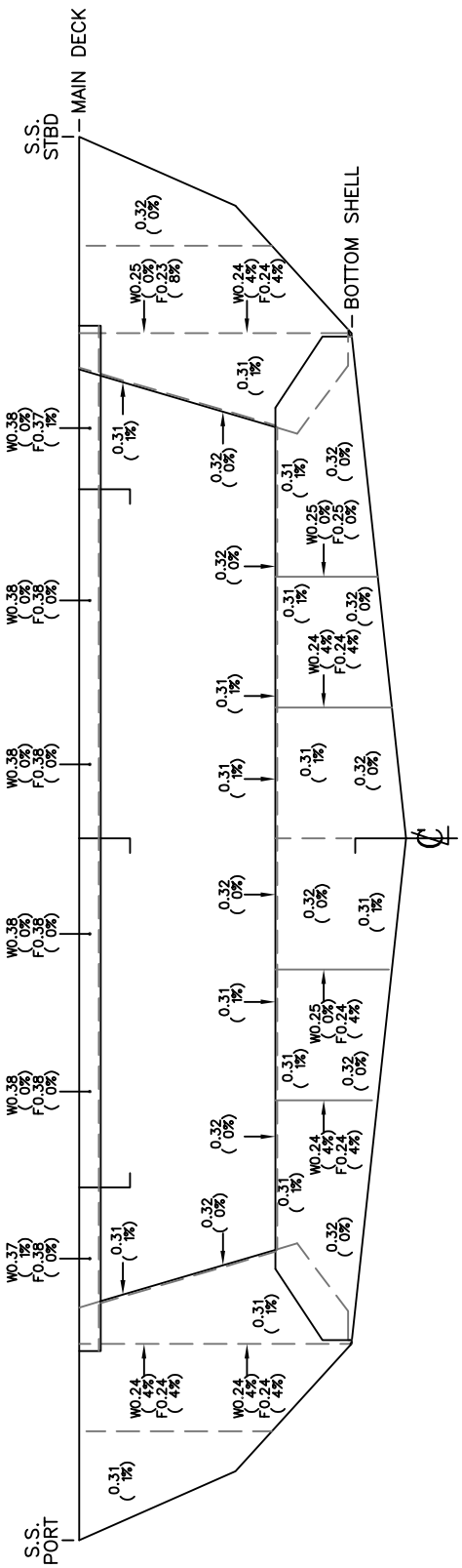
DRAWN BY: G. GRAHAM

JOB # S3603

DWG # No6 FRM 11 12 v1.1

DATE: MARCH 2019

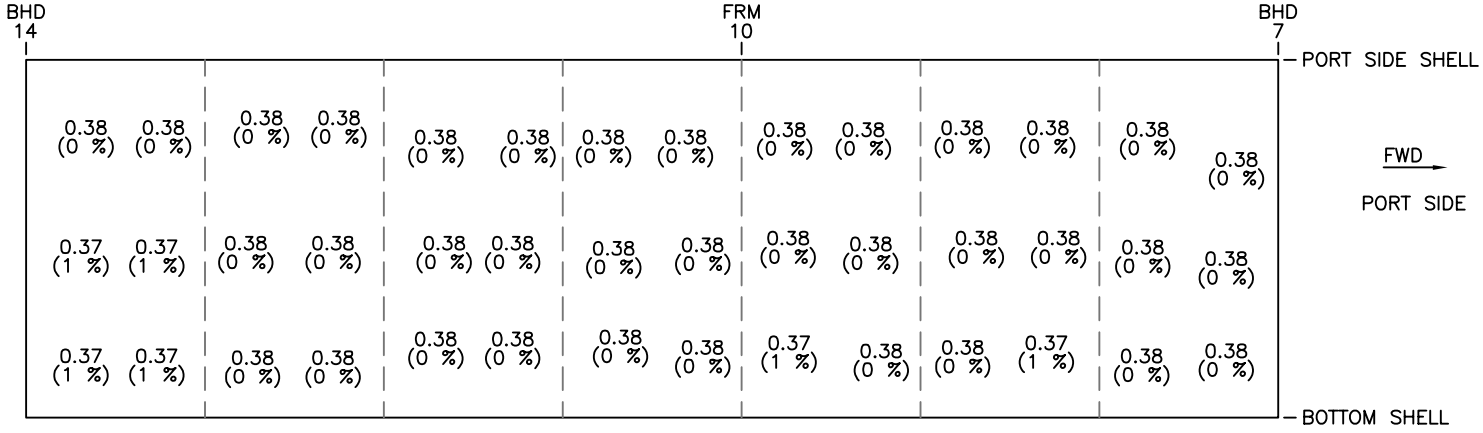
INTERNATIONAL INSPECTION, INC.

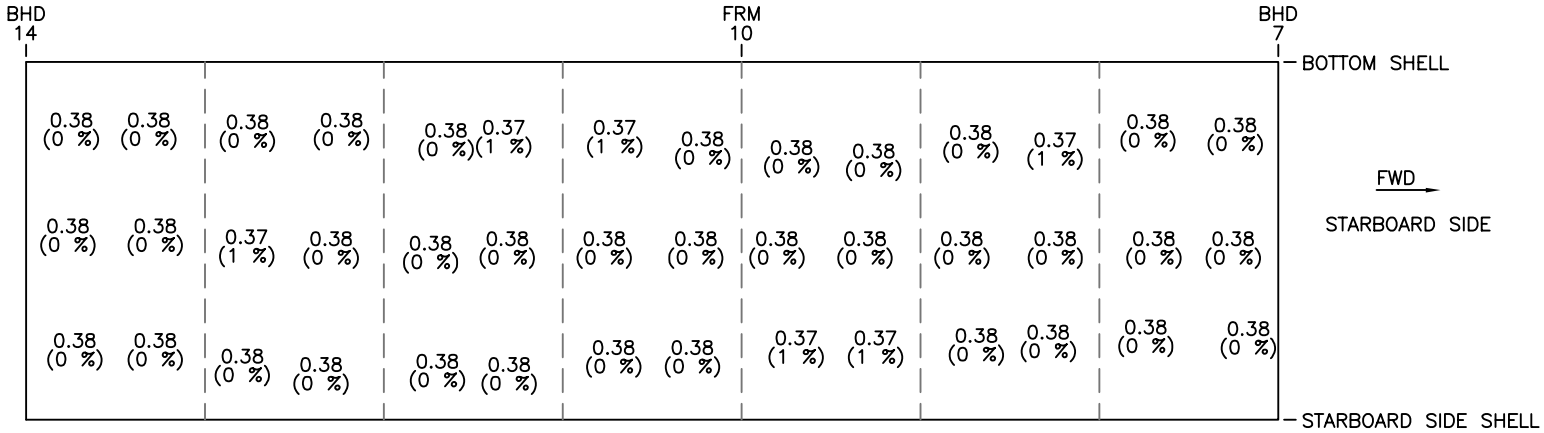


NOTE:
- TRANSVERSE UNDER DECK FRAME L6" x 3.5 x .375".
- SIDE SHELL FRAME .3125" PLATE W/ 4" FLANGE.
- SIDE SHELL FRAME STIFFENERS L3" x 2" x .25".
- TRANSVERSE BOTTOM FRAME 36" x 4"FlgPlt x .3125" C/F.
- TRANSVERSE BOTTOM FRAME STIFFENERS L3" x 2.5" x .25".

W = WEB / F = FLANGE.

VESSEL: M/V GUEMES		DESCRIPTION: No.6 VOID - FRAME 13 LOOKING FORWARD	
DRAWN BY: G. GRAHAM	JOB # S3603	DWG # No6 FRM 13 v1.1	DATE: MARCH 2019





NOTE:
NO ORIGINAL SCANTLINGS AVAILABLE AT TIME OF SURVEY.
NOMINAL THICKNESS MEASUREMENTS OBTAINED TO
DETERMINE PERCENT WASTAGE.

NOMINAL THICKNESS USED:
– TURN OF BILGE PLATING .375"

VESSEL: M/V GUEMES

DESCRIPTION: No.6 VOID - PLATING IWO KEEL COOLERS
PLAN VIEW

DRAWN BY: G. GRAHAM

JOB # S3603

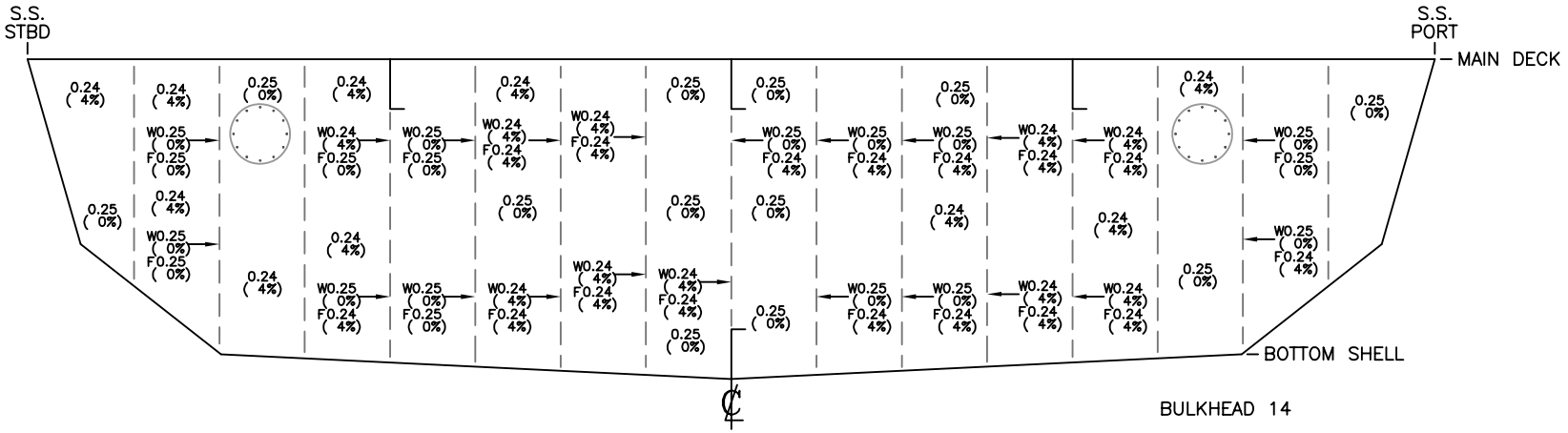
DWG # No6 VOID BTM PLT v1.1

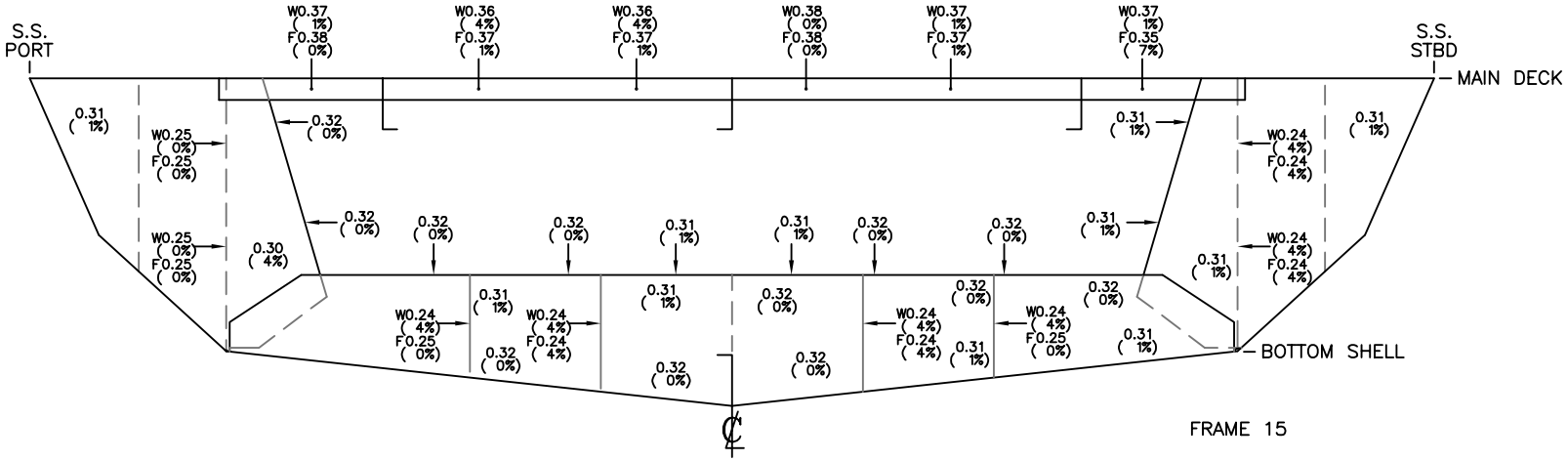
DATE: MARCH 2019

INTERNATIONAL INSPECTION

Specialists in Nondestructive Examination

No.7 VOID INTERNALS





NOTE:
- BULKHEAD 14 PLATING .25".
- BULKHEAD 14 VERTICAL STIFFENERS L5" x 3" x .25".
- FRAME 15 TRANSVERSE UNDER DECK FRAME L6" x 3.5 x .375".
- FRAME 15 SIDE SHELL FRAME .3125" PLATE W/ 4" FLANGE.
- FRAME 15 SIDE SHELL FRAME STIFFENERS L3" x 2" x .25".
- FRAME 15 TRANSVERSE BOTTOM FRAME 36" x 4"FlgPlt x .3125" C/F.
- FRAME 15 TRANSVERSE BOTTOM FRAME STIFFENERS L3" x 2.5" x .25".

W = WEB / F = FLANGE.

VESSEL: M/V GUEMES

DESCRIPTION: No.7 VOID - BULKHEAD 14 & FRAME 15 LOOKING FORWARD

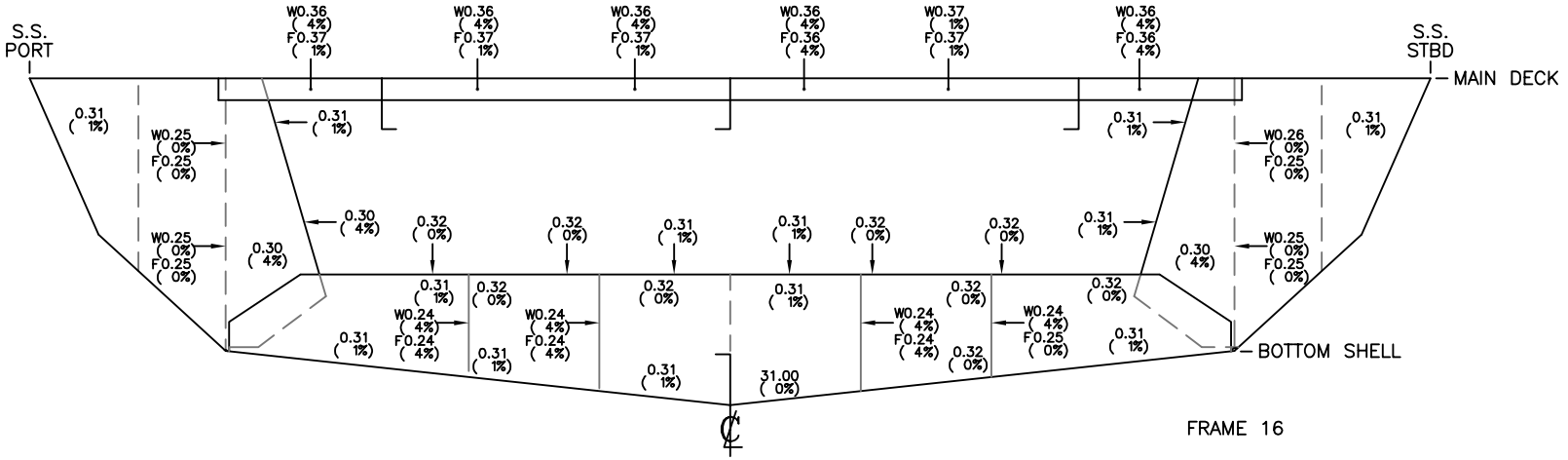
DRAWN BY: G. GRAHAM

JOB # S3603

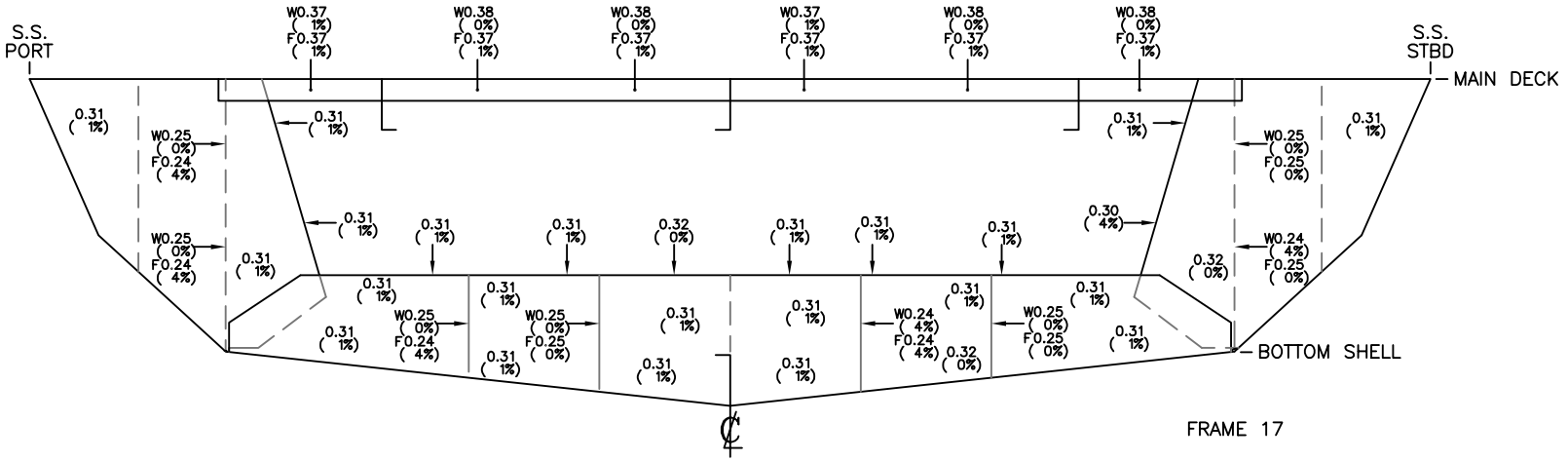
DWG # No7 FRM 14 15 v1.1

DATE: MARCH 2019

INTERNATIONAL INSPECTION, INC.



FRAME 16



FRAME 17

NOTE:
- TRANSVERSE UNDER DECK FRAME L6" x 3.5 x .375".
- SIDE SHELL FRAME .3125" PLATE W/ 4" FLANGE.
- SIDE SHELL FRAME STIFFENERS L3" x 2" x .25".
- TRANSVERSE BOTTOM FRAME 36" x 4"FlgPlt x .3125" C/F.
- TRANSVERSE BOTTOM FRAME STIFFENERS L3" x 2.5" x .25".

W = WEB / F = FLANGE.

VESSEL: M/V GUEMES

DESCRIPTION: No.7 VOID - FRAME 16 & 17 LOOKING FORWARD

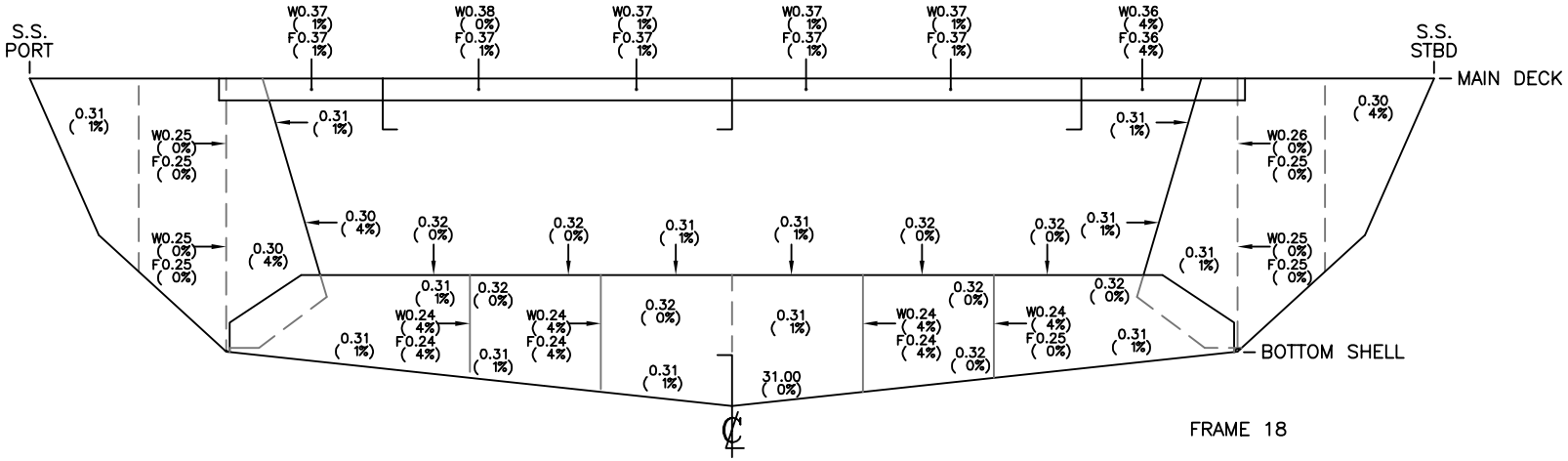
DRAWN BY: G. GRAHAM

JOB # S3603

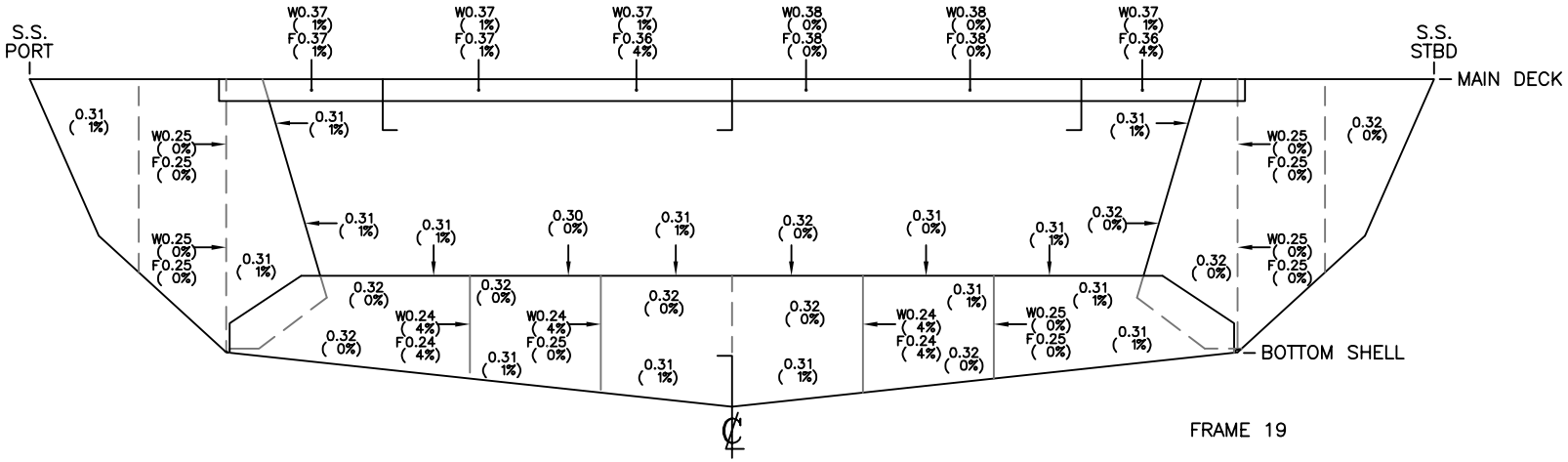
DWG # No7 FRM 16 17 v1.1

DATE: MARCH 2019

INTERNATIONAL INSPECTION, INC.



FRAME 18



FRAME 19

NOTE:
- TRANSVERSE UNDER DECK FRAME L6" x 3.5 x .375".
- SIDE SHELL FRAME .3125" PLATE W/ 4" FLANGE.
- SIDE SHELL FRAME STIFFENERS L3" x 2" x .25".
- TRANSVERSE BOTTOM FRAME 36" x 4"FlgPlt x .3125" C/F.
- TRANSVERSE BOTTOM FRAME STIFFENERS L3" x 2.5" x .25".

W = WEB / F = FLANGE.

VESSEL: M/V GUEMES

DRAWN BY: G. GRAHAM

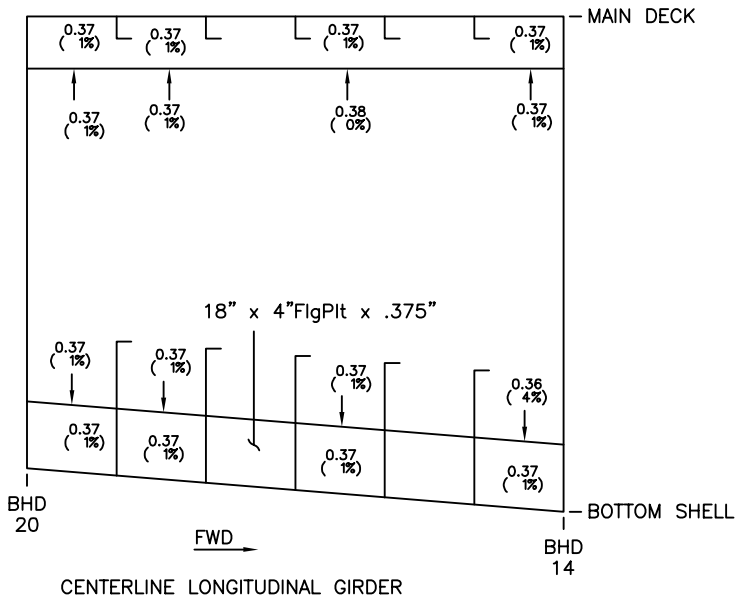
JOB # S3603

DWG # No7 FRM 18 19

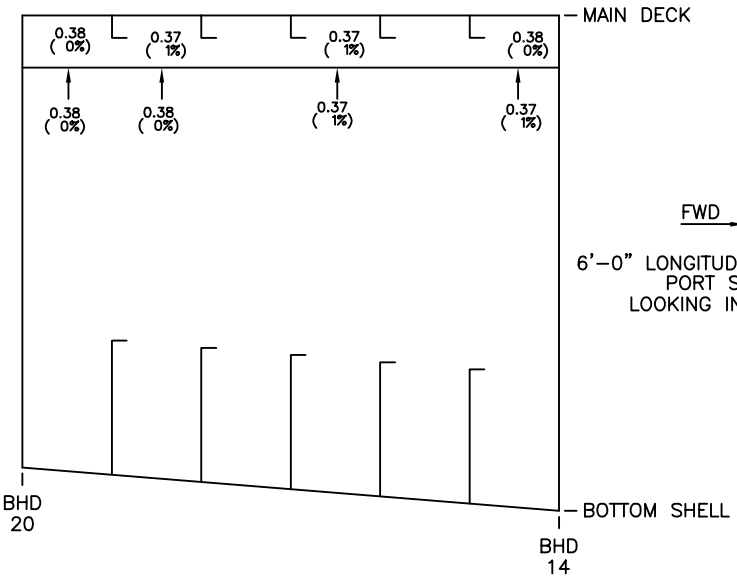
v1.1

DESCRIPTION: No.7 VOID - FRAME 18 & 19 LOOKING FORWARD

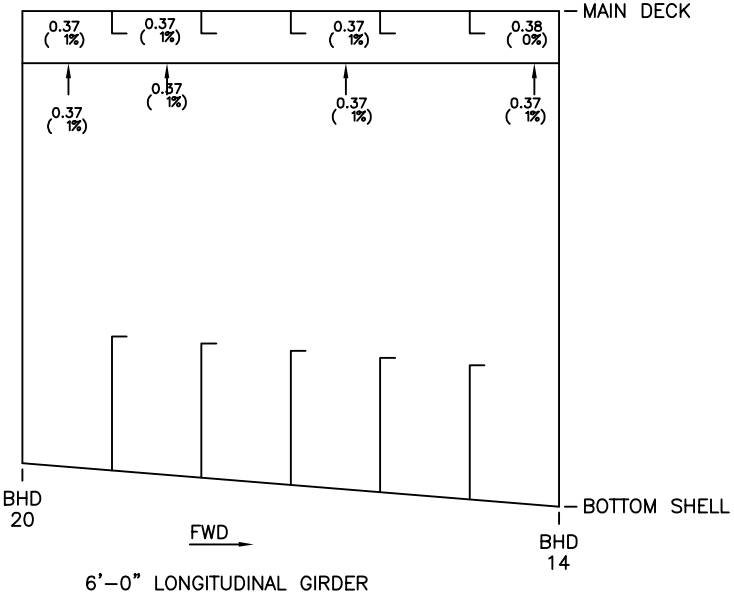
DATE: MARCH 2019



CENTERLINE LONGITUDINAL GIRDER
LOOKING INBOARD



6'-0" LONGITUDINAL GIRDER
PORT SIDE
LOOKING INBOARD



6'-0" LONGITUDINAL GIRDER
STARBOARD SIDE
LOOKING INBOARD

NOTE:
CENTERLINE LONGITUDINAL GIRDER 14" x 4"FlgPlt x .375 UNLESS NOTED OTHERWISE.
6'-0" LONGITUDINAL GIRDER 14" x 4"FlgPlt x .375 UNLESS NOTED OTHERWISE.
W = WEB / F = FLANGE.

VESSEL: M/V GUEMES

DESCRIPTION: No.7 VOID - LONGITUDINAL GIRDERS
VIEWED AS NOTED

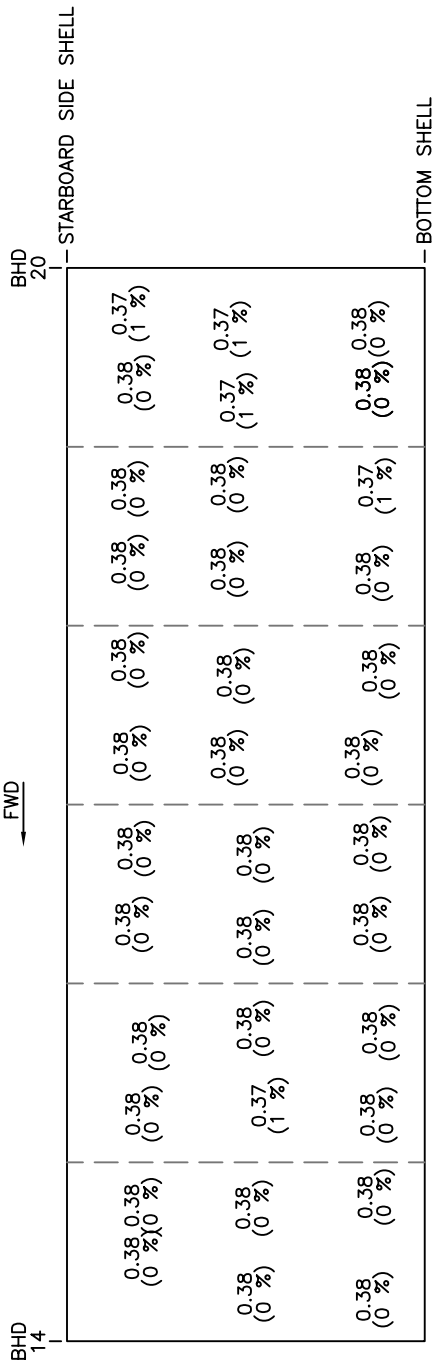
DRAWN BY: G. GRAHAM

JOB # S3603

DWG # No7 LGIR

v1.1

DATE: MARCH 2019



NOTE:
NO ORIGINAL SCANTLINGS AVAILABLE AT TIME OF SURVEY.
NOMINAL THICKNESS MEASUREMENTS OBTAINED TO DETERMINE PERCENT WASTAGE.

NOMINAL THICKNESS USED:
- TURN OF BILGE PLATING .375"

VESSEL: M/V GUEMES	DESCRIPTION: No.7 VOID - PLATING IWO KEEL COOLERS STARBOARD SIDE - PLAN VIEW
DRAWN BY: G. GRAHAM / JOB # S3603	DWG # No7 VOID BTM PLT v1.1 / DATE: MARCH 2019

INTERNATIONAL INSPECTION

Specialists in Nondestructive Examination

No.8 VOID INTERNALS

VESSEL: M/V GUEMES

DRAWN BY: G. GRAHAM

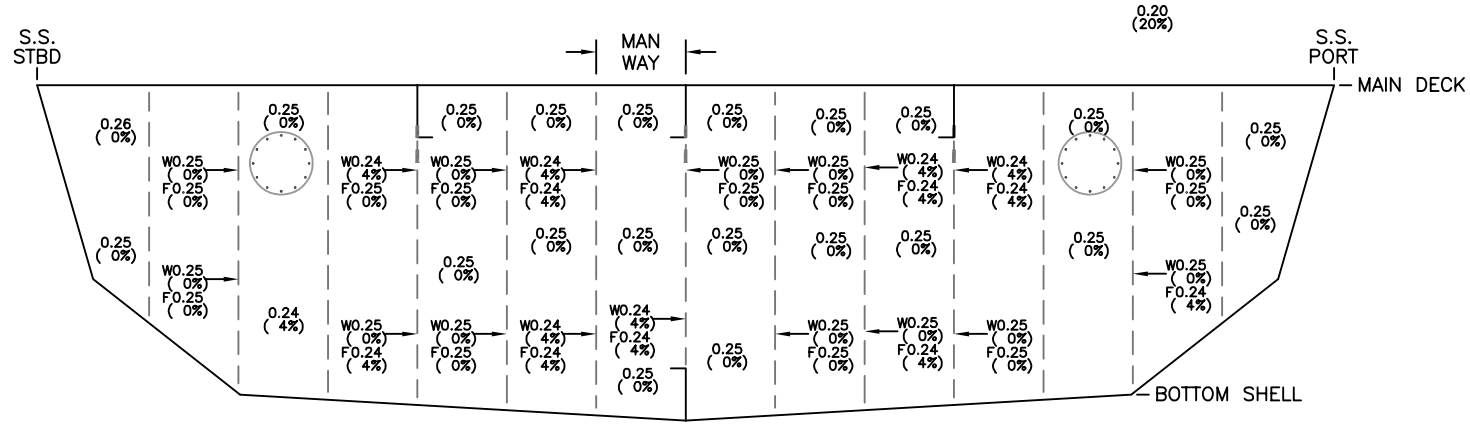
JOB # S3603

DWG # No8 BHD 20

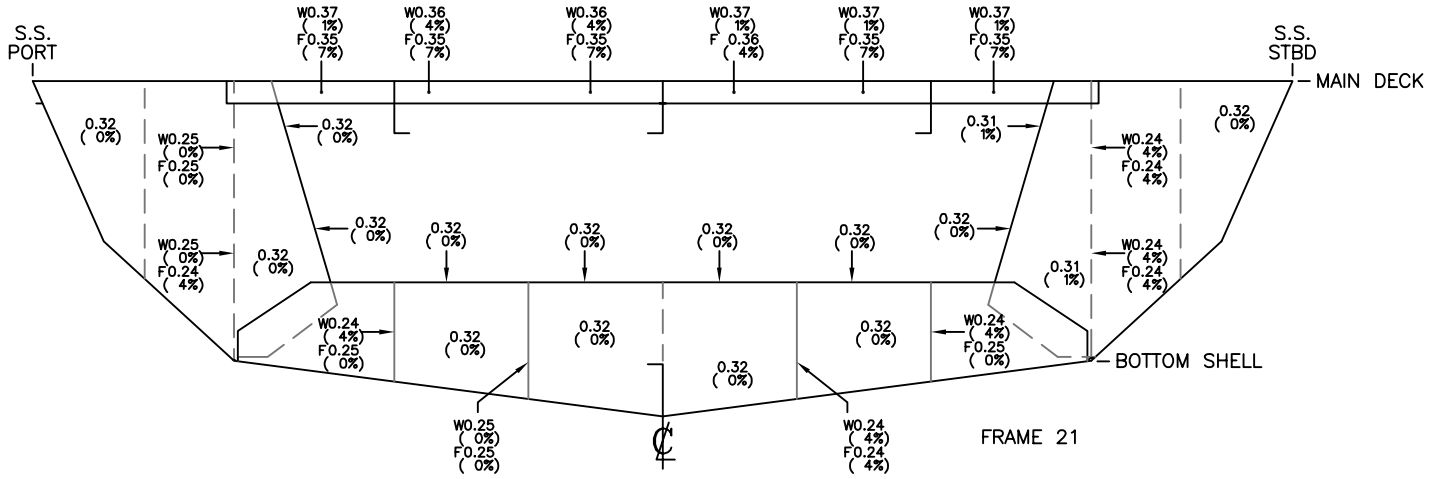
v1.1

DATE: MARCH 2019

DESCRIPTION: No.8 VOID - BULKHEAD 20 & FRAME 21 LOOKING FORWARD



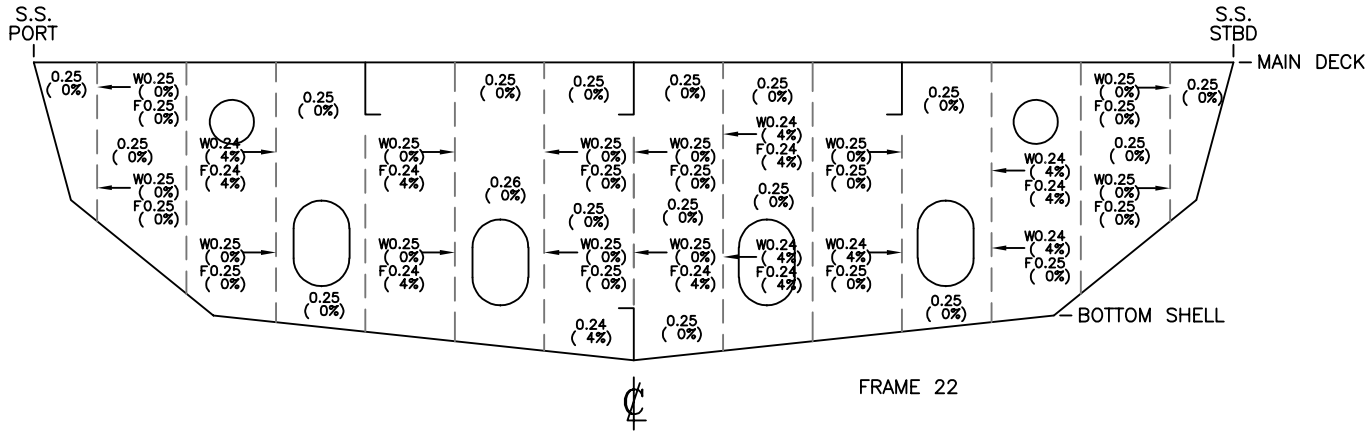
BULKHEAD 20

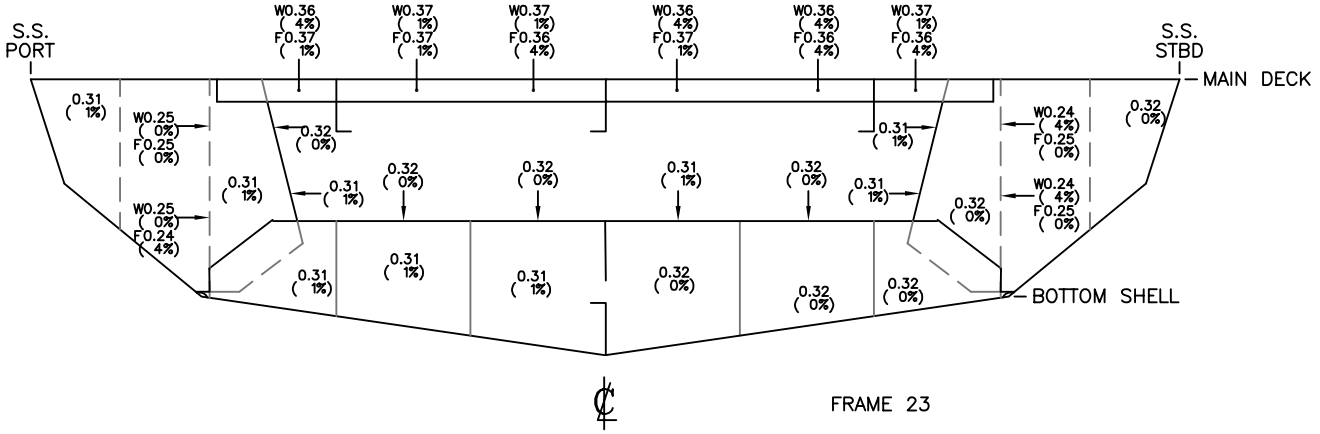


FRAME 21

NOTE:
- BULKHEAD 20 PLATING .25".
- BULKHEAD 20 VERTICAL STIFFENERS L5" x 3" x .25".
- FRAME 21 TRANSVERSE UNDER DECK FRAME L6" x 3.5 x .375".
- FRAME 21 SIDE SHELL FRAME .3125" PLATE W/ 4" FLANGE.
- FRAME 21 SIDE SHELL FRAME STIFFENERS L3" x 2" x .25".
- FRAME 21 TRANSVERSE BOTTOM FRAME 36" x 4"FlgPlt x .3125" C/F.
- FRAME 21 TRANSVERSE BOTTOM FRAME STIFFENERS L3" x 2.5" x .25".

W = WEB / F = FLANGE.





NOTE:
- SWASH FRAME PLATING .25"
- SWASH FRAME STIFFENING L3" x 2.5" x .25".
- TRANSVERSE UNDER DECK FRAME L6" x 3.5 x .375".
- SIDE SHELL FRAME .3125" PLATE W/ 4" FLANGE.
- SIDE SHELL FRAME STIFFENERS L3" x 2" x .25".
- TRANSVERSE BOTTOM FRAME 36" x 4"FlgPlt x .3125" C/F.
- TRANSVERSE BOTTOM FRAME STIFFENERS L3" x 2.5" x .25".

W = WEB / F = FLANGE.

VESSEL: M/V GUEMES

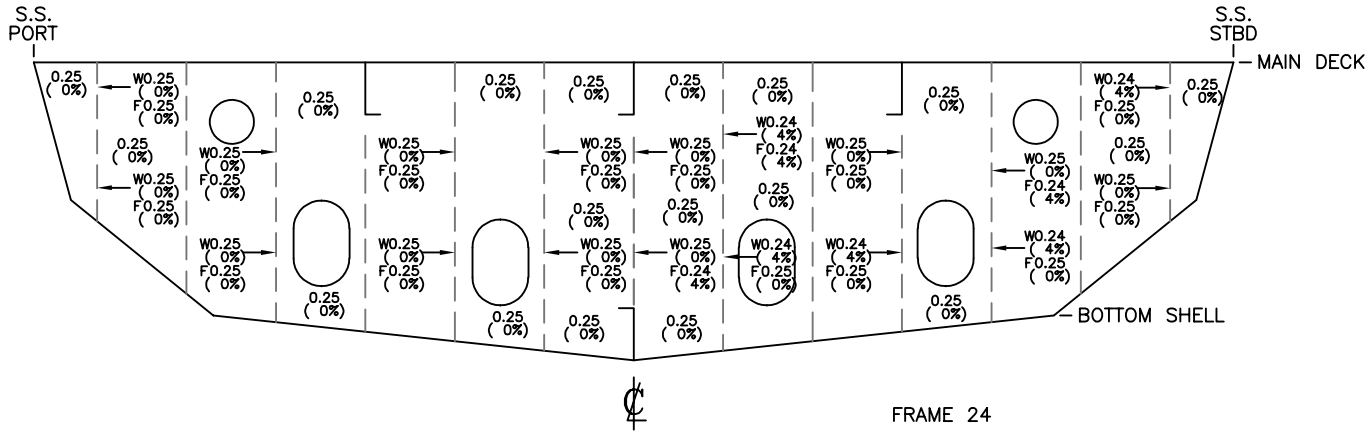
DESCRIPTION: No.8 VOID - FRAMES 22 & 23 LOOKING FORWARD

DRAWN BY: G. GRAHAM

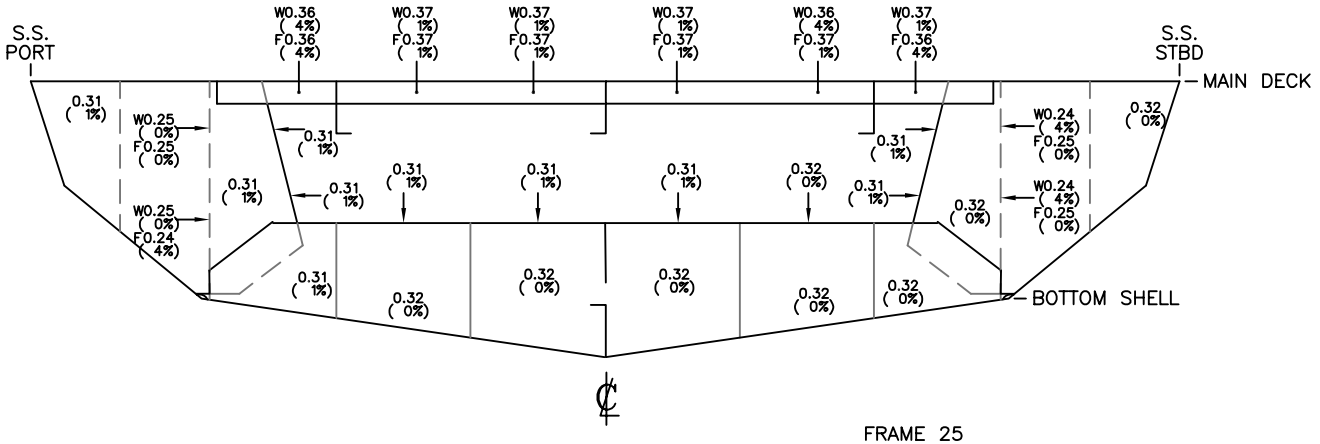
JOB # S3603

DWG # No8 FRM 22 23 v1.1

DATE: MARCH 2019



FRAME 24



FRAME 25

NOTE:
- SWASH FRAME PLATING .25"
- SWASH FRAME STIFFENING L3" x 2.5" x .25".
- TRANSVERSE UNDER DECK FRAME L6" x 3.5 x .375".
- SIDE SHELL FRAME .3125" PLATE W/ 4" FLANGE.
- SIDE SHELL FRAME STIFFENERS L3" x 2" x .25".
- TRANSVERSE BOTTOM FRAME 36" x 4"FlgPlt x .3125" C/F.
- TRANSVERSE BOTTOM FRAME STIFFENERS L3" x 2.5" x .25".

W = WEB / F = FLANGE.

VESSEL: M/V GUEMES

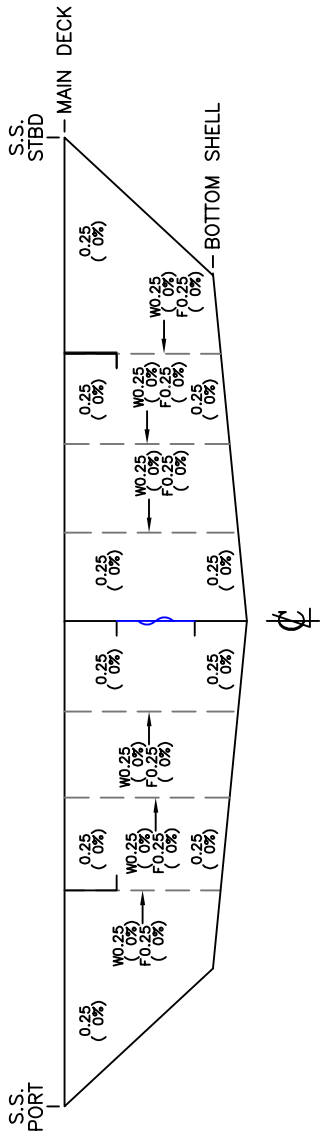
DESCRIPTION: No.8 VOID - FRAMES 24 & 25 LOOKING FORWARD

DRAWN BY: G. GRAHAM

JOB # S3603

DWG # No8 FRM 24 25 v1.1

DATE: MARCH 2019



NOTE:
FRAME 26 PLATING .25".
FRAME 26 STIFFENING L3" x 2.5" x .25".
W = WEB / F = FLANGE.

VESSEL: M/V GUEMES		DESCRIPTION: No.8 VOID - FRAME 26 LOOKING AFT	
DRAWN BY: G. GRAHAM	JOB # S3603	DWG # No8 FRM 26 v1.1	DATE: MARCH 2019

VESSEL: M/V GUEMES

DESCRIPTION: No.8 VOID - LONGITUDINAL GIRDERS
VIEWED AS NOTED

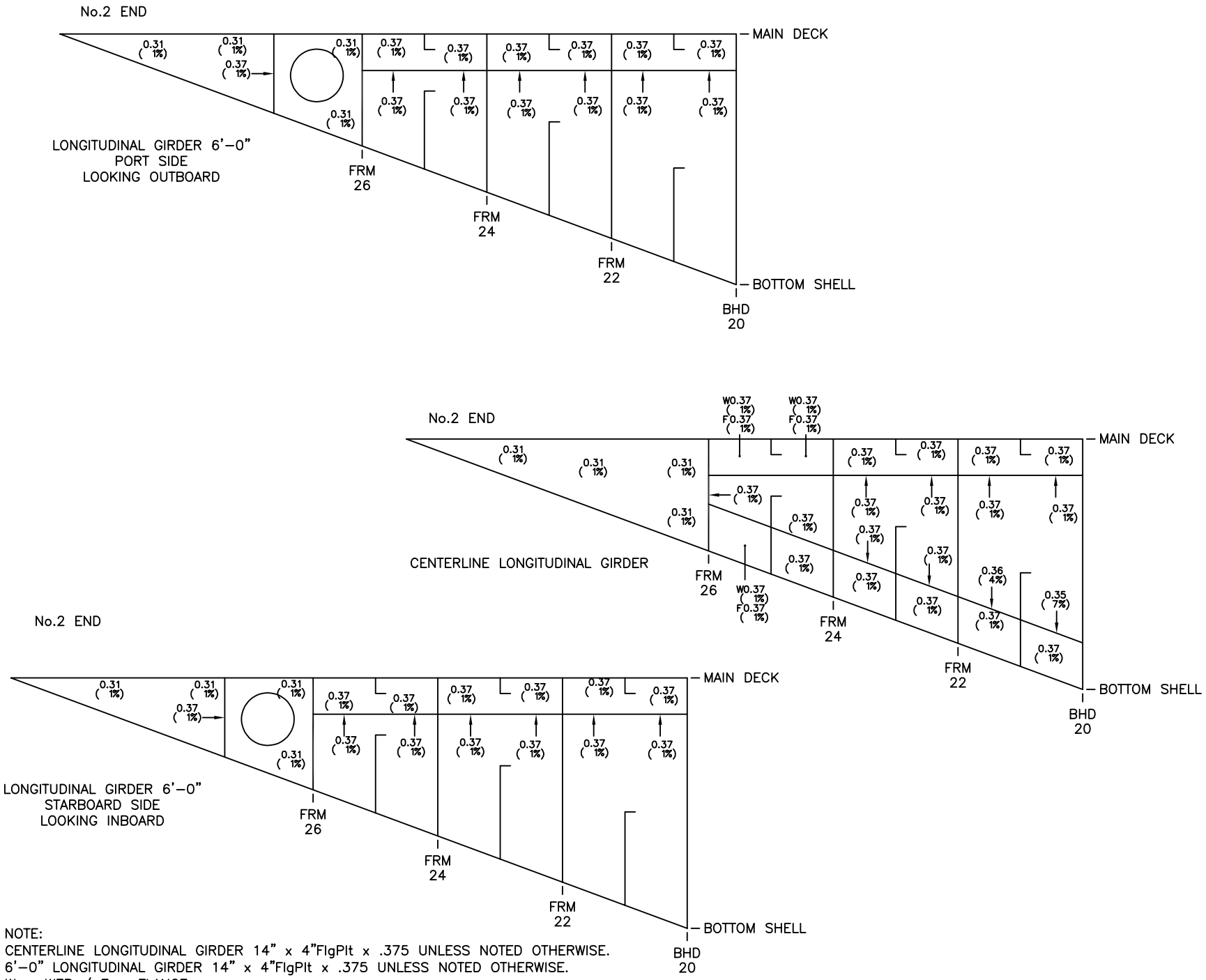
DRAWN BY: G. GRAHAM

JOB # S3603

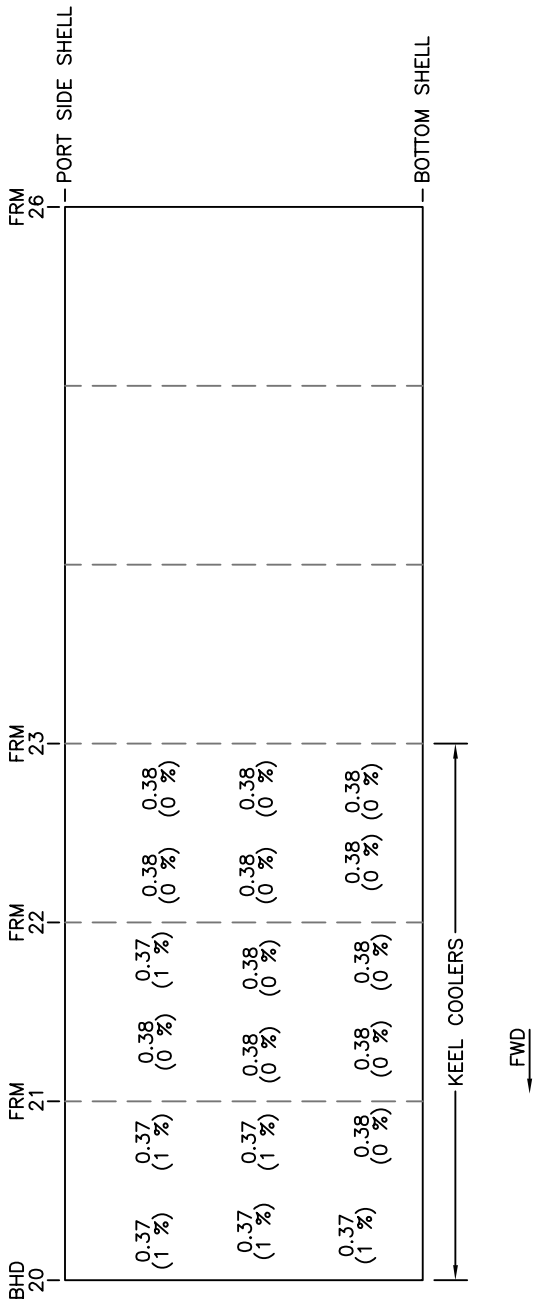
DWG # No8 LGIR

v1.1

DATE: MARCH 2019



NOTE:
CENTERLINE LONGITUDINAL GIRDER 14" x 4"FlgPlt x .375 UNLESS NOTED OTHERWISE.
6'-0" LONGITUDINAL GIRDER 14" x 4"FlgPlt x .375 UNLESS NOTED OTHERWISE.
W = WEB / F = FLANGE.



NOTE:
NO ORIGINAL SCANTLINGS AVAILABLE AT TIME OF SURVEY.
NOMINAL THICKNESS MEASUREMENTS OBTAINED TO DETERMINE PERCENT WASTAGE.

NOMINAL THICKNESS USED:
- TURN OF BILGE PLATING .375"

VESSEL: M/V GUEMES	No.8 VOID - PLATING IWO KEEL COOLERS DESCRIPTION: PORT SIDE - PLAN VIEW
DRAWN BY: G. GRAHAM / JOB # S3603	DWG # No8 VOID BTM PLT v1.1 / DATE: MARCH 2019

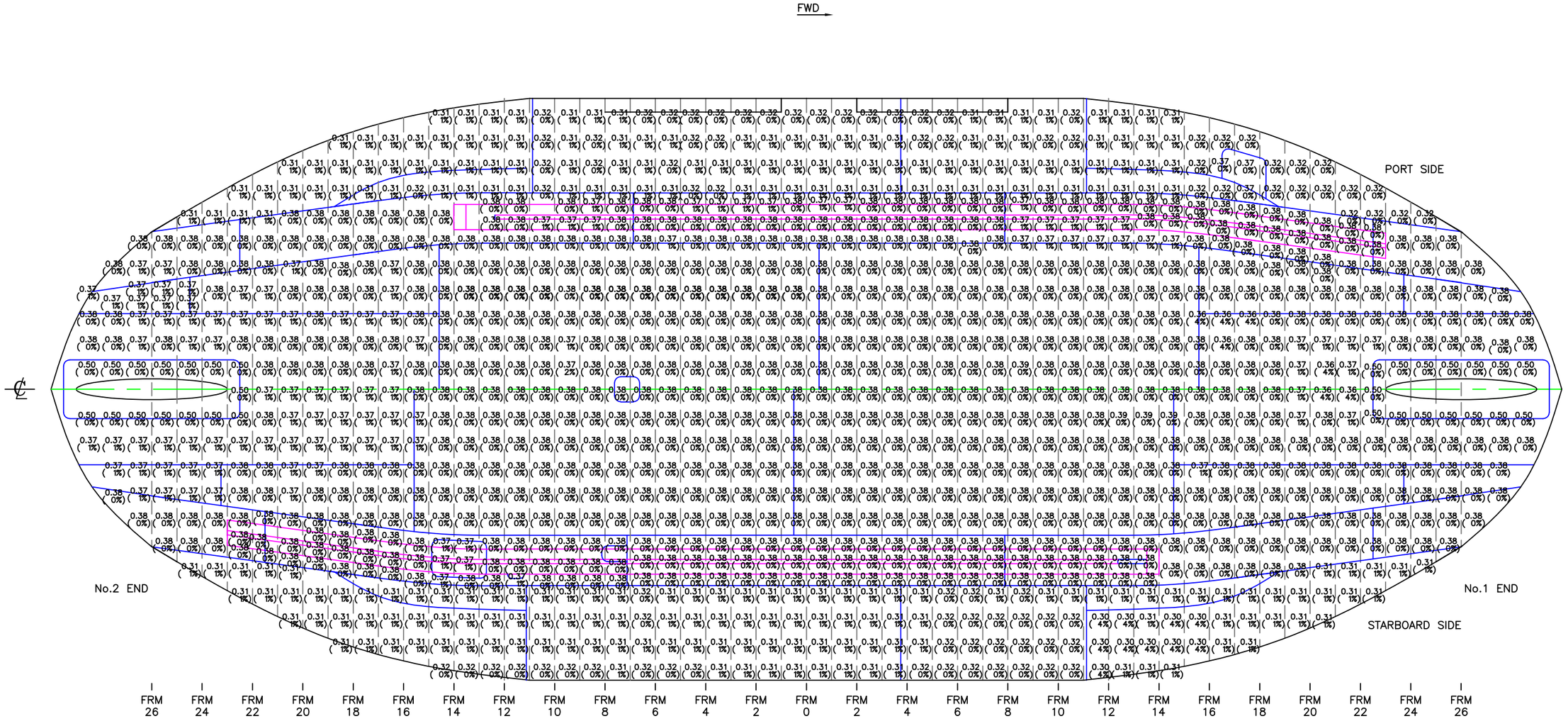
INTERNATIONAL INSPECTION

Specialists in Nondestructive Examination

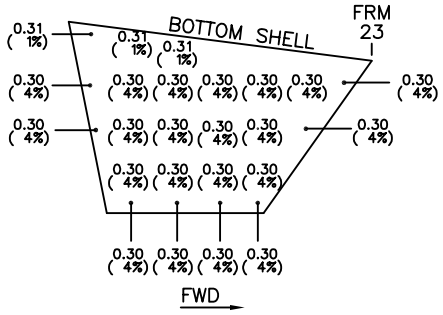
BOTTOM SHELL PLATING

&

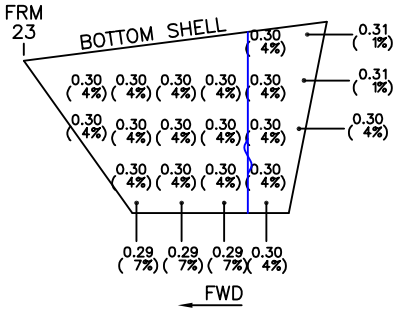
SKEGS



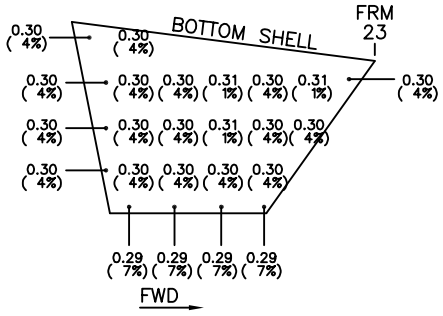
VESSEL: M/V GUEMES		DESCRIPTION: BOTTOM AND SIDE SHELL PLATING PLAN VIEW	
DRAWN BY: G. GRAHAM	JOB # S3603	DWG # HULL v1.1	DATE: MARCH 2019



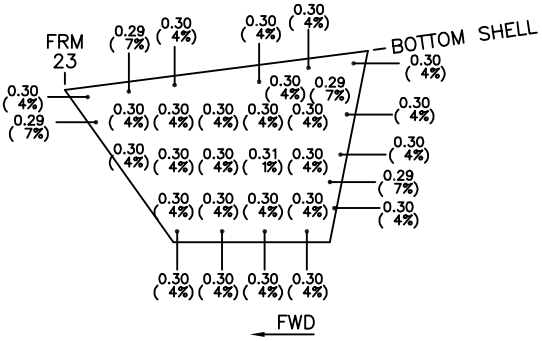
No1 END SKEG
STARBOARD SIDE
OOKING INBOARD



No1 END SKEG
PORT SIDE
OOKING INBOARD



No2 END SKEG
STARBOARD SIDE
OOKING INBOARD



No2 END SKEG
PORT SIDE
OOKING INBOARD

NOTE:
– SKEG .375" AS PER ORIGINAL SCANTLINGS.
ALL PREVIOUS REPORTS BY INTERNATIONAL INSPECTION SHOW INSTALLED PLATING WITH A NOMINAL THICKNESS OF .3125".
ALL UT MEASUREMENTS BASED OFF .3125" PLATING.

VESSEL: M/V GUEMES	DESCRIPTION: SKEG PLATING - No.1 END / No.2 END LOOKING INBOARD
DRAWN BY: G. GRAHAM	JOB # S3603
DWG # Skeg v1.1	DATE: MARCH 2019

Photo No. 1
No. 1 end looking aft port side

Photo No. 2
No. 1 end Z-drive Unit

Photo No. 3
Refurbished propeller

Photo No. 4
No. 2 end looking forward port side

Photo No. 5
No. 2 end looking forward starboard side

Photo No. 6
Interior void, representative sample of internal coatings

Photo No. 7
Interior void, representative sample of internal coatings

Photo No. 8
Main deck looking aft from No. 1 end

Photo No. 9
Main engine and compartment

Photo No. 10
Z-drive assembly, upper unit

Photo No. 11
Main deck apron showing new insert

Photo No. 12
Passenger Lounge

Photo No. 13
Pilothouse Control Console

Appendix D

See pages C-36 through C-103 for
UT Inspection Report

Appendix E

M/V Guemes 2019 Generator Load Study Plan

Contact Information:

Conor Shannon, Project Manager

(360) 479-5600

Produced By:

ART ANDERSON

202 PACIFIC AVE., BREMERTON, WA, 98337

September 25, 2019

Table of Contents

References

1: Dwg. No. SKA-320-01 Rev A Guemes Island Ferry, M/V Guemes, Electrical A/C One-Line

2: Dwg. No. SKA-320-02 Rev – MV Guemes Electrical System Load Analysis

Introduction

Skagit County Washington has contracted with Art Anderson (AA) to conduct a lifecycle valuation and propulsion study along with the Guemes's FY19 dry dock and overhaul period. Part of this study is to review the existing generator system and determine if there is a more economical and efficient set up that will better support the ferry system. The M/V Guemes has a single 60kW Stamford Yukon Model MGKNEF 45-60 generator. This generator is sized to and serves to power the vessel's normal electrical loads, the vessel's fire pump, and the Anacortes and Guemes Island Ferry Terminals (when shoreside power is lost). However, on a regular basis, it is only powering the vessel's electrical loads, which account for between approximately 8 and 22 percent of the generator's capacity, Reference [2]. Skagit County is reporting irregular maintenance issues with the M/V Guemes's generator due to severe underloading of the generator.

A potential solution to this problem is to reduce the size of the M/V Guemes's generator to only handle the vessel's loads. This would then require emergency power to be located shoreside at the ferry terminals. The loads on both the M/V Guemes and the ferry terminals have been calculated or estimated in previous work, Reference [2]. In both cases, these results are based on assumptions of what items on the shore and on the vessel are running simultaneously. Live load monitoring, however, has not been completed to determine the actual load demands on either the ferry terminal or the vessel. In order to accurately determine the most efficient generator for both the ferry terminals and the vessel, it is important to capture real time voltage and current data averaged over a period of time and captured during specific loading conditions.

This study will accomplish three things:

1. *Record voltage and current draw on the M/V Guemes over the course of several (a minimum of ten) days of normal operations. The purpose of this monitoring is to identify the typical load which a new vessel generator will have to provide during operations. Additionally, specific high loading conditions will be identified and captured for extended periods to identify the peak loading the new generator will be required to support.*

2. *Record the voltage levels and current draw at the Guemes Island Ferry Terminal over the course of several (a minimum of ten) days during normal operations for the ferry terminal loads that the vessel supports during power outages.*

3. *Record the voltage levels and current draw at the Anacortes Ferry Terminal over the course of several (a minimum of ten) days during normal operations for the ferry terminal loads that the vessel supports during power outages.*

VECA Electric and Technologies of Bellingham, WA has been contracted by Skagit County to conduct the testing.

Vessel Data Recording

The M/V Guemes's existing Yukon generator is 60kW, 60HZ, 480V, 3-Phase. This generator feeds the main switchboard located in the deckhand room which then feeds the fire pump and panel LP200. LP200 supplies all of the other electrical loads on the vessel. See Figure 1 from Reference [1].

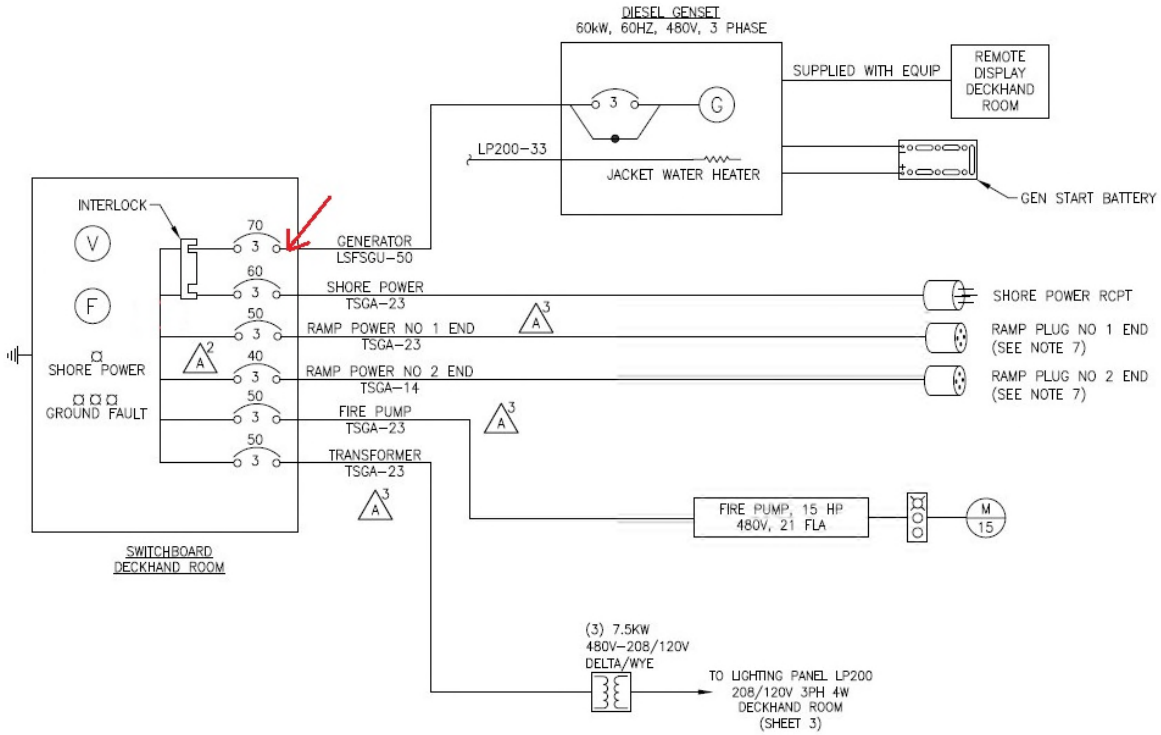


Figure 1: Guemes Electrical One-Line

The Recording Event Meter shall be connected to the panel in the area pointed to in red in Figure 1.

Events to Record

At a minimum, the following events shall be recorded:

1. *Continuous recording of the Guemes during normal operations for a minimum of 10 full days. Specific attention should be paid to power deviations which vary from the normal or average readings, and the ferry operations that were occurring during these spikes or lulls. To the greatest extent possible, the power demands from the*

vessel should be captured by recording which equipment is on at which times. For example, if certain lights and a heater typically run during the evenings and night, then those loads should be identified. Then during the day, it should generally be understood what is turned off. These different than normal conditions shall be identified by Skagit County so VECA and Art Anderson can correlate the reading from certain time periods to those load cases.

2. *Approximately three hours simulation of the full load winter operations with all lighting and heaters turned on as if the vessel is operating in cold weather during night hours. If possible, this condition should be captured while the vessel is transiting during routine service. The specific electrical equipment on/off conditions shall be noted during these periods of testing.*

3. *Fire pump start-up operations during recording events one and two above. The pump shall be started, run for a minimum of ten minutes, and shut down at least three times in each condition. Specific attention shall be paid to the power demands in this condition.*

4. *Fire pump running operations during recording event two. The fire pump shall be operated as if actively fighting a fire for at least 10 minutes (attach one or more fire hoses and direct the fully open spray overboard if necessary), for a total of three sessions.*

The above data shall be captured and organized in a manner that allows Skagit County and Art Anderson to clearly identify these conditions. Both raw and filtered data shall be provided. The filtered data shall summarize the averages of the loads seen in each condition.

Guemes Island and Anacortes Ferry Terminal Recording

Both ferry terminals are currently fed 480V 3-Phase power by Puget Sound Energy . This power feeds a panel with a 200-amp disconnect, which then feeds the main Panel B which has its own 200-amp Main Breaker. Art Anderson began providing updated electrical arrangements and drawings for both ferry terminals in 2016, but the project was delayed and to our knowledge not implemented. However, based on preliminary work, the panel arrangement should be similar to what is shown in Figure 2. The main Panel B then supplies power to a 60-amp transfer switch which then supplies Panel C which contains the breakers for the span hoist, for the bridge hydraulics (apron), and for Panel D (e.g., the bus shelter lighting). The emergency generator also supplies power to the transfer switch identified above. If the arrangements differ from what is shown below, the differences shall be annotated and identified to Skagit County and Art Anderson.

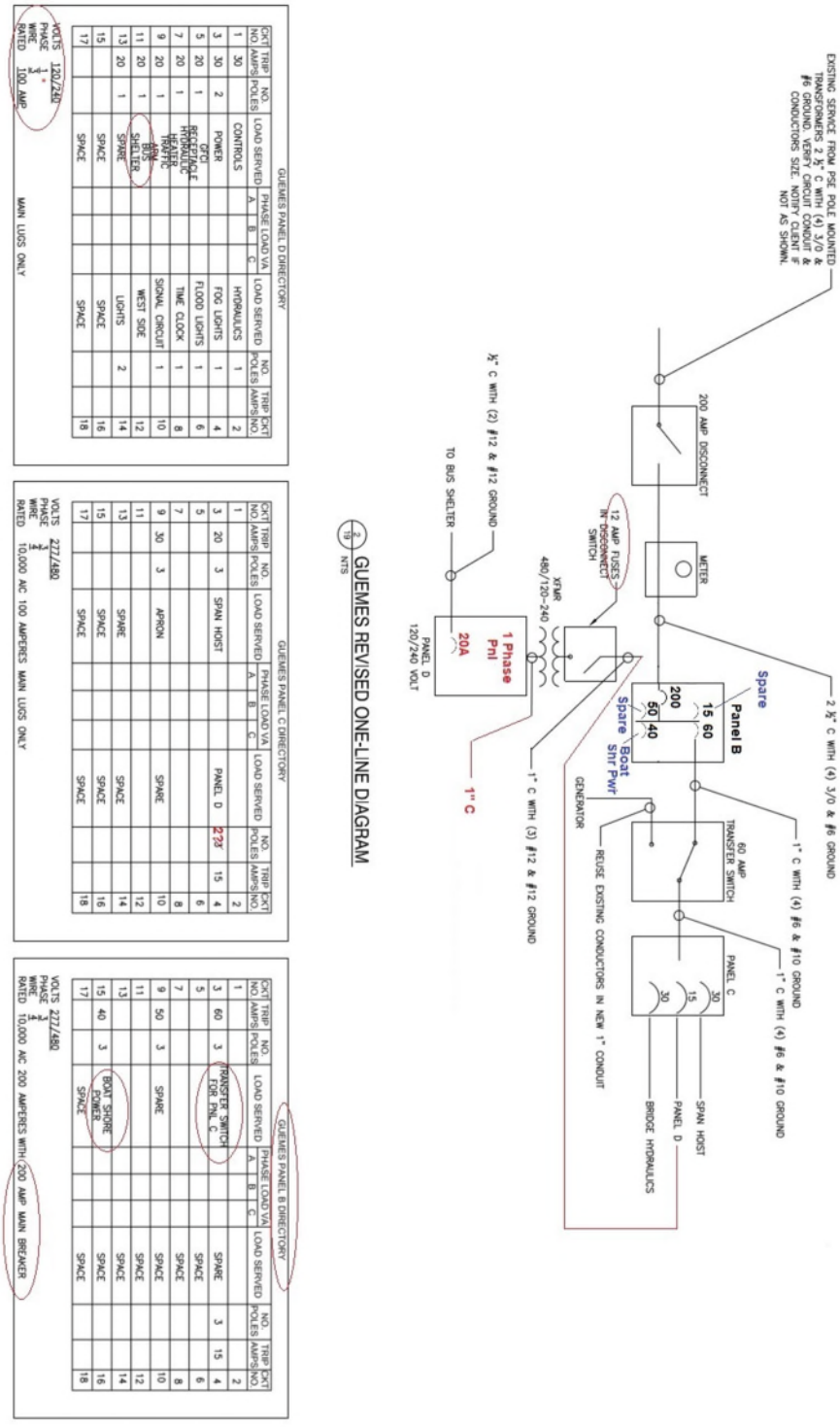


Figure 2: Terminal One-Line (Guemes shown: Anacortes similar)

The recording event meter shall be connected between the respective ferry terminal meter and the ferry terminal's, respective, Panel B. If the arrangements differ from above, all efforts shall be taken to ensure that the data being captured includes all items that are, also, supplied by the emergency generator.

Events to be Recorded

For the ferry terminals, current and voltage shall be recorded for a minimum of 10 full days during normal operations. It is not believed that there are any high draw events such as the heaters or fire pump on the vessel. However, power spike or lulls shall be identified and the reason for them attempted to be identified. The main deviations in power shall occur when the vessel arrives/departs the dock and the ramp is operating.

Both raw and filtered data shall be provided. The filtered data shall summarize the averages of the loads seen in each condition.

Appendix F

DENT METER REPORT SUMMARIES

SKAGIT COUNTY

500 I AVENUE
ANACORTES, WA 98221

#618391

400A MAIN OFFICE

Data Summary

Data File Name: 400a main office.elog

First Data Record End Time: 01/01/12 00:30:00

Last Data Record End Time: 01/13/12 00:15:00

Monitoring Period Duration: 12.00 days

Peak Demand

Window Size Min.: 15

Channel	KW	KVA	KVAR
Power 5	27.470 23:30:00 01/06/2012	27.675 23:30:00 01/06/2012	9.817 20:40:00 01/01/2012
Power 6	Off		

Totalizers

Channel	KWH	-KWH	+KWH	KVAH	KVARH	-KVARH	+KVARH
Power 5	1558.305	-0.000	1558.305	1679.464	366.038	-0.054	366.092

Channel	Average	Maximum (Date Time)	Minimum (Date Time)	Total
Power 1 Min. Volt	282.520	285.883 (01/08/12 03:15:00)	267.854 (01/07/12 16:15:00)	
Power 1 Max. Volt	285.642	288.080 (01/06/12 20:45:00)	283.298 (01/12/12 20:45:00)	
Power 1 Avg. Volt	284.767	286.922 (01/03/12 01:15:00)	282.503 (01/12/12 20:45:00)	
Power 1 Min. Amp	1.318	25.823 (01/01/12 07:15:00)	0.000 (01/13/12 00:15:00)	
Power 1 Max. Amp	27.708	88.567 (01/01/12 20:30:00)	0.000 (01/12/12 20:15:00)	

Power 1 Avg. Amp	6.936	33.747 (01/06/12 23:30:00)	0.000 (01/12/12 20:15:00)		
Power 1 KW Hours	0.468	2.378 (01/06/12 23:30:00)	0.000 (01/12/12 23:45:00)	539.507	
Power 1 Max. KW	6.935	20.419 (01/06/12 20:30:00)	0.000 (01/12/12 20:15:00)		
Power 1 Avg. KW	1.873	9.513 (01/06/12 23:30:00)	0.000 (01/12/12 20:15:00)		
Power 1 KVA Hours	0.493	2.394 (01/06/12 23:30:00)	0.000 (01/12/12 23:45:00)	568.122	
Power 1 Max. KVA	7.857	24.805 (01/01/12 20:30:00)	0.000 (01/12/12 20:15:00)		
Power 1 Avg. KVA	1.973	9.575 (01/06/12 23:30:00)	0.000 (01/12/12 20:15:00)		
Power 1 Min. dPF	0.46	1.00 (01/13/12 00:00:00)	-1.00 (01/11/12 03:15:00)		
Power 1 Max. dPF	0.96	1.00 (01/13/12 00:15:00)	-1.00 (01/08/12 11:30:00)		
Power 1 Avg. dPF	0.97	1.00 (01/13/12 00:15:00)	-0.99 (01/11/12 10:00:00)		

Power 1 THD = 19.777329

Power 2 Min. Volt	280.324	284.203 (01/10/12 04:45:00)	213.378 (01/03/12 12:00:00)		
Power 2 Max. Volt	283.442	286.141 (01/03/12 06:00:00)	280.132 (01/06/12 23:30:00)		

Power 2 Avg. Volt	282.562	285.154	(01/04/12 04:00:00)	279.287	(01/06/12 23:30:00)
Power 2 Min. Amp	2.136	27.265	(01/03/12 10:00:00)	0.000	(01/13/12 00:15:00)
Power 2 Max. Amp	28.810	97.030	(01/07/12 23:00:00)	0.000	(01/12/12 07:45:00)
Power 2 Avg. Amp	8.321	33.738	(01/06/12 23:30:00)	0.000	(01/12/12 07:45:00)
Power 2 KW Hours	0.545	2.331	(01/06/12 23:30:00)	0.000	(01/12/12 08:15:00) 627.275
Power 2 Max. KW	7.070	19.498	(01/10/12 21:00:00)	0.000	(01/12/12 07:45:00)
Power 2 Avg. KW	2.178	9.323	(01/06/12 23:30:00)	0.000	(01/12/12 07:45:00)
Power 2 KVA Hours	0.587	2.355	(01/06/12 23:30:00)	0.000	(01/12/12 08:15:00) 675.790
Power 2 Max. KVA	8.104	26.999	(01/07/12 23:00:00)	0.000	(01/12/12 07:45:00)
Power 2 Avg. KVA	2.346	9.420	(01/06/12 23:30:00)	0.000	(01/12/12 07:45:00)
Power 2 Min. dPF	0.77	1.00	(01/12/12 07:45:00)	-0.70	(01/09/12 08:45:00)
Power 2 Max. dPF	0.95	1.00	(01/13/12 00:15:00)	-1.00	(01/11/12 11:45:00)
Power 2 Avg. dPF	0.94	1.00	(01/12/12 07:45:00)	0.53	(01/05/12 07:00:00)

Power 2 THD = 15.418523

Power 3 Min. Volt	280.500	284.203 (01/02/12 13:15:00)	267.724 (01/03/12 12:15:00)	
Power 3 Max. Volt	283.555	306.174 (01/03/12 12:00:00)	280.519 (01/09/12 21:45:00)	
Power 3 Avg. Volt	282.675	284.840 (01/02/12 13:30:00)	279.803 (01/06/12 23:30:00)	
Power 3 Min. Amp	0.870	23.005 (01/01/12 07:15:00)	0.000 (01/13/12 00:15:00)	
Power 3 Max. Amp	25.819	99.907 (01/07/12 23:30:00)	0.000 (01/12/12 19:45:00)	
Power 3 Avg. Amp	5.360	31.031 (01/06/12 23:30:00)	0.000 (01/12/12 19:45:00)	
Power 3 KW Hours	0.340	2.158 (01/06/12 23:30:00)	0.000 (01/12/12 20:15:00)	391.495
Power 3 Max. KW	5.947	17.794 (01/07/12 23:30:00)	0.000 (01/12/12 19:45:00)	
Power 3 Avg. KW	1.359	8.634 (01/06/12 23:30:00)	0.000 (01/12/12 19:45:00)	
Power 3 KVA Hours	0.378	2.170 (01/06/12 23:30:00)	0.000 (01/12/12 20:15:00)	435.515
Power 3 Max. KVA	7.263	27.806 (01/07/12 23:30:00)	0.000 (01/12/12 19:45:00)	
Power 3 Avg. KVA	1.512	8.680 (01/06/12 23:30:00)	0.000 (01/12/12 19:45:00)	
Power 3 Min. dPF	0.50	1.00 (01/12/12 19:45:00)	-0.99 (01/06/12 07:30:00)	
Power 3 Max. dPF	0.98	1.00 (01/13/12 00:15:00)	-1.00 (01/02/12 03:30:00)	

Power 3 Avg. dPF 0.88 1.00 (01/13/12 00:15:00) -0.99 (01/12/12 03:45:00)

Power 3 THD = 0.000000

Power 5 Min. Volt 281.423 284.526 (01/10/12 04:45:00) 269.211 (01/03/12 12:00:00)

Power 5 Max. Volt 284.003 285.991 (01/06/12 20:45:00) 281.661 (01/06/12 23:30:00)

Power 5 Avg. Volt 283.335 285.366 (01/03/12 05:15:00) 280.991 (01/06/12 23:30:00)

Power 5 Min. Amp 1.472 24.413 (01/01/12 07:15:00) 0.000 (01/13/12 00:15:00)

Power 5 Max. Amp 26.213 93.537 (01/07/12 23:30:00) 0.000 (01/10/12 04:15:00)

Power 5 Avg. Amp 6.873 32.839 (01/06/12 23:30:00) 0.000 (01/10/12 04:15:00)

Power 5 KW Hours 1.353 6.868 (01/06/12 23:30:00) 0.000 (01/10/12 04:15:00) 1558.298

Power 5 Max. KW 18.902 55.759 (01/06/12 20:30:00) 0.000 (01/10/12 04:15:00)

Power 5 Avg. KW 5.411 27.470 (01/06/12 23:30:00) 0.000 (01/10/12 04:15:00)

Power 5 KVA Hours 1.458 6.919 (01/06/12 23:30:00) 0.000 (01/10/12 04:15:00) 1679.478

Power 5 Max. KVA 22.181 78.368 (01/07/12 23:30:00) 0.000 (01/10/12 04:15:00)

Power 5 Avg. KVA 5.831 27.675 (01/06/12 23:30:00) 0.000 (01/10/12 04:15:00)

Power 5 Min. dPF	0.73	1.00	(01/10/12 04:15:00)	-0.95	(01/10/12 06:15:00)
Power 5 Max. dPF	0.99	1.00	(01/13/12 00:15:00)	0.51	(01/01/12 19:30:00)
Power 5 Avg. dPF	0.95	1.00	(01/12/12 22:15:00)	0.43	(01/01/12 18:00:00)

PLEASE NOTE: Results suggest that some values may be distorted by THD.

Setup Summary

Setup Table Description: 3 Phase - 4 Wire

Power 1 - Power: VHi: L1, VLo: N; PT = 1.000; CT = 5000.000; Phase Shift = 0.000; CT Type = RoCoil

Power 2 - Power: VHi: L2, VLo: N; PT = 1.000; CT = 5000.000; Phase Shift = 0.000; CT Type = RoCoil

Power 3 - Power: VHi: L3, VLo: N; PT = 1.000; CT = 5000.000; Phase Shift = 0.000; CT Type = RoCoil

Power 5 - Power Sum: 1,2,3

Memory Type: Ring

Line Frequency: 60 Hz

Integration Period: 15 Minutes

Logger Summary

Logger Description Line: 470011-022

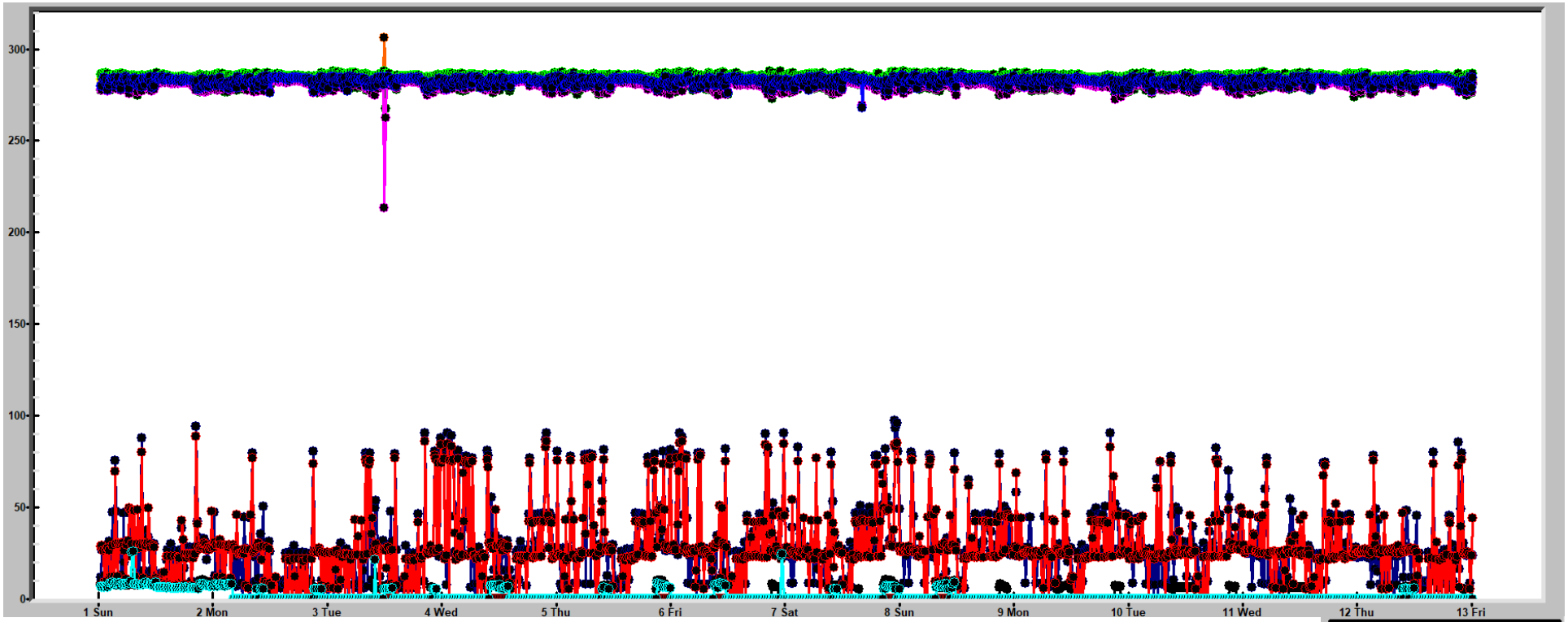
Logger Serial Number: XC1406077

Logger Type: ELITEpro XC

Firmware Version: ES400.257

400A MAIN OFFICE

MINIMUM & MAXIMUM VOLTAGE
MINIMUM & MAXIMUM AMPERAGE

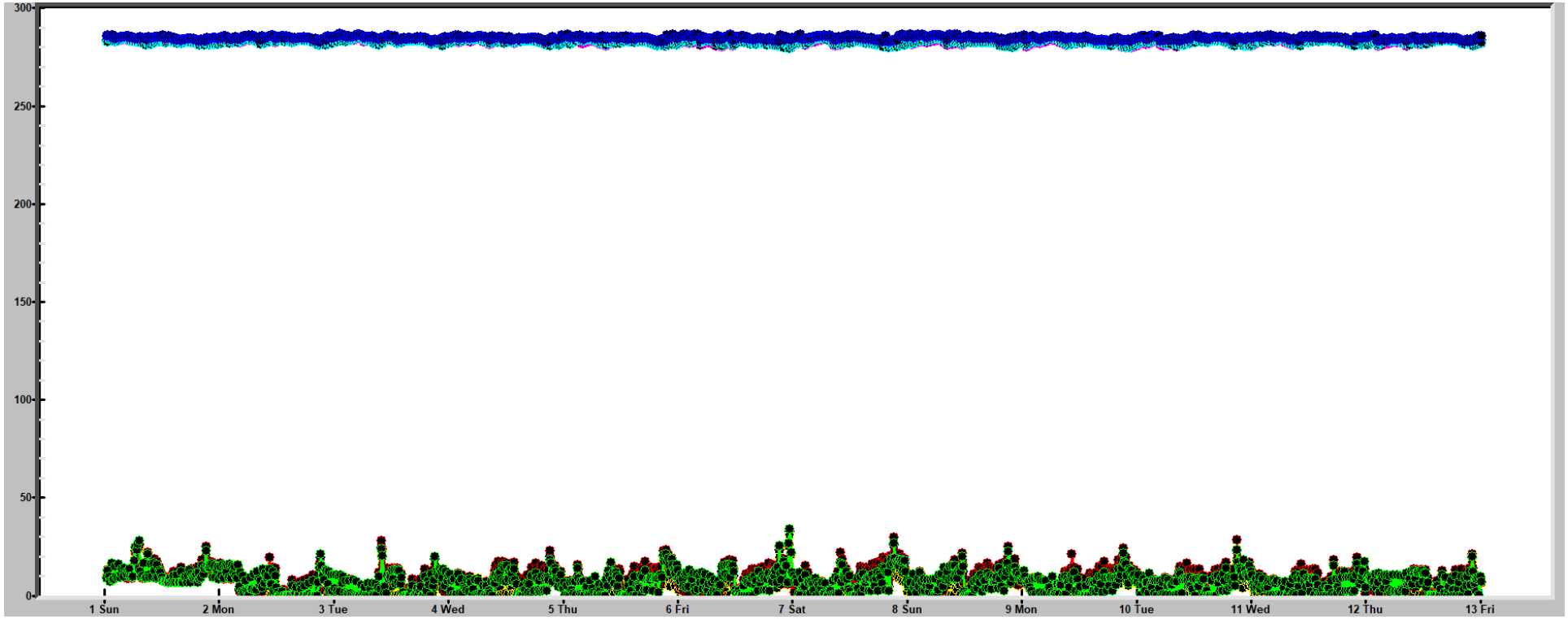


Analysis Summary

Power 1 Min. Volt L1 Phase
Avg. 282.52, Min. 267.85, Max. 285.88
Power 1 Max. Volt L1 Phase
Avg. 285.64, Min. 283.30, Max. 288.08
Power 1 Min. Amp L1 Phase
Avg. 1.32, Min. 0.00, Max. 25.82
Power 1 Max. Amp L1 Phase
Avg. 27.71, Min. 0.00, Max. 88.57
Power 2 Min. Volt L2 Phase
Avg. 280.32, Min. 213.38, Max. 284.20
Power 2 Max. Volt L2 Phase
Avg. 283.44, Min. 280.13, Max. 286.14
Power 2 Min. Amp L2 Phase
Avg. 2.14, Min. 0.00, Max. 27.26
Power 2 Max. Amp L2 Phase
Avg. 28.81, Min. 0.00, Max. 97.03
Power 3 Min. Volt L3 Phase
Avg. 280.50, Min. 267.72, Max. 284.20
Power 3 Max. Volt L3 Phase
Avg. 283.56, Min. 280.52, Max. 306.17
Power 3 Min. Amp L3 Phase
Avg. 0.87, Min. 0.00, Max. 23.00
Power 3 Max. Amp L3 Phase
Avg. 25.82, Min. 0.00, Max. 99.91
Power 5 Min. Volt 3 Phase Sy...
Avg. 281.42, Min. 269.21, Max. 284.53
Power 5 Max. Volt 3 Phase Sy...
Avg. 284.00, Min. 281.66, Max. 285.99
Power 5 Min. Amp 3 Phase Sy...
Avg. 1.47, Min. 0.00, Max. 24.41
Power 5 Max. Amp 3 Phase Sy...
Avg. 26.21, Min. 0.00, Max. 93.54

400A MAIN OFFICE

AVERAGE
VOLTAGE & AMPERAGE



Analysis Summary

----- Power 1 Avg. Volt L1 Phase
Avg. 284.77, Min. 282.50, Max. 286.92

----- Power 1 Avg. Amp L1 Phase
Avg. 6.94, Min. 0.00, Max. 33.75

----- Power 2 Avg. Volt L2 Phase
Avg. 282.56, Min. 279.29, Max. 285.15

----- Power 2 Avg. Amp L2 Phase
Avg. 8.32, Min. 0.00, Max. 33.74

----- Power 3 Avg. Volt L3 Phase
Avg. 282.68, Min. 279.80, Max. 284.84

----- Power 3 Avg. Amp L3 Phase
Avg. 5.36, Min. 0.00, Max. 31.03

----- Power 5 Avg. Volt 3 Phase Sy...
Avg. 283.33, Min. 280.99, Max. 285.37

----- Power 5 Avg. Amp 3 Phase Sy...
Avg. 6.87, Min. 0.00, Max. 32.84

FERRY

Data Summary

Data File Name: Ferry.elog

First Data Record End Time: 10/23/19 17:00:00

Last Data Record End Time: 11/04/19 10:00:00

Monitoring Period Duration: 11.76 days

Peak Demand

Window Size Min.: 15

Channel	KW	KVA	KVAR
Power 5	30.844 12:44:28 10/29/2019	31.994 12:44:28 10/29/2019	8.224 12:42:57 10/28/2019
Power 6	Off		

Totalizers

Channel	KWH	-KWH	+KWH	KVAH	KVARH	-KVARH	+KVARH
Power 5	1130.180	-0.000	1130.180	1223.890	198.817	-0.001	198.818

Channel	Average	Maximum (Date Time)	Minimum (Date Time)	Total
Power 1 Min. Volt	269.866	283.815 (11/03/19 00:45:00)	0.000 (11/04/19 05:45:00)	
Power 1 Max. Volt	283.293	302.456 (10/26/19 07:30:00)	279.235 (10/26/19 19:45:00)	
Power 1 Avg. Volt	280.012	284.727 (10/24/19 22:30:00)	275.345 (11/04/19 06:00:00)	
Power 1 Amp Hours	1.296	7.944 (10/29/19 12:45:00)	0.000 (11/04/19 05:30:00)	1128.766
Power 1 Max. Amp	8.703	139.030 (10/28/19 12:45:00)	0.000 (11/04/19 05:30:00)	

Power 1 Avg. Amp 5.184 31.778 (10/29/19 12:45:00) 0.000 (11/04/19 05:30:00)

Power 1 KW Hours 0.333 2.140 (10/29/19 12:45:00) 0.000 (11/04/19 05:30:00) 290.013

Power 1 Max. KW 2.049 21.001 (10/28/19 12:45:00) -9.345 (11/01/19 06:15:00)

Power 1 Avg. KW 1.332 8.560 (10/29/19 12:45:00) 0.000 (11/04/19 05:30:00)

Power 1 Max. KVA 2.339 30.545 (10/28/19 12:45:00) 0.000 (11/04/19 05:30:00)

Power 1 Avg. KVA 1.438 8.767 (10/29/19 12:45:00) 0.000 (11/04/19 05:30:00)

Power 1 Min. dPF 0.33 1.00 (11/04/19 05:30:00) -0.97 (10/29/19 14:00:00)

Power 1 Max. dPF 0.88 1.00 (11/04/19 10:00:00) -1.00 (11/04/19 07:00:00)

Power 1 Avg. dPF 0.98 1.00 (11/04/19 09:30:00) -0.99 (11/04/19 07:45:00)

Power 1 THD = 33.338970

Power 2 Min. Volt 267.885 281.428 (10/25/19 01:45:00) 0.000 (11/04/19 05:45:00)

Power 2 Max. Volt 282.442 297.941 (10/31/19 12:45:00) 275.300 (10/26/19 19:30:00)

Power 2 Avg. Volt 278.404 282.878 (11/03/19 00:45:00) 273.905 (10/31/19 07:00:00)

Power 2 Amp Hours 2.127 10.733 (10/29/19 12:45:00) 0.000 (11/04/19 05:30:00) 1852.868

Power 2 Max. Amp 14.699 151.216 (10/26/19 07:30:00) 0.000 (11/04/19 05:30:00)

Power 2 Avg. Amp 8.509 42.933 (10/29/19 12:45:00) 0.000 (11/04/19 05:30:00)

Power 2 KW Hours 0.578 2.936 (10/29/19 12:45:00) 0.000 (11/04/19 05:30:00) 503.564

Power 2 Max. KW 3.857 20.995 (10/28/19 12:45:00) 0.000 (11/04/19 05:30:00)

Power 2 Avg. KW 2.313 11.743 (10/29/19 12:45:00) 0.000 (11/04/19 05:30:00)

Power 2 Max. KVA 3.970 32.880 (10/26/19 07:30:00) 0.000 (11/04/19 05:30:00)

Power 2 Avg. KVA 2.347 11.827 (10/29/19 12:45:00) 0.000 (11/04/19 05:30:00)

Power 2 Min. dPF 0.88 1.00 (11/04/19 05:30:00) -1.00 (10/28/19 21:00:00)

Power 2 Max. dPF 0.84 1.00 (11/04/19 10:00:00) -1.00 (11/04/19 09:45:00)

Power 2 Avg. dPF 1.00 1.00 (11/04/19 09:30:00) -0.99 (11/04/19 06:00:00)

Power 2 THD = 14.985229

Power 3 Min. Volt 268.716 283.363 (10/28/19 22:45:00) 0.000 (11/04/19 05:45:00)

Power 3 Max. Volt 282.994 295.619 (10/29/19 12:45:00) 274.720 (10/26/19 19:45:00)

Power 3 Avg. Volt 278.954 284.570 (10/28/19 22:45:00) 271.854 (10/26/19 19:30:00)

Power 3 Amp Hours 1.620 10.229 (10/29/19 12:45:00) 0.000 (11/04/19 05:30:00) 1410.814

Power 3 Max. Amp 12.251 168.369 (10/30/19 13:00:00) 0.000 (11/04/19 05:30:00)

Power 3 Avg. Amp 6.479 40.915 (10/29/19 12:45:00) 0.000 (11/04/19 05:30:00)

Power 3 KW Hours 0.374 2.582 (10/29/19 12:45:00) 0.000 (11/04/19 05:30:00) 325.801

Power 3 Max. KW 2.881 23.255 (10/30/19 13:00:00) 0.000 (11/04/19 05:30:00)

Power 3 Avg. KW 1.496 10.328 (10/29/19 12:45:00) 0.000 (11/04/19 05:30:00)

Power 3 Max. KVA 3.267 37.294 (10/30/19 13:00:00) 0.000 (11/04/19 05:30:00)

Power 3 Avg. KVA 1.781 11.156 (10/29/19 12:45:00) 0.000 (11/04/19 05:30:00)

Power 3 Min. dPF 0.78 1.00 (11/04/19 05:30:00) -0.94 (10/29/19 10:00:00)

Power 3 Max. dPF 0.99 1.00 (11/04/19 10:00:00) -1.00 (10/27/19 09:15:00)

Power 3 Avg. dPF 0.92 1.00 (11/04/19 05:30:00) 0.49 (10/24/19 14:15:00)

Power 3 THD = 45.614016

Power 5 Min. Volt	269.416	282.761	(10/26/19 03:00:00)	0.000	(11/04/19 05:45:00)
Power 5 Max. Volt	282.433	296.070	(10/26/19 07:30:00)	277.020	(10/26/19 19:30:00)
Power 5 Avg. Volt	279.123	283.890	(10/28/19 22:45:00)	274.567	(10/31/19 07:00:00)
Power 5 Amp Hours	1.681	9.635	(10/29/19 12:45:00)	0.000	(11/04/19 05:30:00) 1464.142
Power 5 Max. Amp	11.412	133.972	(10/28/19 12:45:00)	0.000	(11/04/19 05:30:00)
Power 5 Avg. Amp	6.724	38.542	(10/29/19 12:45:00)	0.000	(11/04/19 05:30:00)
Power 5 KW Hours	1.285	7.658	(10/29/19 12:45:00)	0.000	(11/04/19 05:30:00) 1119.374
Power 5 Max. KW	8.389	57.943	(10/28/19 12:45:00)	0.000	(11/04/19 05:30:00)
Power 5 Avg. KW	5.141	30.632	(10/29/19 12:45:00)	0.000	(11/04/19 05:30:00)
Power 5 Max. KVA	9.191	81.321	(10/28/19 12:45:00)	0.000	(11/04/19 05:30:00)
Power 5 Avg. KVA	5.566	31.750	(10/29/19 12:45:00)	0.000	(11/04/19 05:30:00)
Power 5 Min. dPF	0.92	1.00	(11/04/19 05:30:00)	-0.84	(10/25/19 23:30:00)
Power 5 Max. dPF	1.00	1.00	(11/04/19 09:30:00)	0.97	(10/24/19 14:30:00)
Power 5 Avg. dPF	0.99	1.00	(11/04/19 05:30:00)	0.89	(10/24/19 15:00:00)

PLEASE NOTE: Results suggest that some values may be distorted by THD.

Setup Summary

Setup Table Description: 3 Phase - 4 Wire

Power 1 - Power: VHi: L1, VLo: N; PT = 1.000; CT = 5000.000; Phase Shift = 0.000; CT Type = RoCoil

Power 2 - Power: VHi: L2, VLo: N; PT = 1.000; CT = 5000.000; Phase Shift = 0.000; CT Type = RoCoil

Power 3 - Power: VHi: L3, VLo: N; PT = 1.000; CT = 5000.000; Phase Shift = 0.000; CT Type = RoCoil

Power 5 - Power Sum: 1,2,3

Memory Type: Ring

Line Frequency: 60 Hz

Integration Period: 15 Minutes

Logger Summary

Logger Description Line: 167003

Logger Serial Number: SP1203060

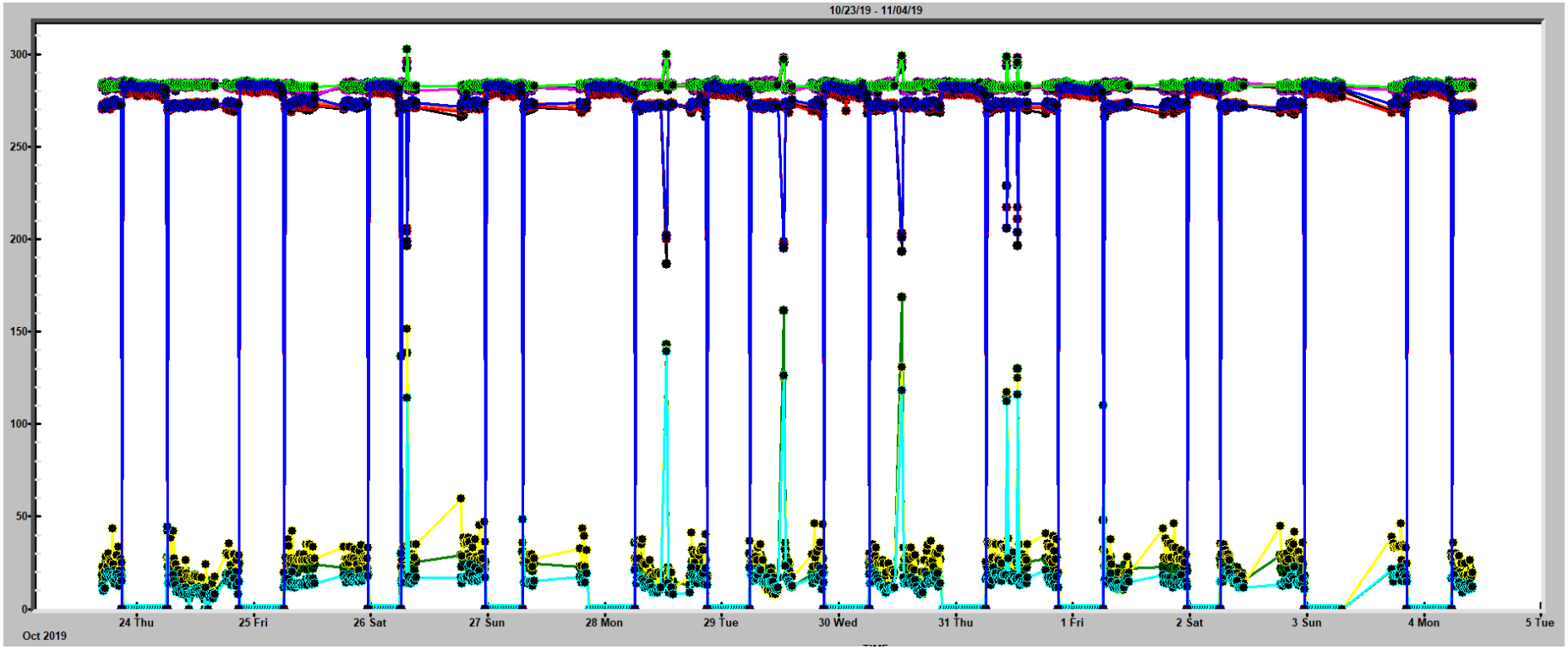
Logger Type: ELITEpro SP

Firmware Version: ES400.257

FERRY

MINIMUM & MAXIMUM VOLTAGE

MAXIMUM AMPERAGE



Analysis Summary

Power 1 Min. Volt L1 Phase
Avg. 269.87, Min. 0.00, Max. 283.82

Power 1 Max. Volt L1 Phase
Avg. 283.29, Min. 279.23, Max. 302.46

Power 1 Max. Amp L1 Phase
Avg. 8.70, Min. 0.00, Max. 139.03

Power 2 Min. Volt L2 Phase
Avg. 267.88, Min. 0.00, Max. 281.43

Power 2 Max. Volt L2 Phase
Avg. 282.44, Min. 275.30, Max. 297.94

Power 2 Max. Amp L2 Phase
Avg. 14.70, Min. 0.00, Max. 151.22

Power 3 Min. Volt L3 Phase
Avg. 268.72, Min. 0.00, Max. 283.36

Power 3 Max. Volt L3 Phase
Avg. 282.99, Min. 274.72, Max. 295.62

Power 3 Max. Amp L3 Phase
Avg. 12.25, Min. 0.00, Max. 168.37

Power 5 Min. Volt 3 Phase Sy...
Avg. 269.42, Min. 0.00, Max. 282.76

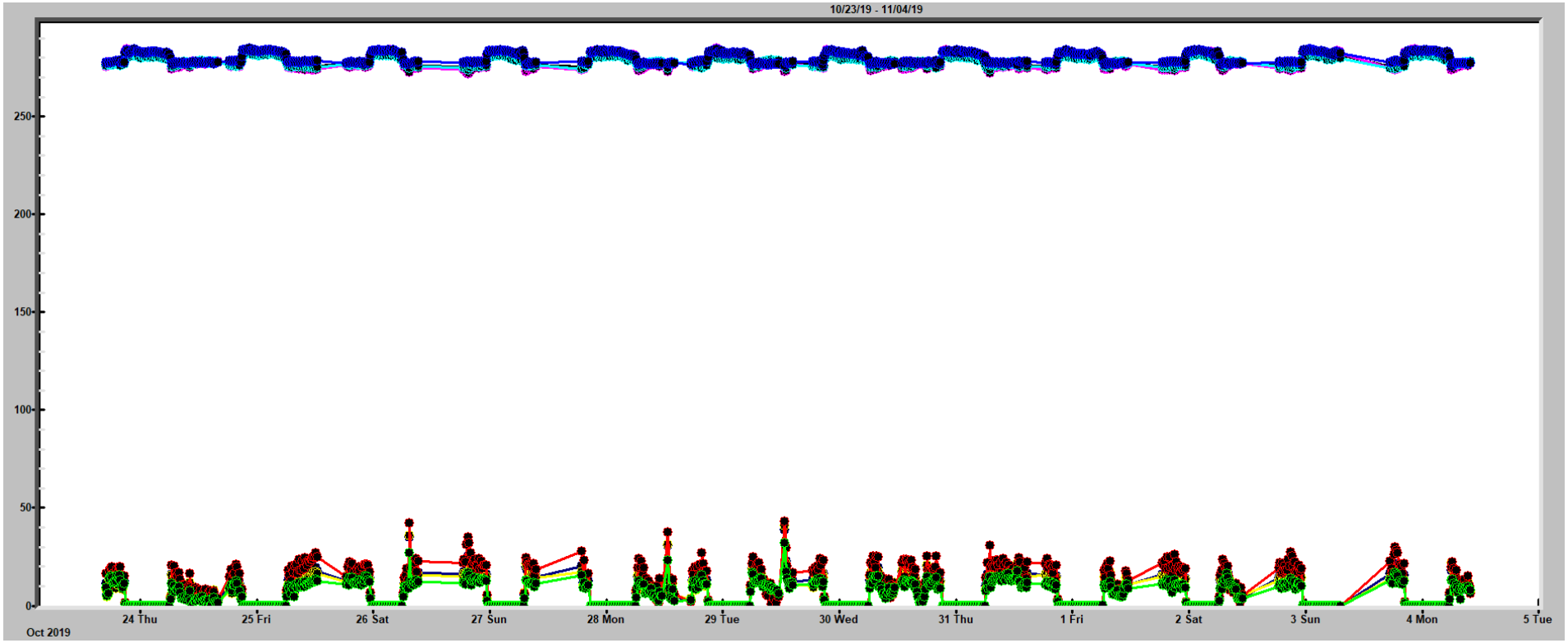
Power 5 Max. Volt 3 Phase Sy...
Avg. 282.43, Min. 277.02, Max. 296.07

Power 5 Max. Amp 3 Phase Sy...
Avg. 11.41, Min. 0.00, Max. 133.97

FERRY

AVERAGE

VOLTAGE & AMPERAGE



Analysis Summary

Power 1 Avg. Volt L1 Phase
Avg. 280.01, Min. 275.35, Max. 284.73

Power 1 Avg. Amp L1 Phase
Avg. 5.18, Min. 0.00, Max. 31.78

Power 2 Avg. Volt L2 Phase
Avg. 278.40, Min. 273.90, Max. 282.88

Power 2 Avg. Amp L2 Phase
Avg. 8.51, Min. 0.00, Max. 42.93

Power 3 Avg. Volt L3 Phase
Avg. 278.95, Min. 271.85, Max. 284.57

Power 3 Avg. Amp L3 Phase
Avg. 6.48, Min. 0.00, Max. 40.92

Power 5 Avg. Volt 3 Phase Sy...
Avg. 279.12, Min. 274.57, Max. 283.89

Power 5 Avg. Amp 3 Phase Sy...
Avg. 6.72, Min. 0.00, Max. 38.54

GUEMAS ISLAND

Data Summary

Data File Name: Guemes island.elog

First Data Record End Time: 10/23/19 10:30:00

Last Data Record End Time: 11/04/19 09:15:00

Monitoring Period Duration: 12.00 days

Peak Demand

Window Size Min.: 15

Channel	KW	KVA	KVAR
Power 5	-2.520 20:14:32 10/26/2019	5.093 20:14:32 10/26/2019	3.043 20:51:32 10/25/2019
Power 6	Off		

Totalizers

Channel	KWH	-KWH	+KWH	KVAH	KVARH	-KVARH	+KVARH
Power 5	-13.004	-13.235	0.230	85.260	9.200	-1.194	10.393

Channel	Average	Maximum (Date Time)	Minimum (Date Time)	Total
Power 1 Min. Volt	280.329	284.971 (10/23/19 14:00:00)	243.735 (10/25/19 21:00:00)	
Power 1 Max. Volt	284.140	286.587 (10/29/19 06:00:00)	281.222 (10/25/19 07:15:00)	
Power 1 Avg. Volt	283.450	285.577 (10/23/19 14:00:00)	280.571 (11/01/19 08:00:00)	
Power 1 Min. Amp	0.000	0.000 (11/04/19 09:15:00)	0.000 (11/04/19 09:15:00)	
Power 1 Max. Amp	23.880	191.114 (10/28/19 20:15:00)	0.000 (11/04/19 09:15:00)	

Power 1 Avg. Amp	0.288	3.582 (10/27/19 08:15:00)	0.000 (11/04/19 09:15:00)		
Power 1 KW Hours	0.006	0.113 (10/27/19 08:15:00)	-0.002 (11/02/19 20:15:00)	7.436	
Power 1 Max. KW	2.725	23.820 (10/24/19 12:00:00)	-3.309 (11/02/19 22:15:00)		
Power 1 Avg. KW	0.026	0.451 (10/27/19 08:15:00)	-0.008 (11/02/19 18:30:00)		
Power 1 KVA Hours	0.020	0.251 (10/27/19 08:15:00)	0.000 (11/04/19 09:15:00)	23.298	
Power 1 Max. KVA	6.495	50.287 (10/28/19 20:15:00)	0.000 (11/04/19 09:15:00)		
Power 1 Avg. KVA	0.081	1.004 (10/27/19 08:15:00)	0.000 (11/04/19 09:15:00)		
Power 1 Min. dPF	0.75	1.00 (11/04/19 09:15:00)	-0.30 (10/23/19 16:15:00)		
Power 1 Max. dPF	1.00	1.00 (11/04/19 09:15:00)	1.00 (11/04/19 09:15:00)		
Power 1 Avg. dPF	0.83	1.00 (11/04/19 09:15:00)	-0.57 (10/23/19 16:15:00)		

Power 1 THD = 239.373839

Power 2 Min. Volt	283.239	287.815 (10/30/19 12:45:00)	266.227 (11/01/19 19:00:00)		
Power 2 Max. Volt	286.974	289.366 (10/25/19 15:15:00)	283.549 (10/29/19 08:30:00)		

Power 2 Avg. Volt 286.287 288.538 (10/26/19 13:15:00) 282.987 (11/01/19 07:15:00)

Power 2 Min. Amp 0.000 0.000 (11/04/19 09:15:00) 0.000 (11/04/19 09:15:00)

Power 2 Max. Amp 24.505 200.153 (10/26/19 13:15:00) 0.000 (11/04/19 09:15:00)

Power 2 Avg. Amp 0.284 3.546 (10/24/19 06:45:00) 0.000 (11/04/19 09:15:00)

Power 2 KW Hours 0.011 0.120 (10/26/19 23:15:00) 0.000 (11/04/19 09:15:00) 12.575

Power 2 Max. KW 4.074 35.035 (10/29/19 20:15:00) 0.000 (11/04/19 09:15:00)

Power 2 Avg. KW 0.044 0.479 (10/26/19 23:15:00) 0.000 (11/04/19 09:15:00)

Power 2 KVA Hours 0.020 0.252 (10/24/19 06:45:00) 0.000 (11/04/19 09:15:00) 23.257

Power 2 Max. KVA 6.738 53.532 (10/26/19 13:15:00) 0.000 (11/04/19 09:15:00)

Power 2 Avg. KVA 0.081 1.007 (10/24/19 06:45:00) 0.000 (11/04/19 09:15:00)

Power 2 Min. dPF 0.80 1.00 (11/04/19 09:15:00) -0.21 (11/02/19 15:00:00)

Power 2 Max. dPF 1.00 1.00 (11/04/19 09:15:00) 1.00 (11/04/19 09:15:00)

Power 2 Avg. dPF 0.90 1.00 (11/04/19 09:15:00) 0.36 (10/25/19 06:45:00)

Power 2 THD = 132.497276

Power 3 Min. Volt	282.459	287.880 (10/23/19 10:45:00)	264.547 (10/28/19 18:30:00)	
Power 3 Max. Volt	286.036	289.560 (10/25/19 11:15:00)	282.709 (11/01/19 17:30:00)	
Power 3 Avg. Volt	285.346	288.560 (10/23/19 11:00:00)	282.082 (11/03/19 16:45:00)	
Power 3 Min. Amp	0.039	13.421 (10/26/19 20:15:00)	0.000 (11/04/19 09:15:00)	
Power 3 Max. Amp	25.514	193.752 (10/28/19 18:30:00)	0.000 (11/04/19 09:15:00)	
Power 3 Avg. Amp	0.472	14.857 (10/26/19 20:15:00)	0.000 (11/04/19 09:15:00)	
Power 3 KW Hours	-0.029	0.000 (11/04/19 09:15:00)	-0.715 (10/26/19 20:15:00)	-33.006
Power 3 Max. KW	-6.856	0.000 (11/04/19 09:15:00)	-50.786 (10/23/19 10:30:00)	
Power 3 Avg. KW	-0.115	0.000 (11/04/19 09:15:00)	-2.860 (10/26/19 20:15:00)	
Power 3 KVA Hours	0.034	1.058 (10/26/19 20:15:00)	0.000 (11/04/19 09:15:00)	38.616
Power 3 Max. KVA	7.012	51.670 (11/04/19 07:15:00)	0.000 (11/04/19 09:15:00)	
Power 3 Avg. KVA	0.134	4.233 (10/26/19 20:15:00)	0.000 (11/04/19 09:15:00)	
Power 3 Min. dPF	0.58	1.00 (11/04/19 09:15:00)	-1.00 (11/03/19 10:15:00)	
Power 3 Max. dPF	1.00	1.00 (11/04/19 09:15:00)	-0.99 (10/29/19 08:15:00)	

Power 3 Avg. dPF 0.99 1.00 (11/04/19 09:15:00) -0.99 (11/04/19 07:45:00)

Power 3 THD = 58.278851

Power 5 Min. Volt 282.410 286.371 (10/24/19 22:30:00) 266.637 (10/25/19 21:00:00)

Power 5 Max. Volt 285.625 287.643 (10/29/19 06:00:00) 283.075 (10/29/19 08:15:00)

Power 5 Avg. Volt 285.028 286.830 (10/25/19 15:00:00) 282.480 (10/29/19 08:15:00)

Power 5 Min. Amp 0.013 4.474 (10/26/19 20:15:00) 0.000 (11/04/19 09:15:00)

Power 5 Max. Amp 21.523 157.349 (10/26/19 13:15:00) 0.000 (11/04/19 09:15:00)

Power 5 Avg. Amp 0.348 5.961 (10/26/19 20:15:00) 0.000 (11/04/19 09:15:00)

Power 5 KW Hours -0.011 0.000 (11/04/19 09:15:00) -0.630 (10/26/19 20:15:00) -13.000

Power 5 Max. KW -3.099 25.564 (10/30/19 11:30:00) -43.237 (10/23/19 11:30:00)

Power 5 Avg. KW -0.045 0.000 (11/04/19 09:15:00) -2.520 (10/26/19 20:15:00)

Power 5 KVA Hours 0.074 1.273 (10/26/19 20:15:00) 0.000 (11/04/19 09:15:00) 85.189

Power 5 Max. KVA 17.750 127.545 (10/26/19 13:15:00) 0.000 (11/04/19 09:15:00)

Power 5 Avg. KVA 0.296 5.093 (10/26/19 20:15:00) 0.000 (11/04/19 09:15:00)

Power 5 Min. dPF	0.73	1.00	(11/04/19 09:15:00)	-0.98	(10/26/19 07:45:00)
Power 5 Max. dPF	1.00	1.00	(11/04/19 09:15:00)	-0.65	(11/01/19 18:00:00)
Power 5 Avg. dPF	0.97	1.00	(11/04/19 09:15:00)	-0.99	(11/03/19 18:00:00)

PLEASE NOTE: Results suggest that some values may be distorted by THD.

Setup Summary

Setup Table Description: 3 Phase - 4 Wire

Power 1 - Power: VHi: L1, VLo: N; PT = 1.000; CT = 5000.000; Phase Shift = 0.000; CT Type = RoCoil

Power 2 - Power: VHi: L2, VLo: N; PT = 1.000; CT = 5000.000; Phase Shift = 0.000; CT Type = RoCoil

Power 3 - Power: VHi: L3, VLo: N; PT = 1.000; CT = 5000.000; Phase Shift = 0.000; CT Type = RoCoil

Power 5 - Power Sum: 1,2,3

Memory Type: Ring

Line Frequency: 60 Hz

Integration Period: 15 Minutes

Logger Summary

Logger Description Line: 470011-019

Logger Serial Number: XC1406079

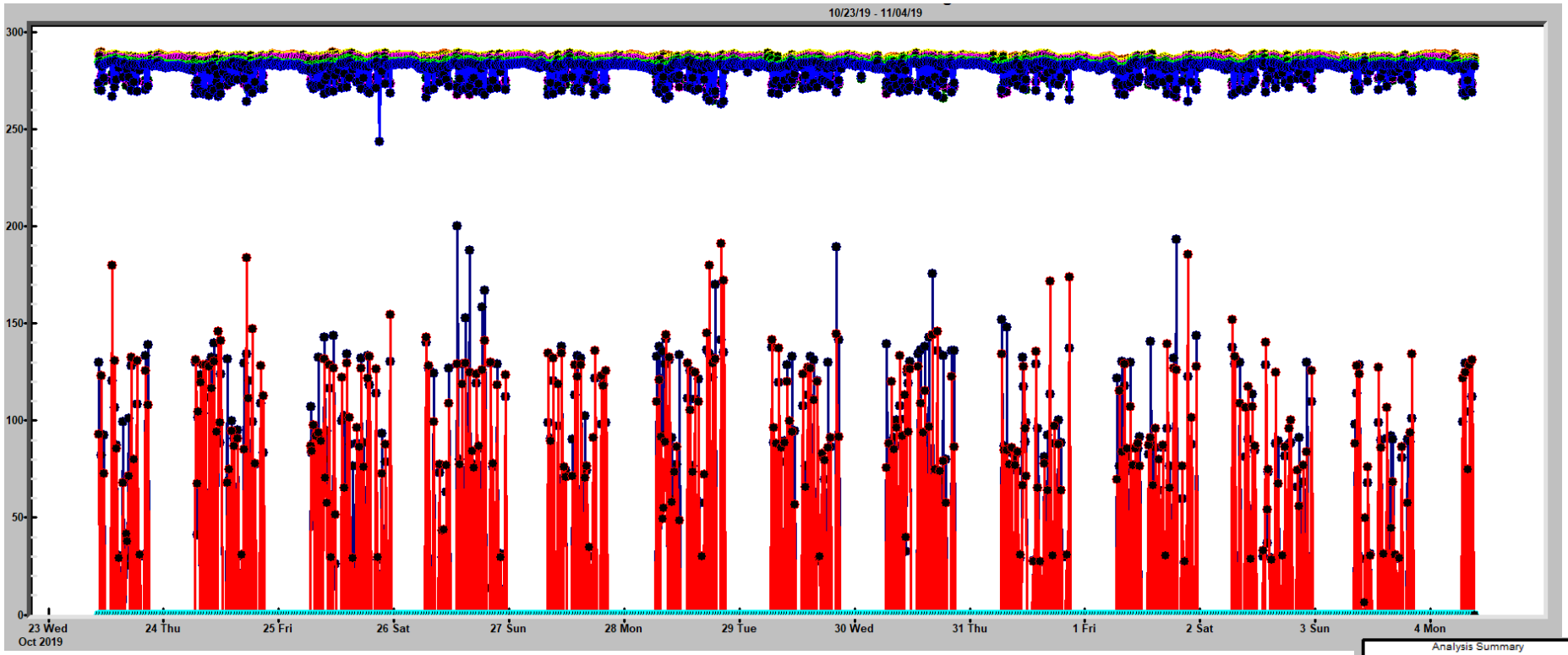
Logger Type: ELITEpro XC

Firmware Version: ES400.257

GUEMAS ISLAND

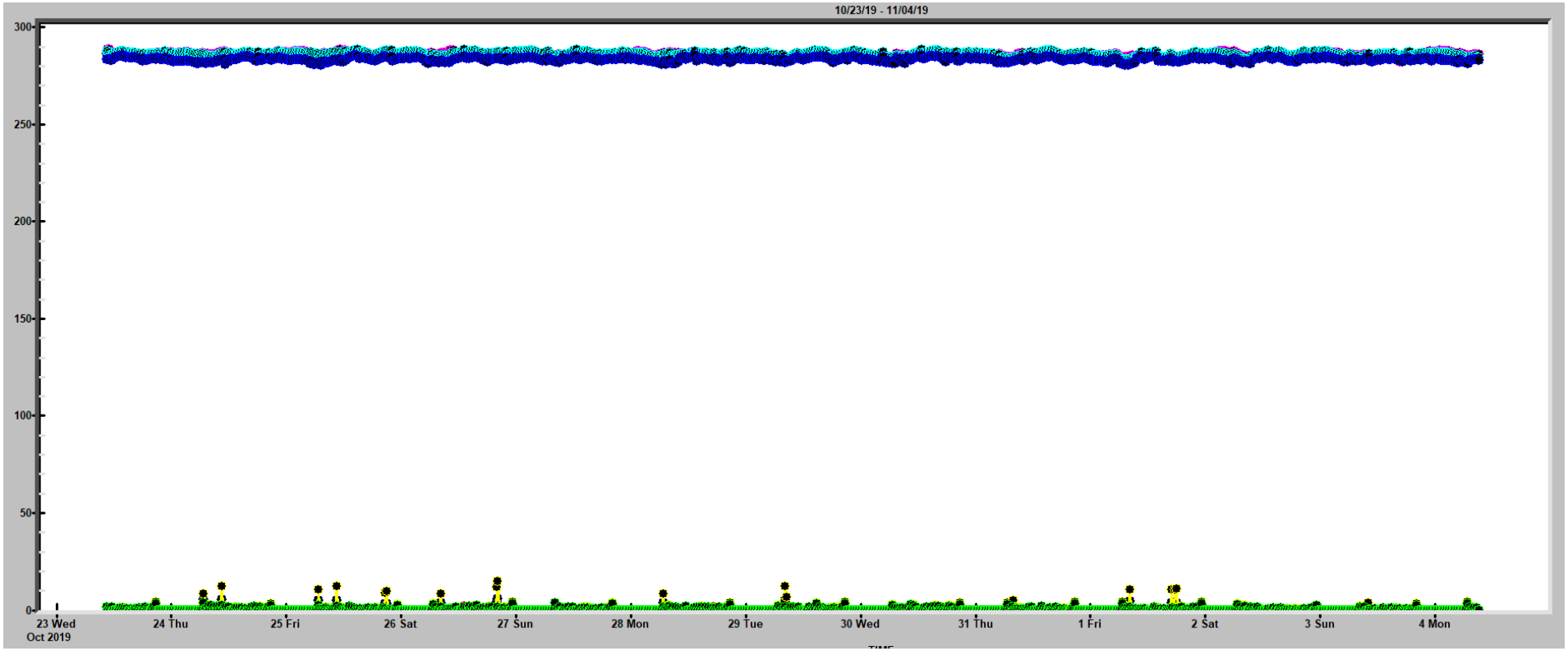
MINIMUM & MAXIMUM VOLTAGE

MINIMUM & MAXIMUM AMPERAGE



GUEMAS ISLAND

AVERAGE
VOLTAGE & AMPERAGE



Analysis Summary

----- Power 1 Avg. Volt L1 Phase
Avg. 283.45, Min. 280.57, Max. 285.58

----- Power 1 Avg. Amp L1 Phase
Avg. 0.29, Min. 0.00, Max. 3.58

----- Power 2 Avg. Volt L2 Phase
Avg. 286.29, Min. 282.99, Max. 288.54

----- Power 2 Avg. Amp L2 Phase
Avg. 0.28, Min. 0.00, Max. 3.55

----- Power 3 Avg. Volt L3 Phase
Avg. 285.35, Min. 282.08, Max. 288.56

----- Power 3 Avg. Amp L3 Phase
Avg. 0.47, Min. 0.00, Max. 14.86

----- Power 5 Avg. Volt 3 Phase Sy...
Avg. 285.03, Min. 282.48, Max. 286.83

----- Power 5 Avg. Amp 3 Phase Sy...
Avg. 0.35, Min. 0.00, Max. 5.96

Appendix G

M/V Guemes 2019 Generator Replacement Requirements

Contact Information:
Conor Shannon, Project Manager
(360) 479-5600

Produced By:

ART ANDERSON
202 PACIFIC AVE., BREMERTON, WA, 98337

December 18, 2019

Table of Contents

References

1: Dwg. No. SKA-320-01 Rev A Guemes Island Ferry, M/V Guemes, Electrical A/C One-Line

2: Dwg. No. SKA-320-02 Rev – MV Guemes Electrical System Load Analysis

3: VECA Dent Meter Report Summaries, Report #618391

Introduction

Between 23 October and 4 November 2019, VECA installed a Dent Power Monitor on the M/V Guemes, the Guemes Island Ferry Terminal, and the Anacortes Ferry Office. The Monitor recorded real time voltage and amperage of the different ferry system components in several operating conditions. The focus of this study was to determine/confirm the actual loading on the vessel's auxiliary generator. The intent is to use this data to size a replacement generator that is more appropriately sized and/or better designed to reduce the negative effects produced by the existing generator due to the unique operating requirements.

The Guemes's auxiliary generator is meant to serve the following three purposes:

1. Provide power to the vessel's normal operating hotel loads to primarily include lighting and electric heaters.

2. Provide power to the vessel's single electric fire pump (Note that the vessel has two other hydraulic fire pumps).

3. Provide power to operate the Anacortes and Guemes Island Terminal ramps in the event of a power outage.

This document will summarize the findings of the load study and frame the operating conditions which a new auxiliary generator must be capable of supporting. It will then seek requests for quotes of systems that are best suited to meet these requirements.

The Existing Problem

The normal loads acting on the generator are the vessel hotel loads, which only draw approximately 15 – 20 max Kw at low amps. However, starting the electric fire pump or the 15 hp terminal ramp motor, while the vessel is running its hotel loads, requires peak values of ~150 amps, ~60 Kw, and ~80 kVA. The vessel generator must be capable of supporting both conditions.

The existing generator set is a 60Kw Yukon generator mated to a FPT N45 SM2X prime rated Tier 3 diesel engine. Under most conditions, the generator is being loaded at less than 30% and noticeable wet stacking problems are occurring. Skagit County has reported irregular maintenance concerns and health concerns for its crew due to the heavy smoke that frequently exits the generators exhaust. Fixing, or at least improving, these two problems (wet stacking and health concerns) is paramount and the driving factor behind installing a new generator.

Load Study Results

VECA's load monitoring collected voltage and amperage across all three phases on the vessel and terminals. Power was then calculated. Data points were collected every four cycles and then grouped into 15-minute intervals and plotted. The below graphs summarize the average power, maximum power, and maximum reactive power to help show the typical load cases the generator supports.

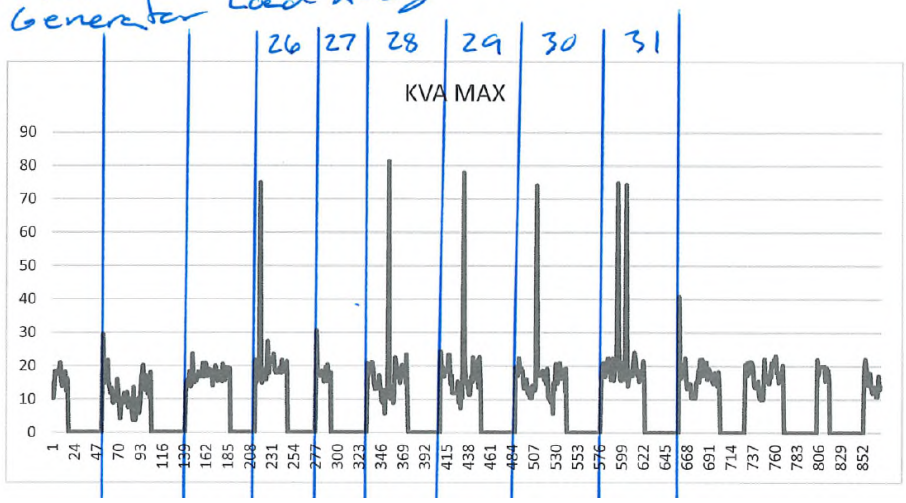
As seen from the below Kw-Avg graph, over most 15-min intervals, the vessel is only drawing between 5 and 15 Kw when powering its hotel loads. These fluctuations are due to turning on/off heaters and various lighting. When one of the 15 hp electric motors are running (fire pump or terminal), the vessel is drawing between 26 and 32 Kw. During these periods the average running amperage is below 40. Voltage fluctuates between 260 and 280.

The below Kw-Max graph displays the maximum power drawn during each 15-minute interval. As shown, during the vessels 18-hour operating day, the power frequently peaks at close to or slightly below 20 Kw. During motor start-ups, this peaks to between 48 and 58 Kw. Note that these peak values are near instantaneous and drop down immediately after a few cycles. During these motor starts, amperage peaked at between ~130 and 160 instantaneously. However, the average amperage over these operations was less than 40, as discussed above.

The below maximum power (kVA-Max) graph shows the high spikes when starting the electric motors. This paired with the second graph below, shows a severe voltage drop, amperage spike, and low power factor during these conditions. Because these spikes are short lived, and the existing generator doesn't show an issue with starting the motors, it is believed that a similarly sized generator will be able to support these loads. **However, a big question of this study is how low of a rating can we go and continue to support starting these motors?**

Note that the divisions drawn over the graphs represent the day of data acquisition.

CESKA007.013
CMS Notes
VECA Generator Load Study



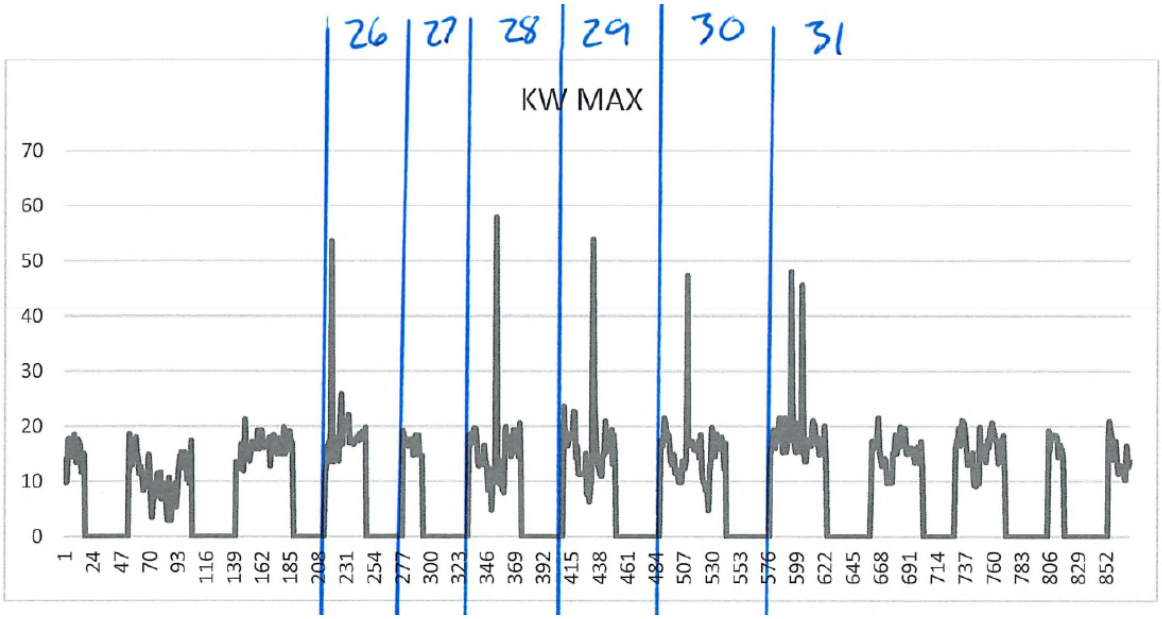
26: Fire pump start up / Run w/ Heaters on

28: -operated pump w/ Lights/ heaters on 10 min
-Cycled Pump on/off
~~operated~~
-operated Fire pump w/ Lights/heaters 10 min

29: Winter Cond. w/ Fire Pump Cycled

30: Fire pump on no hoses

31: Both Fire pump running 2 x 10 min interval

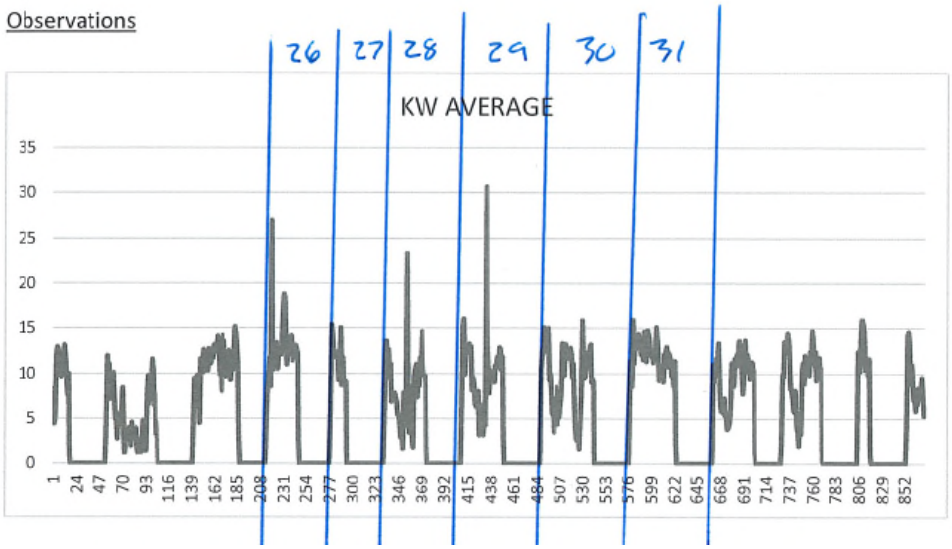


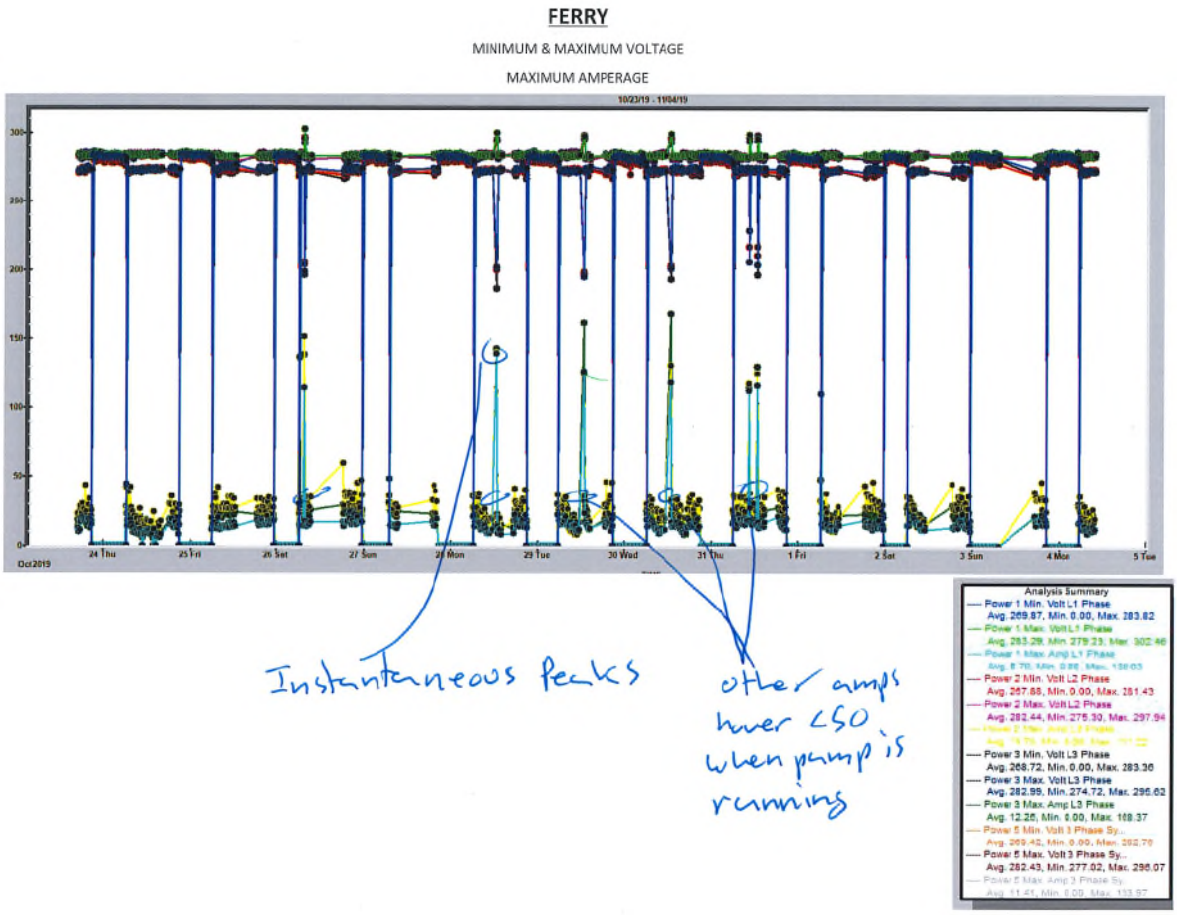
26: Max Voltage

28: Max Max Amps

29: Max Avg Amps

Observations





New Generator Selection Guidance / Questions to Suppliers

Given a description of the required operating conditions, please provide responses to how new generator will support the following:

1. With max Kw frequently being at or close to 30% rated power, is there a way to determine how frequent these peaks need to occur to keep the temperature high enough to "significantly" reduce wet stacking and long term maintenance concerns?

2. How much advantage does the common rail fuel injection system have over a traditional injection system in allowing more efficient burning and less excess?

3. Can anything be done to the exhaust system design to re-route / extend without amplifying the problem?

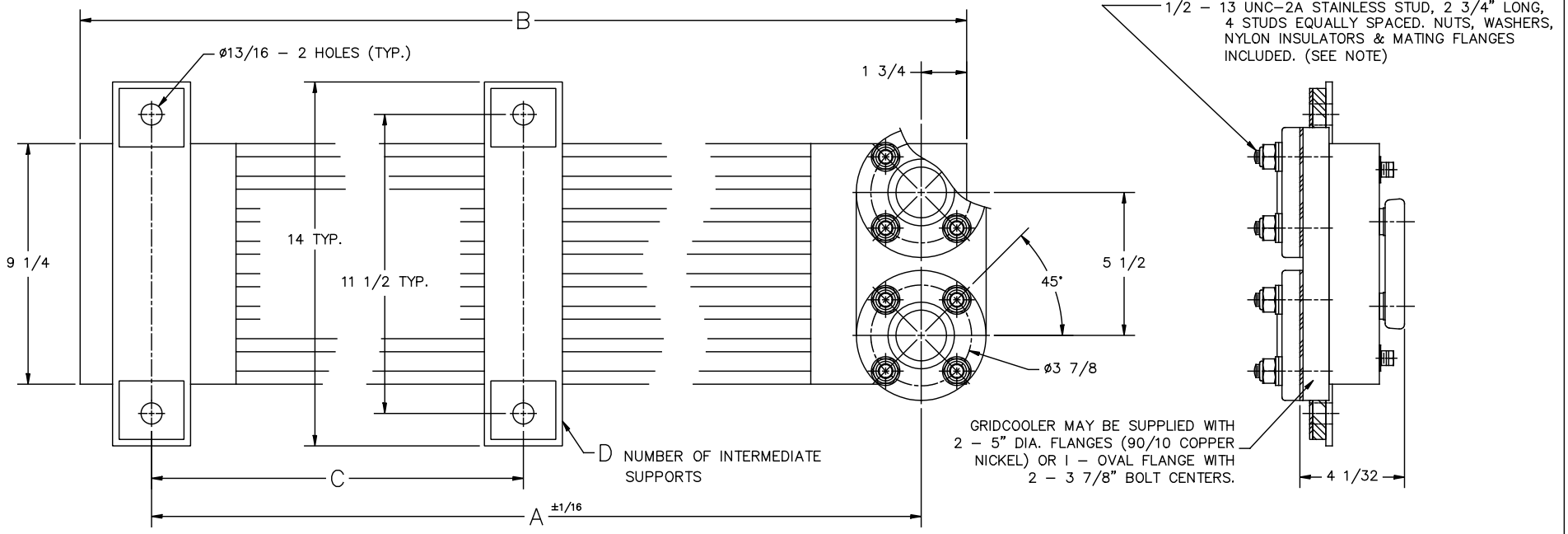
4. Is there a way to de-rate the power rating for normal ops and then quickly adjust it when a pump needs to be started?

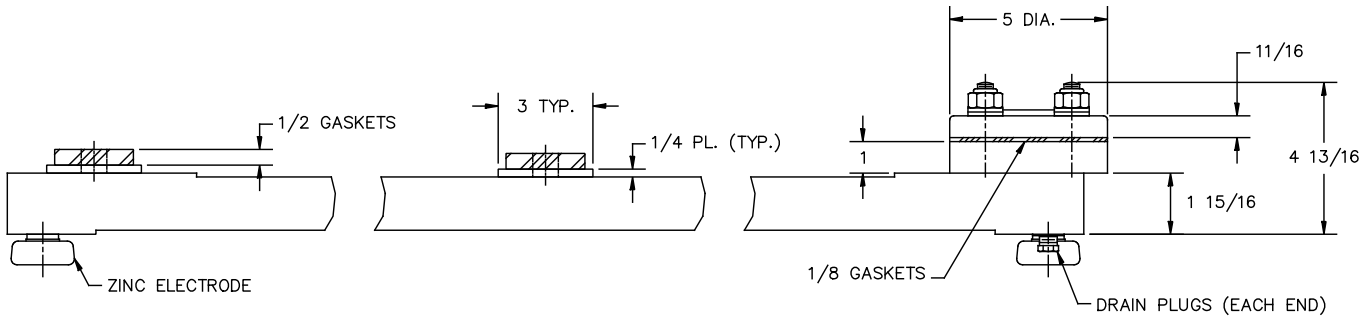
5. Other than by trial and error, is there a way to estimate how low of a power rating we can get by with and still start the motors without too much bogging down?

6. Would some sort of load bank be recommended or other method to increase the loading to get it to a point where "significant" improvement in wet stacking and the other related problems occur?

7. Will wet stacking be a concern for a generator sized for motor run current only say 40kW using soft starts when the house loads are about 20kW?

8. The selected generator must be keel cooler capable and integrate into the below system.





NOTE – MATING FLANGE CONSISTS OF A CARBON STEEL (A105) 150# SLIP–ON FOR 1 1/2" PIPE WITH A 1.95" I.D.

(ALL DIMENSIONS ARE IN INCHES)

GRIDCOOLER ® IS A REGISTERED TRADEMARK OF THE R.W. FERNSTRUM & COMPANY.

MODEL	CN827U–Z	CN833U–Z	CN839U–Z	CN845U–Z	CN851U–Z	CN857U–Z	CN863U–Z	CN869U–Z	CN875U–Z	CN881U–Z	CN887U–Z
A	27	33	39	45	51	57	63	69	75	81	87
B	31 1/2	37 1/2	43 1/2	49 1/2	55 1/2	61 1/2	67 1/2	73 1/2	79 1/2	85 1/2	91 1/2
C						28 1/2	31 1/2	34 1/2	37 1/2	40 1/2	43 1/2
D	NONE		BLANK			1	1	1	1	1	1

TOLERANCES (EXCEPT AS NOTED)	REVISIONS			R.W. FERNSTRUM & COMPANY MENOMINEE, MICHIGAN		
DECIMAL ±	NO.	DATE	BY	GRIDCOOLER INSTALL. DIMENSIONS		
FRACTIONAL ±	1					
ANGULAR ±	2					
	3			DRAWN BY RULEAU	SCALE 1/4	MATERIAL
	4			CHK'D	DATE 3–6–03	DRAWING NO. CN800U–Z–5
	5			TRACED	APP'D	

Appendix H

Generator Load Study

Solutions to the generator issues relied on knowing the load on the generator both in normal operation and with the fire pump or shore side ramp operating. The loads on both the *Guemes* and the ferry terminals have been calculated or estimated in previous work. In both cases, the results were based on assumptions of what items on the shore and on the vessel were running simultaneously. Live load monitoring, however, had not been completed to determine the actual load demands on either the ferry terminal or the vessel. In order to determine potential solutions, it was important to capture real time voltage and current data averaged over a period of time and during specific loading conditions for both the ferry terminals and the vessel.

Art Anderson developed a detailed plan [E] to record specific electrical data throughout normal operations and simulated emergencies. Skagit County contracted VECA to install a load monitoring device to collect voltage and amperage across all three phases on the vessel and terminals. The data collection took place between 23 October and 4 November 2019. VECA installed a Dent Power Monitor on the *Guemes*, the Guemes Island Ferry Terminal, and the Anacortes Ferry Office to record real time voltage and amperage of the ferry system components in several operating conditions. The focus of the study was to determine/confirm the actual loading on the vessel's auxiliary generator and use the data to size a replacement generator that would be more appropriately sized and/or better designed to reduce the negative effects produced by the existing generator due to the unique operating requirements.

The load study concluded the vessel's average normal hotel loads were between 5 and 15 kW with peaks around 20kW. See Appendix F for the complete data from VECA. See Appendix G for a more detailed explanation of the results and the effects on installing a new generator. This study confirmed the existing generator was consistently operating below 30% of rated power output.

Generator Replacement Options

Four potential solutions were discussed. The first potential solution was to replace the existing generator with a modern common rail generator of similar size. One vendor reported common rail generators not having the same issues with wet stacking at low loads. However, this was not verified through independent research and did not address the particulate emissions problems of diesel engines operating at low loads. The second potential solution was to reduce the size of the generator to only handle the vessel's hotel loads, which only draw approximately 15 – 20 max kW. This would require emergency power be located shoreside at the ferry terminals and the removal of the vessel's main electric fire pump. The new generator would more consistently operate in an optimal range, thereby reducing wet stacking and particulate matter emissions. The third potential solution was to add a load bank onto the existing generator. A load bank would "artificially" increase the load on the generator with resistors to a more optimum range. One vendor reported the ability of the load bank to sense the system electrical draw and adjust the load bank to operate the engine within a certain load range. The local USCG inspectors were not familiar with the use of load banks on this type of system but were not opposed to the potential use. If this option is pursued, we recommend early USCG involvement to minimize surprises and delays. The fourth potential option, as recommended by a vendor, was to run two 30 kW generators in parallel. One would only run during regular

operations while the other would be turned on only while starting the electric fire pump or shore side motors.

After a thorough evaluation of all of the options, Skagit County decided to replace the generator with a brand new similarly sized generator with a common rail fuel system and pursue load bank installation in the future. This allowed the ferry to maintain the ability to operate the fire pump and the lift span in case of emergency or power outage.