GOLDEN RAY Hearing

22 September 2020

CAPT Welborn: The time is 1031. We are back on the record in the matter of: the capsizing of the Motor Vessel GOLDEN RAY on September 8, 2019 while transiting the St. Simons Sound in Brunswick, Georgia.

Good morning. Today is Tuesday, September 22, 2020. It is the seventh and final day of the public hearing into the capsizing of the GOLDEN RAY. I am Captain Blake Welborn the Lead Investigating Officer for this 7th District Formal Investigation. The Commander, 7th District, has convened this investigation under the authority of Title 46, United States Code, Section 6301 and Title 46, Code of Federal Regulations, Part 4, to investigate the facts and circumstances surrounding the capsizing of the GOLDEN RAY. This investigation was mutually agreed upon to be a joint effort between the ship's flag state, the Republic of the Marshall Islands, the U.S. National Transportation Safety Board (also known as NTSB), the Korean Maritime Safety Tribunal (also known as KMST), and the U.S. Coast Guard.

Present today including myself, are the following members of this Formal Investigation: Mr. Lee Willett and LCDR [redacted], who is also serving as our Recorder. The legal counsel to this investigation is LT [redacted].

The National Transportation and Safety Board is participating in this hearing. Captain David Flaherty, investigator-in-charge, is appearing virtually.

The Republic of the Marshall Islands' representative is Mr. Thomas Bremer, who is physically here at the hearing.

In addition, the Korean Maritime Safety Tribunal personnel are monitoring this hearing virtually and will provide me with questions to ask on their behalf. I will note when I begin asking the questions posed by KMST.

I would like to request the cooperation of all persons present to minimize any disruptive influence on the proceedings in general and on the witnesses in particular. Witnesses are appearing before the members of this Formal Investigation to provide valuable information that will assist in the investigation. We request members of the public be courteous and respectful of the hearing location during these proceedings and attend via livestream to comply with the Federal, State, and Local COVID-19 guidelines.

For those of you participating via phone or video, I ask that you mute yourself until I've recognized you for your questions unless you wish to make an objection. All media inquiries and comments regarding the hearing should be sent to GoldenRayPublicHearing@gmail.com. This email should only be used for questions regarding the hearing. All questions regarding the response efforts should be directed to the Incident Command Post.

The Coast Guard has designated Parties In Interest to this investigation. I have designated the following organizations and individuals as Parties in Interest: the Brunswick Bar Pilots Association; including Captain Bruce Fendig and Captain Jonathan Tennant; and the Owners of the GOLDEN RAY, including Hyundai Glovis and G-Marine. The lead counsel for the Brunswick Bar Pilots Association, Captain Fendig, and Captain Tennant are remotely attending the hearing with a representative, Captain Cameron, appearing virtually. The lead counsel for the Owners of the GOLDEN RAY, including Hyundai Glovis and G-Marine, are physically here at the hearing.

The Coast Guard now calls the following and first witness of the day, LT [redacted].

Recorder: Mr. [redacted] please stand and raise your right hand? A false statement given to an agency of the United States is punishable by fine and or imprisonment under 18 United States Code 1001 and the uniform code of military justice. Knowing this do you solemnly swear that the testimony you're about to give will be the truth, the whole truth and nothing but the truth so help you God?

LT [redacted]: I do.

Recorder: Thank you please be seated. Captain the witness is ready.

CAPT WELBORN: Thank you Commander [redacted]. Good morning Lieutenant, how are you this morning?

LT [redacted]: Good morning Captain, doing well, sir.

CAPT WELBORN: Good. Thank you for appearing today. I know that you have prepared a presentation that will speak to your accreditations, your training and your qualifications. So without further ado I would like for you to just go ahead and begin your presentation.

LT [redacted]: Roger that Captain.

CAPT WELBORN: Lieutenant I'm sorry, one moment. Are you a party in interest to this investigation?

LT [redacted]: No I'm not Captain.

CAPT WELBORN: Are you represented by counsel?

LT [redacted] No I'm not Captain.

CAPT WELBORN: Then please proceed.

LT [redacted]: Good morning I'm [redacted]. For this portion of my testimony I will give an overview for the analysis conducted by Marine Safety Center in support of this investigation. I will begin with my education and background and then I'll introduce some basic naval architect theory. I will discuss the computer model we created at the Marine Safety Center to analyze the GOLDEN RAY's stability. And I'll present the results of that stability during the capsized voyage and the results of the stability during the two voyages prior to the capsizing. I'm currently a Naval Architect at the Marine Safety Center in Washington, D.C. My team within the Marine Safety Center reviews large vessel stability, structure and fire protection for compliance with U.S. and International regulatory standards. I have a Bachelor's Degree in Naval Architecture and Marine Engineering, a Master's Degree in Naval Architecture and Marine Engineering and a Master's in Mechanical Engineer. I'm a professional Engineer in the State of Michigan and I have previous Coast Guard experience underway as an Engineer and as shore base inspector. I will start by introducing two concepts, the righting arm and the righting arm curve. Understanding these ideas is going key to understanding the results of the analysis. So pictured on the slide we have a ship that's floating in water. Any floating ship is going to have two internal forces that apply, a weight which acts downward and an equal but opposite force of buoyancy abbreviated FB which acts upwards. The weight acts as a center of gravity or G and the force of buoyancy acts as the center of buoyancy or B. The center of buoyancy the metacenter or the middle of the underwater volume of the ship. At zero heel the weight and the force of buoyancy are directly in vertical alignment of each other. They are also in line at the metacenter or M which is the imaginary rotational point above [in audible]. Now

let's say an external force such as a gust of wind or wave hits the hull in the port side. This causes the vessel to heel or rotate to starboard and let's suppose it heels 5 degrees for this example. The centroid or the middle of the underwater volume shifts to the starboard side of the vessel the location of the center of buoyancy also shifts to starboard. This causes a misalignment between the weight and the force buoyancy. A misalignment between two objects, two objects is called a [in audible]. Now referencing the B on the right hand side of the slide we have one force that's pushing down and another that's pushing up. And these two forces are going to cause the B in the diagram to rotate counter clockwise causing counter clockwise moments. Now the distance for separation between the forces is called a moment arm. The longer the moment arm or in other words the larger the separation between the two forces the larger the corresponding moment. Looking back at the ship the same principal applies. The weight and of force of buoyancy are separated by a distance, this creates the counter clockwise moment called the righting moment that wants to rotate the back to its upright positon. Now in order to quantify how much potential has the ship has to rotate back to that upright positon we [in audible] a horizontal distance between the two forces. That's called the righting arm or GZ. The larger the righting arm the more righting moment or more potential the vessel has to rotate itself to that upright position. Now for angle of heel for the vessel we're going to plot that righting arm, GZ in what's called a righting arm curve. On this curve the X or the horizontal axis is angle of heel and the Y for vertical axis each corresponding righting arm or that horizontal separation between the weight and the force of buoyancy. So in this example for this heeling 053 let's say the righting arm is 1 meter. What we'll do is we'll plot at 1 meter on the righting

arm curve and that heel angle of 5 degrees. Now let's say this vessel heels even more to starboard, 10 degrees. Because the centroid of the underwater volume shifts even more to starboard the center of buoyancy, B is going to shift even further to starboard. This creates an even larger righting arm and we'll say that 2 meters is the example. Then we'll plot that righting arm at 2 meters for the heeling of 10 degrees on the righting arm curve. Using the same procedure for each angle of heel generates a full righting arm curve shown on the right hand side of the slide and that righting arm curve is critical to assessing stability. Now let's look at the same vessel, now has a large amount of weight on the top deck. For purposes of this explanation I'm going to over simply this and ignore the fact that there's a change in placement of the added weight. However, this added weight on the top deck would cause the center of gravity to rise. But the location of the center buoyancy is going to stay the same. This results in a smaller separation between the forces or in other words a smaller righting arm GP. In this case the righting arm for that 10 degree to heel may be a length .5 meters. Plotting that new righting arm on the righting arm curve, same vessel in a different loading condition and then doing this for each angle of heel results in the new purple righting arm curve which is smaller than the red righting arm curve. Well now remove that weight on the top deck and we're back to our original loading condition. Let's instead suppose this vessel filled a large ballast tank. This is going to provide a lot of weight near the keel, the center of gravity is going to shift down. We now have a larger distance from G to B or a larger righting arm shown by the green separation. A larger righting arm is more favorable to stability because there's a larger corresponding righting moment that's trying to rotate the vessel back to that upright positon. Now let's say this new righting arm with the

vessel ballasted is 2.5 meters. We'll plot that value on the righting arm curve pretending there's a heel and doing this for each angle of heel results in the new larger green righting arm curve for the same vessel. To summarize this concept raising the center of gravity decreases the vessel's righting arm and lowering the center of gravity increases the vessels righting arm. A vessel with higher righting arms will produce a righting arm curve more area under it like the green righting arm curve. The area under the righting arm curve is directly proportional to the righting energy or total potential the vessel has to reduce capsize. The more area under the curve the more total potential the vessel to make this capsize. In the next slide we're going to take a closer look at the property that a righting arm must have to be in compliance. So if the vessel is comprised [in audible] such as the GOLDEN RAY the righting arm must be certain property satisfied by the 2008 IMO Intact stability code, IS code in every condition afloat. The first property is called the metacentric height or GM. The GM is the initial slope or radiant of the righting arm curve. A higher GM results in higher initial slope and better stability at small angles of heel up to approximate 7 degrees. IS code specifies that all vessels with a GM must be at least 0.15 meters. Next requirement set aside by the Intact stability code deals with a maximum righting arm for the highest value of the righting arm curve. The maximum righting arm must have a value of at least 0.2 meters and that value must occur in an angle of heel of 30 degrees or greater. The third property specified by the Intact stability code is the area under the righting arm curve. As I described earlier in that area is directly proportional to the righting energy or total potential the vessel has to right itself. IS code --- yes, sir.

[Paused for technical issues].

CAPT WELBORN: We'll take a momentary pause while we reboot the livestream so we can get the picture back of LT [redacted] explanation. I do apologize for the break in the action. This is a very difficult and technical concept I want to make sure that we have LT [redacted] – so Lieutenant if you would continue please.

LT [redacted]: Yes, sir. So I was discussing the properties that a vessel must have, that a vessel's righting arm curve must have to comply with the 2008 IMO Intact stability code. So the first property required that is required to comply with the IMO Intact Stability Code such as the GOLDEN RAY is a value of the GM or the metacentric height. A higher GM results in a higher initial slope of the righting arm curve and better stability at small angles of heel up to approximately 7 degrees. The IS code specifies that for all vessels the GM must be at least 0.15 meters. The next requirement that specified by the Intact Stability Code deals with the maximum righting arm or the highest value of that righting arm curve. The maximum righting arm must have a value of at least 0.2 meters and that value must occur at a heel angle of 30 degrees or greater. The third property specified by the Intact Stability Code is the area under the righting arm curve. As I said earlier that area is directly proportional to the righting energy or the total potential the vessel has to right itself. The IS Code specifies the minimum between 0 and 30 degrees, between 30 and 40 degrees and between 0 and 40 degrees. For the latter two area requirements if the vessel takes on water due to down flooding which is defined as entry of sea water into the hull through a non-watertight or non-weathertight fitting prior to 40 degrees of heel only the area up until that down flooding angle can be counted. Finally the IS Code includes what's caused a severe wind and rolling criteria. This criteria is a little more complex but essentially its purpose is to ensure that the

vessel will not capsize given both a sea wind, which is the wind acting at a right angle to the keel and simultaneous waves induced. So now that I've covered the basic stability concepts I'm going to move into how these concepts were applied to asses GOLDEN RAY's stability during the capsize. We first needed to transfer in the hull shape of the vessel into a 3D computer model which we could use to calculate the vessel's righting arm curve. This was done using a software called GHS or General Hydrostatics which is the same software we use at the Marine Safety Center to check the stability of U.S. Flagged vessels. We took a variety of measurements on the vessel's plan and constructed the computer model rendered on the slide. We then took that model and constructed the vessel's tanks. Constructing each tank individually made so that they could be individually loaded within the model and loading each tank individually allowed us to account for what's known as pre-surface spec, or the decrease in stability due to the virtual rise from the center of gravity as the liquid shifts. This slides shows the computer model with the tanks and decks added. Next in order to generate an accurate righting arm curve we needed to obtain an accurate weight and center of gravity by accounting for everything on board at the time of the capsizing. The table on this slide shows the four categories of weights applied in the corresponding VCG or vertical center of gravity which is in other words the height of each item above the keel. The first category is what is called the light ship. The light ship is essentially the weight of the keel hull and structure. The GOLDEN RAY's light ship of approximately 21,400 metric tons with the center of gravity of 18.3 meters above the keel was determined from the stability test after the vessel was built in 2017. Next the weight of the tanks would apply in accordance with levels reported by the vessel's recovered IMACS

computer. Screen shot which is shown at the top right hand side of the slide. The values from the IMACS computer time stamped immediately prior to the capsize reads. Now there are several small tanks that were not recovered by the vessel's IMACS computer, such as fresh water and lube oil tanks. And for this analysis it those tanks were loaded in accordance with departure conditions from the vessel's trim and stability. As I mentioned previously each tank was filled individually in the GHS software so that pre-surface specs can be accounted for. But this table reflects the total weight of all the liquid in the tanks approximately 4600 metric tons. The weight of the vehicle cargo was applied using the weights from centers listed on the Brunswick departure stowing plan. An extract of which is shown on the right hand side of the slide. This plan showed the weight and location of group of vehicles broken down by vehicle type and port of loading for departure. After verifying this loading plan for consistency it was a total of the vehicle identification number list, center of each vehicle group were calculated and applied to the computer model with the corresponding weights listed on the plan. This resulted in a total of approximately 8800 metric tons of cargo. It had a center of 24.3 meters above the keel. We also tendered for various miscellaneous weight including provisions, stores, cargo lashing equipment and firefighting CO2 weight. And the weights and centers of these items were applied to the model in accordance with departure conditions from the trim and stability booklet. The final loading condition shown applied was then applied to the computer model for 35,000 metric tons was applied to the weight. And that weight was applied at a height of 18.2 meters above the keel. This allowed us resulting the center of buoyancy and also the resulting mean draft of 9.35 meters. As this draft was generally consistent with the draft reported by the

IMACS computer and the draft reported by the crew prior to departure this indicated that a generally accurate loading condition was applied to the model. With this information applied to the computer model righting arm curves were then calculated for the vessel in the capsized voyage. So before I present the righting arm curve for the vessel in the capsized voyage, we first sought to have a perspective from the example or a benchmark loading condition provided to the vessel in the trim and stability booklet. Each dotted line represent a collection of acceptable righting arm curves for the GOLDEN RAY in varying amounts and location of cargo, ballast and fuel. All the total displacement comfortable through total displacement of the vessel during the capsize voyage. Each benchmark loading condition was in full compliance with 2008 Intact Stability Code. In other words the benchmark conditions are acceptable loading conditions provided to the vessel. This red line represents the GOLDEN RAY's righting arm curve during the capsized voyage to port as generated by our model. And the green line represents the righting arm curve during the calculations to starboard. Now these curves are slightly different, but clearly beyond 20 degrees of heel because the starboard side geometry is slightly different on the vessel. There's a cutout for the cargo loading ramp. So both of these righting arm curves are significantly less favorable to stability than the benchmark loading condition because they have significantly less area under the righting arm curve and therefore, they have less righting energy. Our results indicated a GM of 1.76 meters during the calculous voyage whereas the benchmark loading condition had a GM above 3 meters. The capsized voyage righting arms within an assessed mandatory criteria of the 2008 Intex Stability Code and resulted indicated failure of several properties. The area under the righting

arm curve and the severe wind and rolling criteria. So as I demonstrated on the previous slide the righting arm curve for the capsized voyage was significantly lower than that of the benchmark or an example loading condition he failed in the trim and stability booklet. We're now going to take a closer look at why exactly that is by comparing the loads of the vessel in the capsized voyage and the benchmark condition. So top row discharge shows the loads of the capsized voyage including total displacement, total liquid load which includes the weight of the liquid of fuel, ballast and other miscellaneous tanks. The cargo weight and corresponding cargo VCG or vertical center of gravity and the vessel's overall vertical center of gravity. We'll first compare these loads from the vessel on the capsized voyage to condition 18. Both the capsized voyage and condition 18 had similar total displacements and they also had similar cargo vertical center of gravities. However, the vessel had about 1000 metric tons of more cargo weight during the capsized voyage and almost 2000 metric tons less total liquid weight on board. This resulted in a vessel VCG trim over a meter higher in the capsized voyage. And as I covered earlier a higher VCG leads to lower righting arm curves. We'll now compare the loads in the capsized voyage with another benchmark condition, condition 13. Both of these conditions had approximately the total liquid load on board. However, in the capsized voyage the vessel had about 1500 metric tons more cargo and that cargo was at a significantly higher vertical center of gravity. This resulted in a higher vessel vertical center of gravity during the capsized voyage and again the reason for the decreased righting arms. So up until this point I've only covered stability for the vessel while it's not moving. Although analyzing stability in this way is used as an indicator of how the vessel will perform when it is moving in a seaway, because the

GOLDEN RAY capsized during a turn our analysis applies additional static forces which would have likely acted on the vessel during that turn. So going back to a little more theory I'm going to introduce what those additional static forces are that act on the vessel when it's engaged in that turn. So picture the vessel on this slide, this vessel is conducting a turn to starboard and we are viewing the stern. A ship undergoing a turn is going to have a centripetal force which acts outward from the direction of the turn at the center of gravity. There's also a water pressure force that acts opposite to the centripetal force at the center of lateral resistance or CLR which is essentially the center of pressure of the hull. Now these two forces work together to create a counter clockwise moment for a turn to starboard and that's called the turning heeling moment and as result the vessel heels to port when it's engaged in the turn. The equation for the turning heeling moment which is shown at the top of the slide and it's governed by several important elements. The velocity of the vessel, V. The vertical center of gravity of the vessel, how high she is above the keel and radius of the turn or R. So as the velocity and the vertical center of gravity increase as does the turning heeling moment. Additionally as the radius of the turn goes down, a tighter turn, the turning heeling moment is also going to increase. Now since the rudders are angled to starboard in this case for a turn to starboard there's another force at play and that's the turning force from the rudder. This force creates a separate moment with the water pressure force and that's a righting moment in this case called the rudder righting moment and that typically adds against the turning heeling moment. But the rudder righting moment is much smaller so the net effect is that the turning heeling moment, the red and black arrow prevails and thus will heel to port when it's engaged in a turn to starboard. This

net heeling moment reduces the vessel's righting moment and as a result reduces total righting energy. In other words a vessel has less righting energy when it's engaged in a turn. I'm going to show how that looks for the GOLDEN RAY on the next slide. So again I'm now going to demonstrate how the turning heeling moment shown on the previous slide Intacted the righting arm curve for the GOLDEN RAY during the turn in which the vessel capsized. Since the vessel capsized to port we'll focus only on the port righting arm curve. Using data from the portable pilotage unit we estimated that the radius of turn in which the vessel capsized was as high as 800 meters or as low as 500 meters and the vessel was traveling at approximately 13 knots over ground at that time. We then calculated the resulting turn heeling moment and new righting arm curves for the vessel with these moments factored in. The new righting arm curve for the vessel in a turn with a radius 800 meters is shown by the blue dotted line. The righting arm curve for the vessel in the turn had that radius been only 500 meters is shown by the black dotted line. The righting arm curve for the vessel was expected to fall in between these two dotted lines as shown by astatic analysis. The remaining area under the righting arm curve is now even smaller, either as large as the blue shaded area or as small as the gray shaded area. As evident from these areas there was likely had been only a limited amount of remaining righting energy during that turn. What's important to realize about this analysis, however, is that it only accounts static effects of the vessel when it's engaged in a turn. When a vessel enters a turn and the centripetal force first begins to act there is an additional dynamic effect at play which causes the vessel to heel even further to port than would be expected by a static analysis. That's called dynamic overshoot. In cases where a vessel has significant righting energy, the righting energy

can easily withstand the dynamic overshoot. Turning with maximum possible rudder at maximum possible speed is not typically dangerous for most cargo ships. However, in cases where there is only a very small amount of remaining righting energy left the dynamic effects of the turn can easily overcome the remaining righting energy and lead to significant keel or capsizing. Our conclusion indicates that this is likely the case for the GOLDEN RAY. So to recap how this conclusion was reached, number one the way in which the vessel was loaded led to a righting arm curve which indicated insufficient righting energy. On top of this when the GOLDEN RAY turned to starboard this righting energy was further reduced because of the static heeling moment. At that point according to our analysis there was only a comparatively small of remaining righting energy which was likely easily overcome of the dynamic effects of the turn resulting in the vessel capsize. Now that we've established stability conditions that led to the vessel's capsize we're going to transition in to down flooding and how this mas has exacerbated the rate of the capsize. A down flooding point is any fitting along the vessel which can't be closed weather tight or water tight and has the potential of taking on water as the vessel heels. This would cause a decrease in stability due to the added the [in audible] effect and weight of the water. According to the vessel's trim and stability booklet the only down flooding point is a door on deck 13. Angle of keel required to reach this down flooding point is 83 degrees. That's called the down flooding angle. Now there's a number of fittings below that door on deck 13 such as the Pilot door on deck 5, but since they can be closed watertight or weather tight they are not considered down flooding points under normal circumstances. However, as it was reported that the vessel's Pilot door was open during the capsize the vessel's down

flooding angle would have been severely reduced. Our results indicated that with the Pilot door open the vessel would heel to only 17 degrees before down flooding. After 17 degrees of heel it's likely that during the capsize the vessel began to take on water from the Pilot door which would have subsequently decreased the righting arm curve and cause the vessel to heel even further and capsize at an even faster rate. In additional to analyzing stability for the capsize voyage we also analyzed stability for the vessel on its two preceding voyages. The voyage from Jacksonville, Florida to Brunswick, Georgia which was the voyage prior to the capsize and the voyage from Freeport, Texas to Jacksonville, Florida which was the voyage, two voyages prior to the capsize. The loading conditions for these voyages were obtained in a similar manner with that of the capsize voyage using the IMACS tank load and their respective cargo stowage plan. Again for comparison I've shown the benchmark loading conditions or an example loading condition from the vessel's trim and stability booklet. And now I'm going to zoom in on the area of the righting arm curve between 0 and 40 degrees of heel. So here's the righting arm curve for the vessel in the capsized voyage and this is the same curve that I showed previously. Next just a little above that is the righting arm curve for the vessel in the Jacksonville to Brunswick voyage as obtained by our model. And finally in between those two curves is the righting arm curve for the vessel from Freeport to Jacksonville voyage as obtained by our model. Now there was a point and time during the voyage from Freeport where the vessel had taken on additional ballast, but this curves reflects the vessel's condition after that ballast was discharged or the second half of the voyage. Although both the righting arm curves during these two previous voyages are slightly more favorable to stability than in the capsized voyage,

they are still well below the benchmark loading conditions. Our results indicated that the vessel was not in compliance with 2008 Intex Stability Code with either of preceding voyages because it did not pass the area under the righting arm curve requirement or the severe wind and rolling criteria during either loading condition. When contemplating why the vessel didn't capsize in either of the preceding voyages, but did capsize while leaving Brunswick, it's important to understand that failure of the IS Code does not indicate immediate capsize. Rather it indicated that the vessel poses a higher risk of capsize given exposure in certain dynamic conditions such as severe wind and wave and or faster or tighter turns. It's certainly possible that given an exposure to a certain combination of these more severe adverse conditions the vessel could have capsized during either of the preceding voyages. The final piece of the stability analysis we conducted was accessing stability for each of the three voyages had the vessel had additional ballast on board. As I described earlier during the Freeport to Jacksonville voyage the vessel discharged approximately 1500 metric tons of ballast from the number 5 and the number 6 tanks circled on this slide. The picture on this slide represents the vessel's ballasted condition after the discharge. And now the picture on the slide represents the vessel's ballasted condition before the discharge. In order to determine the vessel's stability had it not been discharged we analyzed the vessel with the number 5 and number 6 tanks fully loaded as shown on the slide during each of the three voyages. So going back to that zoomed in version of the righting arm curve the solid lines are the same righting arm curves as before and they represent the vessel through each of the three voyages without the additional ballast. This new dotted line represents the righting arm curve for the vessel in the Freeport to Jacksonville voyage

before that 1500 metric tons of ballast were discharged. The next dotted line represents the Jacksonville to Brunswick voyage had the vessel kept on that additional ballast. And then finally the vessel's righting arm curve during the capsized voyage had the vessel kept that additional ballast on board. All three of these three loading conditions with the additional ballast on board were predicted to result in full compliance with the 2008 Intact Stability Code. The additional righting energy that this 1500 metric tons of ballast would have provided in the capsized voyage is likely to have prevented the capsize due to the added righting energy that it would have provided. So now I'll conclude the presentation with a brief recap of our conclusions. Our results indicated non-compliance with the 2008 Intact Stability Code during the capsized voyage due to the lack of area under the righting arm curve and subsequent lack of righting energy. This was because the vessel had either too much cargo at a high center of gravity or not enough liquid at the low vertical center of gravity. Furthermore, turning keeling moment acting on the vessel then the turn leading up to the capsize reduced the already limited righting energy to even a smaller amount. As this only accounts to static text of the turn the dynamic effects are likely to have overcome that very small amount of remaining righting energy and resulted in the vessel capsize. Which was likely exacerbated by down flooding through the Pilot door. Although the righting arm curves during the preceding voyages indicated likely more righting energy than in the capsized voyage these conditions were also not in compliance with the 2008 Intact Stability Code. However, had the vessel kept the additional ballast on board that was discharged during the Freeport to Jacksonville voyage this would have resulted in full compliance with the 2008 Intact Stability Code and would likely have prevented the

capsize. Thank you. This concludes the opening portion of my testimony. I would be happy to answer any questions.

CAPT WELBORN: Thank you Lieutenant [redacted] You've taken some very technical concepts and relayed those into layman terms and I do appreciate that. Before, I'm sure there are going to be several questions for you. So before we proceed into that I would like to take a quick 10 minute break. The time is now 11:16. We stand in recess.

The hearing recessed at 11:16, 22 September 2020

The hearing was called to order at 11:25, 22, September 2020

CAPT WELBORN: Okay the local time now is 11:25 and we're back on the record of the formal hearing for the capsizing of the GOLDEN RAY. We are presenting follow-on questions for Lieutenant [redacted], U.S. Coast Guard. Lieutenant thank you again for your presentation. I have some follow-on questions regarding definitions of some of the terms that you used within your testimony. So I would like to walk through some of those. The first question I have, a term SOLAS, can you define that for us?

LT [redacted]: Yes Captain. SOLAS is the safety of life at sea which is set of International regulations that the GOLDEN RAY would have had to comply with.

CAPT WELBORN: And that particular document is drafted by an International organization. Can you tell us what organization that is?

LT [redacted]: Yes Captain. The International Maritime Organization or the IMO.

CAPT WELBORN: Lieutenant you also referenced the IS Code. Can you tell us what that is?

LT [redacted] Yes Captain. The IS Code that stand for the Intact Stability Code and SOLAS references the Intact Stability Code which vessels must be in compliance with which are applicable to SOLAS.

CAPT WELBORN: Lieutenant you said that the code specifies a .15 meter, I believe. Tell me what that is again?

LT [redacted]: Yes Captain. The code specifies that all vessels which are applicable to the Intact Stability Code must have a 0.15 meter GM or that's the initial slope of the righting arm curve.

CAPT WELBORN: In this International requirement is it a requirement for all cargo vessels sailing worldwide?

LT [redacted] All vessel which are applicable to SOLAS, yes, sir.

CAPT WELBORN: In this, the GOLDEN RAY was applicable, SOLAS did apply to the GOLDEN RAY, is that correct?

LT [redacted]: That is correct, sir.

CAPT WELBORN: Looking for slide in your presentation. Lieutenant would you refer to slide 46 of your presentation please? Lieutenant you used this slide to talk about the ballast in the cargo vessel in the GOLDEN RAY. Can you tell us where this slide or where these graphics were obtained from?

LT [redacted]: Yes Captain. So these graphics were obtained from the vessel's recovered IMACS computer which is essentially the computer that monitors the vessel's tank load or how full those tanks were.

CAPT WELBORN: Just for the record this IMACS computer was recovered from the vessel in the capsized, you used for analysis throughout the investigation by the joint team. Lieutenant you referred to the T and S booklet. Can you tell us what that is?

LT [redacted] Yes Captain. The T and S booklet is the trim and stability booklet. And that's the stability guidance provided to the vessel from the designer.

CAPT WELBORN: Is that T and S booklet prepared in accordance with any International standards?

LT [redacted]: Yes Captain. That T – the trim and stability booklet is prepared in accordance with the 2008 Intact Stability Code.

CAPT WELBORN: And is that code also an International Maritime Organization document?

LT [redacted] Yes Captain. It's an IMO document.

CAPT WELBORN: You also mentioned benchmark loading conditions. You specifically referenced 13 and 18. Can you tell us what those are?

LT [redacted]: Yes Captain. So those were conditions which represented displacements which were comparable or fairly similar to that of the capsized voyage condition. And I would have reference back in my report what exactly those conditions were labeled as. But they were essentially the vessel is loaded with either a departure or arrival load of ballast and fuel and with a standard cargo load.

CAPT WELBORN: But in short those are references in the T and S booklet, the trim and stability booklet that showed similar situations to the GOLDEN RAY's trim or loading operation in and out of the Port of Brunswick, is that correct?

LT [redacted]: Captain they represent acceptable loading conditions. So again there was some differences between those conditions and the capsized voyage conditions.

CAPT WELBORN: Understood, thank you. Lieutenant, understanding that engineers like specifics if the vessel had experienced a draft that changed less than 1 meter plus or minus, would that have substantially changed your calculation?

LT [redacted] Captain 1 meter is a significant draft difference for this vessel, so the calculations probably would have changed.

CAPT WELBORN: And if the metric tons of cargo had changed by say 100 or 200 metric tons would that have substantially changed your calculation?

LT [redacted]: No Captain. It's likely that 100 or 200 metric tons compared to the 35,000 tons of displacement of the vessel, 100 or 200 metric tons would not likely have substantially changed the analysis.

CAPT WELBORN: I need to reference another within your presentation. Lieutenant those are the questions that I have for you at this point. At this time I would like to refer to our substantially interested parties, or the substantially interested States and move to their questions at this time. So Mr. Bremer from the Republic of Marshall Island do you have questions for this witness?

Mr. Bremer: Yes Captain thank you. Lieutenant [redacted] during your presentation you mentioned the speed of 13 knots over ground was used for your calculations. Could you please describe or inform us if there would be any difference to the stability calculations for the GOLDEN RAY on the capsized voyage with the addition of current?

LT [redacted] Could you repeat part of your question Mr. Bremer, I didn't hear it.

Mr. Bremer: So you, I'll start over from the beginning. You mentioned at 13 knots speed over ground was used for calculations with the model that you generated. Can you describe the expected impacts of current on the stability of the GOLDEN RAY during the capsized voyage specifically leading up to the turn?

LT [redacted] Yes, sir. So the 13 knots was used as part of the static analysis for the vessel. So that's the speed over ground. And that's a determination of the centripetal force. The current isn't a part of that. The current would be more applicable for a dynamic analysis which was beyond the scope.

Mr. Bremer: Okay thank you. And you had mentioned in that you had applied in your model the ballast that was taken on during the voyage from Freeport to Jacksonville to the conditions at the time leading up to the capsizing. Do you know what the calculated drafts would expected to be?

LT [redacted] Yes, sir. Let's me reference the slide. Let me pull it up. Sir, so this represents the draft calculated by our model for each voyage with the additional ballast. So during the capsized voyage with the additional ballast our model predicated a mean draft 9.59 meters under hull water condition.

Mr. Bremer: Okay and. And based on your modeling of the ship would this quantity of ballast brought the GOLDEN RAY into compliance with the trim and stability book and the IS Code?

LT [redacted] Yes, sir. This additional ballast would have brought the vessel in full compliance with both the trim and stability booklet and the Intact Stability Code as calculated by our model.

Mr. Bremer: And you had mentioned that these calculations were using salt water for your model. Can you describe the impacts if fresh water were to be used?

LT [redacted] Yes, sir. If fresh water were to be used the draft would increase. For the, yeah it would increase but not significantly. Less than .5 meters.

Mr. Bremer: And for the departure from Brunswick for your modeling can you please describe how you determined the vehicle weights to be use for your model?

LT [redacted] Yes, sir. So the vehicle weights were taken from the Brunswick departure stowage plan which was provided to us. And those weights were provided in blocks which were designated by the plan. And so we first, those blocks also had descriptions of the vehicles that were in those blocks and we kind of truth checked those first against what was actually in there. And then we took the total weight of each block and we applied that to the model at the location as specified by the plan.

Mr. Bremer: And all of the vehicles that were on board were the weights on that loading or stowage plan, excuse me, that were used?

LT [redacted] Yes, sir. All the weights were on that stowage plan.

Mr. Bremer: Thank you Lieutenant [redacted] I think that's all the questions I have right now.

LT [redacted] Thank you Mr. Bremer.

CAPT WELBORN: Captain Flaherty do you have questions for this witness?

NTSB: Yes I do Captain Welborn. Good morning Lieutenant how are you doing?

LT [redacted] Good Captain, and yourself?

NTSB: I'm doing good. I've got a few questions. The information that you got from this vessel including the computer that was recovered, all the information you used was

available to the officers and crew on board the vessel prior to the vessel departing Brunswick?

LT [redacted] That is my understanding, yes Captain.

NTSB: And it was reported to the investigators that prior to, yeah prior to departing Colonel Island the GM was calculated as being 2.45. Not to put you – how much, not changing the weight of the cargo and the weight of the fuel, how much additional ballast do you think would be required in order for the vessel to actually meet that GM of 2.45?

CAPT WELBORN: If I could step in here Lieutenant, one moment. I believe we've lost our livestream. Standby while we reset the livestream. Captain Flaherty if you would restate your last question.

NTSB: Sure. It was reported to investigators that prior to the casualty occurring the GM of the vessel at the time of departure was 2.45. Not changing the weight of the cargo or the weight of the fuel how much additional ballast would be required for the vessel to have been at, or to have a GM of 2.45.

LT [redacted]: Yes, Captain. So we didn't do an analysis of what that exact number would be. But I can tell you that with the additional 1500 metric tons of ballast the GM is 2.25 meters. So at least 1500 metric tons of ballast.

NTSB: And with that additional 15 metric tons of ballast how significantly would the draft of the vessel change?

LT [redacted]: Yes Captain. So that draft without the 1500 metric tons the mean draft of approximately 9.35 meters, and then actually shown on the slide here that left hand column the mean draft increased to approximately 9.59 meters with 1500 metric tons of additional ballast.

NTSB: Okay. Now you became very – you examined the compute, the IMACS quite extensively I'm sure.

LT [redacted]: Yes, sir.

NTSB: Did you notice prior to the Freeport, did you go before the Freeport port visit?

LT [redacted] I did not go before the Freeport port visit, Captain.

NTSB: Okay. From the Freeport port visit to the vessel departing Colonel's Island the night of the casualty, outside of the additional ballast for the time the vessel is near the hurricane, was there any significant additions or subtraction of ballast?

LT [redacted] I did not note any significant additions or subtractions of ballast during either of the three voyages or during those port visits. And that's by monitoring the IMACS computer.

NTSB: And did you notice any addition of fuel from Freeport to Brunswick?

LT [redacted] I did not notice any significant addition of fuel. Again, I'm not sure I took a detailed look at what exactly the fuel states were other than the time stamps I used for my analysis. There could have been small changes in fuel, but I did not notice a significant change.

NTSB: Was there any significant or noticeable change in where the ballast was transferred around anytime excluding the time of the hurricane, but from Freeport to Brunswick? Was there any movement of ballast?

LT [redacted]: Yes Captain. So I noticed that from Freeport to Jacksonville voyage the vessel had taken on approximately 1500 metric tons of ballast and that was in the earlier part of the voyage. And then I noticed that it had discharged that ballast you know several days after that.

NTSB: And then it was also reported that they used fresh water where the exterior of the vessel. Did you use fresh water or did you use salt water?

LT [redacted]: To load the ballast tanks specifically?

NTSB: No the exterior, the water outside that the vessel was sitting in.

LT [redacted]: Can you repeat your question, I'm not understanding.

NTSB: The vessel, the water that vessel was sitting in it was reported that they had used fresh water versus salt water when determining the stability of the vessel. So ----

Mr. Reisman: Captain Welborn.

CAPT WELBORN: Yes.

Mr. Reisman: I would like to object to this line of questioning. Where as Captain Flaherty is correct that was initially stated in the Coast Guard interviews I believe the Chief Officer subsequently clarified that in his interview with the KMST which is in the record of this proceeding.

NTSB: Well I'll rephrase this question. Did you utilize salt water for your calculations for the stability of the vessel?

LT [redacted] Yes, sir. I used salt water for those calculations.

NTSB: Now when the vessel started to lose stability and it was shortly after the 20 degree turn did you examine the forces that caused the vessel to still continue to make that hard starboard turn?

LT [redacted]: I would answer that as part of this analysis you know the rudder force makes the starboard turn. So to that extent, yes we did analyze that. But again this is from a static perspective and we didn't go to, we did not analyze the dynamics of that turn.

NTSB: Okay, thank you. That's all I have Captain Welborn.

CAPT WELBORN: Thank you Captain Flaherty. I do believe we have a question from KMST. Lieutenant as previously stated I will be reading the questions from KMST. As previously stated I will be reading the questions from KMST as they arrived directly. Since they are unable to be with us physically here in the hearing. So Lieutenant, KMST asks, since the stability of GOLDEN RAY was unstable when it arrived at the Port of Brunswick did that mean GOLDEN RAY could have capsized on its way to Brunswick?

LT [redacted]: Yes. So, right. So we analyzed stability for the vessel in those two preceding voyages. The cargo change in Brunswick was not significant. Our analysis indicated that the vessel did not comply during the inbound voyage with the 2008 Intact Stability Code. A vessel that does not comply with the 200 Intact – 2008 Intact Stability Code has a higher probability of capsizing.

CAPT WELBORN: Thank you Lieutenant. We'll hold the line of questioning open for KMST as we proceed to our PII's. Mr. Reisman do you have questions for this witness?

Mr. Reisman: Thank you Captain. Yes I have a few questions. Lieutenant [redacted] thank you very much for your presentation. I do have a few follow-up questions I would like to ask you. Some you've talked about but I just want to confirm, make sure that I have a full understanding of your testimony. So starting with the cargo weights, I know there's been a lot of discussion on that topic. Is it your conclusion that the cargo weight estimates that was used by the vessel operators were reasonable as compared to the actual weights that were obtained during your analysis?

LT [redacted]: Yes, sir. For the most part they were. There was one area where the weight on the plan indicated a significantly higher weight than I would expect. And I – what I did was I used the actual calculated weight based on the vehicle on that deck.

Mr. Reisman: And your calculations actually determined that the actual weights from the manufacturer were heavier than the estimated weights used by the vessel operators, is that correct?

LT [redacted] Can you repeat the question sir, I'm not understanding.

Mr. Reisman: Certainly. So when you estimated the total of the cargo weight you came up with a higher number than the total cargo weight used by the vessel operators, correct?

LT [redacted]: I don't recall the specifics, sir, off the top of my head. I can reference in the report if needed.

Mr. Reisman: That's okay. We'll move on. If I think that's important enough we'll come back to it. Again so I understand. Had the ship taken on or maintained that 1492, or roughly 1500 metric tons of ballast it would have satisfied all stability criteria both the trim and stability guide and the IMO IS requirements, is that correct?

LT [redacted]: That is correct, sir.

Mr. Reisman: And that is true even if it maintained a precise cargo loading that it had through the Brunswick cargo operations?

LT [redacted]: As applied to our analysis, yes, sir.

Mr. Reisman: So had it maintained that ballast, that additional ballast then it would have satisfied the requirements. Does that tell us that this was not a ship design issue that led to this casualty?

LT [redacted] Yes, sir. I mean in doing this analysis I found nothing that was an issue with the ship design.

Mr. Reisman: And the space planning, in other words where the cargo was located on the ship and how much cargo, that was not inherently deficient or cause of this incident, correct? Because it could have been compensated for and brought the ship into compliance by maintaining or taking on that ballast.

LT [redacted]: Yes, sir. The ship could have been compliance according to our analysis with the Intact Stability Code and the trim and stability booklet if the loading would have changed.

Mr. Reisman: I'm sorry maybe I didn't understand. If the loading of ballast had changed, the cargo configuration itself could have stayed exactly the way it was and the ship would have been in compliance with IMO requirements and the trim and stability requirements simply by maintaining that roughly 1500 metric tons of ballasts, correct?

LT [redacted]: That is correct. Yes, sir.

Mr. Reisman: Thank you for clarifying that. If the stability criteria had been satisfied by maintaining that 1500 metric tons of ballast would there have been any restrictions on the use of rudder during the Brunswick out bound voyage?

LT [redacted]: Yes, sir. We didn't look at that. That's sort of beyond the scope of the analysis.

Mr. Reisman: Fair enough. There was some discussion in your presentation regarding the Pilot door being open and the concept of down flooding. Can you tell us would the ship have capsized had the Pilot door been closed throughout this out bound voyage?

LT [redacted]: Yes, sir. So with the lack of righting energy even prior to possible down flooding the vessel would have heeled significantly and likely result in capsize. Our analysis indicated that the down flooding simply exacerbated the capsizing.

Mr. Reisman: So the Pilot door being left open or being open at that time I should say was not the cause of the capsizing in your opinion, is that correct?

LT [redacted] That's correct.

Mr. Reisman: During your presentation and I think some of the subsequent questions also you talked about some of the benchmark conditions that are shown in the ship's trim and stability guide. Those are, I believe you indicated but I want to confirm, are merely benchmarks, the ships are not required to comply with any specific cargo or ballasting configuration as long as it meets the stability criteria, am I correct?

LT [redacted]: Yes, sir, that's correct. Those are example loading conditions provided to the vessel. The vessel is required to meet the 2008 Intact Stability Code.

Mr. Reisman: Just give me one moment. I think that may be it. Let me look through my notes quickly. One final question. There's always another question, sorry. Captain Flaherty from the NTSB asked you a question about the 2.45 GM that was reported by some of the ship's crew during the investigation and then again in the course of this hearing. Are you able to offer an opinion as to how or why they achieved a 2.45 GM calculation?

LT [redacted]: I'm not able to offer an opinion, no, sir.

Mr. Reisman: And do you have an opinion as to how or why that GM calculation is incorrect? In other words can you explain how they got the wrong calculation?

LT [redacted]: No, sir. That was not part of my responsibility.

Mr. Reisman: Thank you very much. I appreciate your testimony today.

CAPT WELBORN: Anything further Mr. Reisman?

Mr. Reisman: No think you Captain. That's all I've got for this witness.

CAPT WELBORN: Mr. Gilsenan do you have questions for this witness? Mr. Gilsenan do you have questions for this witness?

Mr. Gilsenan: Yes I do Captain. Thank you. I will be brief. Lieutenant [redacted] thank you for your presentation today. I wanted to being with kind of a statement that the vessels call into ports of the United States pay a hard or maintenance tax and this is collected by the Federal Government. And Congress is intended to, or they're supposed to by Statute pay the proceeds of the harbor maintenance tax for maintaining harbors. Are you aware that the project depth at the Port of Brunswick at mean low low water is 11.6 meters of water at the outer bar and 10.7 meters in the harbor?

LT [redacted]: I was not aware of that sir. We didn't look at harbor depths as part of this stability analysis.

Mr. Gilsenan: Okay. I'll represent to you that through no fault of the Corps of Engineers they work with the money they're allocated. The actual depth of the channel is less than the designed project depth. So what I wanted to ask to you -----

CAPT WELBORN: Mr. Gilsenan, this is Captain Welborn. This line of questioning regarding the depths of the channel or what not is outside the expertise of Lieutenant [redacted]. He's strictly looked at the Intact Stability of the vessel itself.

Mr. Gilsenan: Understood Captain. I'm leading up to my one question which is right now. Had the GOLDEN RAY been ballasted to the point that the vessel had a mean

draft of 10 meters would that have increased the vessel's stability? All other conditions being the same.

CAPT WELBORN: Mr. Gilsenan again I believe that's beyond the scope of the analysis that Lieutenant [redacted] is providing. He works within the parameters or the numbers that he was provided and the Intact Stability calculations in addition with the trim and stability booklet provided him some direction in his analysis. These questions regarding project depth of the channel may be a little bit more appropriate for our next witness, Dr. Jeff Falzarano who is our hydrodynamic stability specialist.

Mr. Gilsenan: Captain Welborn if I may just to lay some foundation for my question. Never mind project depth. The testimony today shows that had the 1500 tons of ballast remained on board the vessel the mean draft would have been 9.59 meters instead of the actual capsized voyage draft of 9.35 meters. So and it's also been testified with the 1500 tons of ballast still on board the vessel that the vessel would have been in compliance with the 2008 IMO Intact Stability criteria. So based on that if with the 1500 tons of ballast on board the mean draft would have been 9.59 meters. My question is, and that was more stable than the capsized voyage, had the vessel been ballasted at 10 meters would it have been even more stable. And that's it.

LT [redacted] Yes, sir. I can tell you that the way the vessel was ballasted during the capsized voyage it did not comply with the 2008 Intact Stability Code and with the 1500 additional metric tons of ballast it did comply.

Mr. Gilsenan: Thank you. That's all I have Captain Welborn. Thank you.

CAPT WELBORN: Thank you Mr. Gilsenan. So Lieutenant I have one or two final questions from KMST. Or excuse me additional questions from KMST and I'll read

those again just as they came in. On the inbound transit to the Port of Brunswick GOLDEN RAY used more than 20 degree rudder could that mean GOLDEN RAY could have capsized back then?

LT [redacted]: So looking at the turns on the inbound voyage was beyond the scope of this analysis. We only looked at the turn for a static analysis perspective the turn in which the vessel capsized.

CAPT WELBORN: Question two. Could you please explain why GOLDEN RAY did not capsize on its inbound transit to the Port of Brunswick?

LT [redacted]: Again that was beyond the scope of the analysis.

CAPT WELBORN: I'll standby one moment to see if KMST has any follow-on questions. I see no more follow-on questions from KMST. Lieutenant [redacted] again thank you for your analysis of this. One final question from me. So in your opinion what was the cause of the vessel capsizing?

LT [redacted]: The cause of the vessel capsizing was the lack of righting energy due to the way in which the vessel was loaded.

CAPT WELBORN: And that loading is both cargo and ballast, is that correct?

LT [redacted] That loading is either or. The vessel could have taken on additional ballast to be in compliance with the 2008 Intact Stability Code, the cargo could have also been shifted so that that cargo was at a lower vertical center of gravity.

CAPT WELBORN: Understood. Lieutenant [redacted] thank you very much for your time today. We do appreciate it. Please know that you are you subject to recall as long as we're in these formal proceedings. And at this time the time is currently 12:02. We'll

take a 10 minute recess until we call our next witness Dr. Jeffrey Falzarano. We stand in recess.

The hearing recessed at 12:02, 22 September 2020

The hearing was called to order at 12:30, 22 September 2020

CAPT WELBORN: The local time is now 12:30 we're back on the record in the investigation to the GOLDEN RAY capsizing. A couple housekeeping issues before we proceed. Coast Guard Exhibit 16A, Lieutenant [redacted] PowerPoint and Coast Guard Exhibit 16B his full report will be entered into evidence. Any objections from the SIS's? Hearing none. Any objections for the PII's? Both pieces will then be moved into evidence in this formal hearing. Our next witness is Dr. Jeffrey Falzarano, Texas A&M University. Dr. Falzarano are you with us sir?

Dr. Falzarano: Yes, sir I'm here. Yes, sir.

CAPT WELBORN: Super. Dr. Falzarano can you use the livestream in the background because we hear you live and then we also hear the livestream.

Dr. Falzarano: Yes, sir. Yes, sir. Yes I've done that, uh huh, thank you. Okay, that's better?

CAPT WELBORN: Yes. We will only hear you once now. Dr. Falzarano if you would like to set your video on live so we can see you in our proceedings.

Dr. Falzarano: Yes. Start my video, yes, sir.

CAPT WELBORN: Great there you are. So Dr. Falzarano thank you again for joining us. Lieutenant Commander Moore will swear you in as a witness.

Dr. Falzarano: Okay.

Recorder: A false statement given to an agency of the United States is punishable by fine and or imprisonment under 18 United States Code 1001. Knowing this do you solemnly swear that the testimony you're about to give will be the truth, the whole truth and nothing but the truth so help you God?

Dr. Falzarano: Yeah.

Recorder: Thank you Dr. Falzarano please be seated. Captain the witness is ready.

CAPT WELBORN: Thank you Lieutenant Commander Moore. Dr. Falzarano again thank you for appearing today. Are you represented by counsel?

Dr. Falzarano: No, sir.

CAPT WELBORN: And are you designated as a party in interest to this investigation?

Dr. Falzarano: No, sir.

CAPT WELBORN: Dr. Falzarano before we proceed into your presentation will you speak to your experience and expertise in your presentation?

Dr. Falzarano: Yes, sir. I have a slide on that.

CAPT WELBORN: Perfect. Please proceed.

Dr. Falzarano: This is the hydrodynamic assessment of the car carrier GOLDEN RAY capsizing. Although I am a professor I would you not talk about my affiliation? I've done this during my summer off time. But we can go to the next slide. Next slide. Just a little bit about background. I have a Bachelor's Degree in Naval Architecture from the Web Institute of Naval Architecture. I have Master Degrees in Naval Architecture, Marine Engineering, Aerospace Engineering and Applied Mechanics, and I have a PHD in Naval Architecture all from the University of Michigan. I have 30 plus years of experience as a Naval Architecture Ocean Engineering Faculty doing research and

teaching in this area. I also have experience, specific experience with maneuvering as follows. I undertook maneuvering trials in ICE in Green Bay of the U.S. Coast Guard Cutter MOBILE BAY. I re-introduced the maneuvering testing prediction capability at the off shore model basin for Newport News shipbuilding. I co-authored the ABS guide to vessel maneuverability. I also undertook a validation study and also a revision of the same document. I worked with the NTSB on the CROWN PRINCESS heeling incident. Basically develop – co-developing the kinematic extraction study utilized by them and several subsequent investigations. I recently served two years on the National Academy Transportation Review Board Committee to review U.S. Coast Guard stability rules. And recently undertook a hydrodynamic and past stability analysis of the GENSIES RIVER accident. I'm currently teaching ship and off shore dynamics and control and doing research with my PHD students on ship maneuvering and waves and extreme vessel motion. Next slide please. Just a little bit of an overview and background of the GOLDEN RAY incident. And again this is my understanding. I was given access to a variety of documents in order to base my understanding of this incident on. First and foremost I'm going to say the vessel may have had marginal intact stability as per the IMO 2008 Intact Stability Code. The vessel had just left the Jekyll Island Range and again I apologize this is repetitive to some extent. The Jekyll Island Range and it ventured the Widener 11 area. The Pilot proceeded to turn the vessel with 10 degrees then 20 degrees starboard rudder heading toward the Plantation Creek Range. The vessel became unstable in the Widener 11 area. Little background on these types of vessels. Most vessels like tankers and bulkers maneuvering is generally not – is not coupled to the roll motion. However, for slender high speed ships

with critical GM such as pure care carriers they may experience significant and coupled roll motion when turning and roll motion may subsequently effect the turning ability. This vessel was designed and built by Hyundai NEPO dock yard, Korea's largest ship builder. Which incidentally has a hydrodynamic test facility associated with them. Sea trials of the sister ship SILVER RAY were performed at Ballast draft with stern trim and powering test were done by the Marine Institute of Netherlands. Just a little bit of background of what I'm going to discuss and I hope this compliments the other analysis, but I will talk about the vessel maneuverability. First and foremost there are several IMO, International Maritime Organization resolutions which pertain to this. First and foremost is the MSC 13776 which is about ship maneuvering criteria. And its significantly based upon ship maneuvering at deep water, full load, even keel and design speed. There's another IMO resolution 601 which is about maneuvering poster, maneuvering data available to the crew, to the Pilot and it takes some of that data from the maneuvering criteria and predicts it performance at slow speed and shallow water. We didn't have a complete picture of the maneuvering books since the maneuvering performance, because we didn't have a maneuvering booklet or the corrected sea trials data. That's fine we used what we had. Just a little bit of background. Shallow and narrow channels trim and speed effect the maneuvering hydrodynamics. Okay. Next slide please. Again you know I looked at the data available to me including a NOAA chart and also understood that there may have been some changes from this NOAA chart. And they also had access to a – an early draft of the NTSB report which was able to provide me with some information on the vessel. The water depth and the vessel's speed. Again I think this is the vessel's speed over the ground and would not

consider the possibility of either an ebb tide or a flood tide. Next slide please. Specifically the IMO resolution 137 requires that sea trials be done or corrected for deep water design speed, draft and trim. There are several aspects of ship maneuverability. I'm going to focus on the turning ability, but inherent dynamic stability, the vessel's ability to maintain a straight course, course keeping ability, initial turning and course changing ability,[in audible] ability, turning ability, and stopping ability. Again I'm going to focus on the turning ability and the turning – the turning the coupling of the turning to the roll motion which may have contributed to this accident. Again I'm sorry I'm being a little bit repetitive, but the sea trials are done at ballast, the sea trials were done of the sister were done at ballast draft and stern trim. And there were no corrections provided other than what was on the maneuvering poster which was somewhat what we wanted. The IMO resolution 601 requires a wheelhouse poster and turning and stopping data. The Flag does not require – the Flag does require the corrected sea trial data, but not a maneuvering book. Next slide please. Okay just a little bit of the background to my approach to this analysis. Again I'm just summarizing the results of it. There are more results in the associated reported. And many of the calculations are contained in spreadsheets and computer models, etc. Again I reviewed the vessel and incident data and had access to parts of other studies. I developed a hull hydrodynamic model which considered both the shallow water effects and the bow squat that results from the speed. Validated this prediction technique by comparing to other pure car carriers. Again I wanted to make sure that my hydrodynamic model was reasonable so I compared my hydrodynamic model to other similar vessels, published data. I developed a propeller and rudder hydrodynamic model. I put all that together into

what's called a 3 degree of freedom maneuvering computer simulation model. The 3 degrees of freedom are surge, sway and yaw, horizontal plane. I then validated this computer model by comparing to the maneuvering poster data provided. I then added the roll coupling to the 3 degree of freedom model resulting in a 4 degree of a freedom model and performed time simulations using my model. I validated that model by comparing to the VDR results provided by the NTSB. And then using the above I investigated various what if scenarios including what would be the effect of a higher GM. Okay next slide please. This is a little bit about how a ship turns and my validation as compared to some of the predications provided by the maneuvering poster. So in terms of a ship turning a vessel will be going along a straight course, the rudder, the rudder command will be given, the rudder execute will then result in what's called the first phase of the turning. It's all transient. Then, I have a hand drawn sketch of this later on. And then a second phase and a third phase which is the steady turning which was the focus of another investigation I understand. So this is just a validation of my 3 degree of freedom model with the available data that I had from the maneuvering poster. Again I came up with a hydrodynamic model based upon available data of similar vessels. Okay next slide please. Okay I did an extensive literature survey of basically maneuverability of pure car carriers. And one of the things I came across was some verbiage provided by a Master Thesis by the Swedish, the Swedish University in Stockholm and I will just read that. Be patient with me and hopefully it will give us some understanding of what we're dealing with. So even though maneuverability has been a lower priority it is an important issue for this type of vessel. For example powerful flat rudders with large lever to the center of gravity in combination with low stability gives

these vessels special characteristics while maneuvering that puts high requirements on the auto pilot and the crew. In sharp turns for example the force from the rudder causes the ship to heel and rudder moments have to be kept small to minimize induced resistance. Experience from operations of these vessels also shows that a very active steering is need to keep the course which may depend on the dynamic stability. More knowledge about the dynamic stability or instability of the vessel is need to determine its influence on the resistance and if the resistance can be reduced by changing the course stability properties of the vessel. Just a little bit of a background, these are not my words. I extracted these from a Thesis which was supported by Wallace Marine which is an operator of these type of vessels. So that will give us a little bit of an understanding of the importance of maneuverability and the design of these vessels. But then also the subsequent coupling of the heel which is basically the roll motions of ships. Next slide please. Okay this is a little bit of detail, again I apologize for the drawing on the right hand side. It's my hand sketch. I couldn't find – I couldn't find a sketch but essentially what this figure depicts with the two hulls on the left hand side, the forces that are applied, the rudder force of the initiation of the turn, the inertial reaction force. And then in steady turning what forces are then acting upon the vessel. I believe this was described previously in another presentation. But again I apologize for my hand drawn sketch. But essentially what happens as the vessel initiates a starboard turn the vessel will initially heel inward to the turn, it's a positive roll motion, but it will eventually heel outward to the turn. And we call this the first phase and the third phase. And what you can see is in again my hand drawn figure is the steady turning in the third phase, but the two dynamic overshoots. And those are what I was

trying to model, predict for this vessel in order to – in order to understand the importance of the dynamic response of a vessel in a turn as opposed to its stead turning. Next slide. This is an excerpt of the early draft of the Coast Guard, U.S. Coast Guard MSC report undertaken by Lieutenant [redacted]. And essentially what this does is this, I extracted the estimated stability during the capsize voyage, 1.75 meters, the required again I just took off this chart and some of the data available in the report. I looked at the difference between an initial GM of 1.75 meters which seemed to be the case in the capsize voyage as compared to a 2.69 meter GM, one of the cases in the trim and stability booklet. I would like to point out that the GM as previously described is the initial slope of the righting arm curve. I actually used the full righting arm curve. I was able to digitize and curve fit this data and incorporate that into my simulation model. So again I assumed these data were given. I did not calculate these. Although I did review some of them for my own purposes. But I assumed that this data was given. Next slide please. Of the; many simulation cases that I undertook this I believe would be, you know the most telling. I did literally hundreds of simulation cases in order to validate my simulation model and also to try to answer some what if questions. So on the left hand side is the, my simulation of the accident. I have only a 10 degree rudder, but with the 10 degree rudder you can see that the vessel, how the vessel, the blue curve is the rudder, the orange curve is the roll angle. And what you can see is how the both the steady, the steady angle and also the overshoot. I compared this to the NTSB VDR data and I was relatively close. Okay and so this gave me some confidence in my hydrodynamic model that it was reasonable. And then what I then proceeded to do was to look at various what if scenarios and I think the most telling what if scenario is if the

GM was increased, it was one of those cases in the trim and stability booklets that I extracted and what you can see is that the steady turning is about 1/3 of the steady turning with the lower GM and then the overshoot is about, about half a little bit more than one half. So this kind of tells us that the effect of the reduced GM on the coupling of the roll to the – the coupling of the roll to the turning motion. I would also like to mention that the sea trials of the SILVER RAY, they did include the roll angle which was only about 5 degrees that was observed in the sea trials. But we didn't know what the GM was and the vessel was at the ballast draft with a significant amount of trim by the stern which would make it, very past stable. And so that number doesn't really – doesn't really help us that much. Next and final slide. Based upon my analysis, which I've summarized here. Again there are more results contained in the accompanying report. And I also have many more cases that I – they undertook and more details of my calculation procedure available if needed. But based upon what I – my analysis I would say that the reduced initial and large angle upright stability of the pure car carrier GOLDEN RAY more than likely contributed to the large roll angle – large roll angle ample to oscillations while the vessel was turning to starboard due to the strong coupling of the rolling motions to the maneuvering motion of this vessel. Many factors effect this coupling including the rudder angle, the roll damping and the initial GM. And also the large angle stability. However, a higher GM would have significantly reduced the overshoot roll angle. IMO resolution 137 requires our predictions be made at full load, designed speed and even keel. It is not clear how the vessel satisfied these since both the sea trials report and maneuvering poster do not contain these results. Access to these predictions would have allowed further validation, but again I used what I had

and I went with that. Although not required by International stability regulations it is not clear if the roll coupling to the maneuvering was considered as part of the initial design. Just a side – side light the 2008 Intact Stability Criteria does mention for passenger vessels to determine the steady – the roll angle with a steady turning, but it's not required for this type of vessel. So with that being said. That is my presentation and all the slides are numbered. And so I would be happy to answer questions that may come about. Thank you very much for your attention and thank you Captain Welborn and the other members of the investigating committee for this opportunity to present this data. Thank you very much.

CAPT WELBORN: Dr. Falzarano thank you very much for your time. I would like to clarify a couple of terms with you before we proceed into questions and then we'll take a short recess.

Dr. Falzarano: By all means.

CAPT WELBORN: So Dr. Falzarano you used the PCC term. Can you tell us what that means?

Dr. Falzarano: I'm sorry that's a pure car carrier and I guess I should have said pure car and truck carrier. But it's just a type of vessel, PCC and PC just this type of vessel. This – it's typical of this type of vessel, the large above water forum and the under forum that's typical of these type of vessels.

CAPT WELBORN: So for your analysis those terms are synonymous, they mean the same thing?

Dr. Falzarano: Yes, sir, yes, sir. I'm – yes, sir.

CAPT WELBORN: You also referenced the SILVER RAY. Can you tell us the relationship between the SILVER RAY and the vessel in question the GOLDEN RAY?

Dr. Falzarano: Yes, sir. My understanding is that the SILVER RAY is a sister of the GOLDEN RAY. And the sea trials were actually performed on the SILVER RAY and that data was then subsequently, much of the data was subsequently applied to the GOLDEN RAY. So the maneuvering trials were actually performed on the SILVER RAY. I believe the hulls were identical as far as I know.

CAPT WELBORN: So Captain, excuse me, Dr. Falzarano can you tell me then when you use used the term SILVER RAY you said that the hulls are identical so they're constructed – does that mean they are constructed with the same plans?

Dr. Falzarano: My understanding is they are. Again when I was provided with the sea trail data for the GOLDEN RAY it specifically stated that many of these trials were performed for the SILVER RAY, the sister. And so they must be very close in design, hull form, etc. for that to be allowed. Yes, sir.

CAPT WELBORN: Understood. Thank you for that clarification.

Dr. Falzarano: Yes, sir.

CAPT WELBORN: And Dr. Falzarano you referenced Lieutenant [redacted]s report in the later portion of your presentation along about I believe slide 9, maybe 10. Did you refer to Lieutenant [redacted]s report, did you reference it in the formative stages of your report? Did you use that as a basis for your initial thought?

Dr. Falzarano: Yes, sir. I was provided with a great deal of stability information and in lieu of repeating everything that he had done I thought that my investigation should

compliment his so I basically used his analysis. I reviewed it somewhat, I mean I'm also a Naval Architect. But I used his analysis as my baseline, sir, yes.

CAPT WELBORN: Understood. Those are the formative questions that I have right now Dr. Falzarano. I would like to take a quick 5 minute recess for us to transition our questioning onto our substantially interested States and parties in interest. So the local time now is 12:55, we'll stand in recess for 5 minutes.

Dr. Falzarano: Yes, sir.

The hearing recessed at 12:55, 22 September 2020

The hearing was called to order at 1:00, 22 September 2020

CAPT WELBORN: The local time is now 1 O'clock and we're back on the record for the formal hearing of the capsizing of the Motor Vessel GOLDEN RAY. So Dr. Falzarano as previously stated we'll go through out substantially interested States first. The first will be from the Republic of the Marshall Islands. Mr. Bremer do you have questions for this witness?

Mr. Bremer: Yes Captain thank you. Dr. Falzarano during your testimony you mentioned bow squat was taken into consideration for the GOLDEN RAY. Can you please explain what this is and how that was taken into account in your modeling?

Dr. Falzarano: Yes, sir. As a vessel of this size is in a restricted water, shallow water what will happen is as a function of the speed of the vessel and the water depth relative to the draft the vessel will both sink and trim. And it turns out that for this vessel it will actually trim by the bow. Although it's a very fine formed vessel that's what found and that was what was depicted upon the maneuvering poster. So as a vessel is in shallow water and depending upon its hull form fullness and its speed it will sink and trim. And

in this particular case based upon the relative water depth and the speed of the vessel I utilized a number I predicted and validated that with respect to the poster, maneuvering poster. Is that clear?

Mr. Bremer: Okay thank you.

Dr. Falzarano: You're welcome.

Mr. Bremer: Yes Dr. thank you. In previous testimony mentioned that the GOLDEN RAY transitioned from shallower more confined water to a deeper area. Was this taken into account in your modeling?

Dr. Falzarano: What I did I did several calculations based upon the different water depths, I mean I had to correct the hydrodynamics for both the – for both the relative water depth and also the trim, and so I did take that into account into my calculations. In at least a quasi-static sense, yes. Yes, sir.

Mr. Bremer: Okay thank you. And if we could go back to slide number 8 please.

Dr. Falzarano: Yes, sir.

Mr. Bremer: So I just want to clarify. In the first bullet it mentions a flat rudder. Do you know what type of type of rudder the GOLDEN RAY was fitted with?

Dr. Falzarano: The GOLDEN RAY was fitted with a spade rudder. Which was actually attached to the propeller, I'm sorry there's a special name for that. But it's essentially a spade rudder where the propeller boss is then hinged to the leading edge of the rudder. So yes I did have access to the rudder plan, the rudder design and used that in my calculations, yes, sir.

Mr. Bremer: Okay thank you for the confirmation. If we could next go to slide 12 please. Dr. Falzarano I just want to confirm or clarify for the last two bullets on your

observations and summary slide, was this – are these on here because you did not have the information you needed available to make that assessment, is that correct?

Dr. Falzarano: No, sir. I mean I utilized everything I could in order to validate my computer model. Again if I would have had more data available to me I could have further validated. But no, sir. I was just mentioning what the IMO resolution, which I believe the Republic of Marshall Islands confers with. Specifically they require that the trial data which was done at the ballast draft and stern trim be corrected. And of course that was contained in the maneuvering poster. They do not require a maneuvering booklet which would have had more extensive data though. It's fine. Whatever I had I utilized. If I had more data I would have done more validation. That's all I'm stating, sir.

Mr. Bremer: Okay. So just to clarify the statement is not clear how the vessels satisfies, paraphrase these requirements is because you did not have the information available?

Dr. Falzarano: Yes. I'm sure it was submitted to you, the Republic of Marshall Islands from the initial class society which was DMVGL. But I didn't, I mean I had the maneuvering poster which kind of summarized that data, but it did not specifically, you know show exactly what was, you know it had the turning data but it didn't have the other trials such as the pull out or a spiral test or the zig zag corrected for the deep water and even keel condition. So whatever I had I dealt with. It's all I had, its fine, yes, sir.

Mr. Bremer: Okay. And another question IMO, the resolution 137 that you mentioned. Do you know if this is a requirement to be complied with or a recommendation?

Dr. Falzarano: I believe it's part of referenced in SOLAS and again you probably know more than me. But I did find a two page or a three page from Republic of Marshall Islands that you enforce this, you concurred with this. There are actually two resolutions. One is the 137 which is about the maneuvering criteria and then 601 is about the information available to the crew. It mentions you know the poster, a Pilot card which again we did not have and then a maneuvering booklet again which was not required. So I believe it's part of SOLAS, but sir, I'm a hydrodynamic I'm not a rule person. You would know better than me, sir.

Mr. Bremer: Fully understand. Thank you Dr. And last question that I have. You had mentioned I believe that currents were not taken into account in this model. How would you expect currents to effect the results of your modeling?

Dr. Falzarano: Again I believe it was a flood tide if I understand. And the flood tide, you know although the flood tide was from one – it's kind of hard to say. As the vessel was moving it was – it would probably increase, you know it was opposing the motion, so it would increase the relative velocity over the hull. And although I was not able to predict it, would probably result in an apparent flow speed greater than the speed over the ground and you know effectively be equivalent to the vessel speeding up. But I did not specifically look at that because of the fact that I didn't know as the vessel was turning from the Jekyll Island to the Widener exactly the direction of the tide. So just in the general sense it would probably increase the relative flow of velocity over the hull. But I did not specifically consider that, sir.

Mr. Bremer: Okay. Thank you Dr. Falzarano. No further questions Captain.

CAPT WELBORN: Thank you Mr. Bremer. Captain Flaherty do you have questions for this witness?

NTSB: Yes I do Captain. Good morning Dr., actually good afternoon Dr. how are you doing, sir?

Dr. Falzarano: Good morning how are you. Yeah it's noon here too, yeah.

NTSB: Now the vessel as it was proceeding out had done turns to port 10, 20 degrees. I guess one of the questions could you elaborate if you – why at those moments the vessel didn't seem to show any instability?

Dr. Falzarano: Yes, sir. I think that's a great question. And I think probably a combination of two things. Again this question had been asked previously by the Chair of the investigating committee and I think I mentioned it my report in reference to the similarity of this case to another capsizing of a pure car carrier the HU SOKA (sic) I believe. And so there were probably two things that effected the vessel not capsizing in those previous turns. One I believe would be the fact that those turns were not as extreme as these turns. I mean I don't have the exact angles in front of me but if you look at the chart. And the other would be the speed of the vessel which would affect the squat, affect the stability of the vessel. So you know as far as I know, again I did not investigate this completely. But it would be the, two things would be the extremeness of the turns, the angle of the turn, change in heading and also the speed of the vessel. And again subsequent to Mr. Bremer's observation possibly the flood tide could have also effected the relative flow over the vessel. And also decrease the vessel's stability and effectiveness. So I can only speculate. I did not do specific calculations with regards to this, sir.

NTSB: Okay, understood. Now with respect to the vessel as it was coming up on the Widener initially the vessel made a 10 degree rudder turn and there was no indication at least at that moment that the vessel was unstable. And then at the 20 degree turn is when things started to occur with the vessel losing stability. After that both the Pilot and the Master of the vessel ordered helm commands to counteract what was occurring on the vessel. Could you explain why those counter turns to both mid-ships and then full to port having no effect on the vessel's ability to recover or at least not continue to heel over?

Dr. Falzarano: Sir, again you know the 10 degree, 20 degree rudder were done very soon after one another. I specifically looked at just the 10 degree rudder to see what the relative effect of the stability was. But I think things were happening very quickly. And you know applying a rudder and, like you said initially it did not feel like it was unstable but again it takes time for these things to happen. Although they're happening very quickly it takes time for these – the hydrodynamic forces to interact with inertia of the vessel. So I believe it was just a time situation and you know again dealing with a vessel that's unstable is, you know it's trying to balance a pencil on its tip. It's very hard to do. So I think just a lot of things were happening and you know the large vessel, large inertia, things take time. Especially things take time with regards to surge, sway and yaw. Things happened very slowly. With regards to the roll things actually happen relatively quickly. So there's this coupling between the two sort of horizontal plane and vertical motions and so it's kind of hard to say exactly what happened. To be frank.

NTSB: Could you explain when a vessel loses stability what is the vessel trying to do in, I guess the physics of it when it's heeling around? Could you kind of elaborate on that?

Dr. Falzarano: Actually that's a good question. And the reason why it's a good question is because we're actually talking about two types of stability which I described in my report. One is the upright roll stability that Lieutenant [redacted] analyzed in detail The second type of stability is the horizontal plane path stability, the maneuvering stability. And it turns out that they're coupled to each other for these types of vessels. And so the vessel's inability to travel in a straight path you basically a small rudder angle is going to do nothing, but eventually the vessel will turn very quickly. The path stability is actually strongly coupled to the roll. And I believe that's what happened here. It's a case of not only the coupling of the roll motion to the maneuvering motions, but also the fact with the – both were unstable. It was upright unstable beyond a certain angle and it was horizontal plane unstable. You could see that from the VDR results that you provided that the [in audible] was constantly using the rudder during the transit of the Jekyll Island because the vessel was in fact path unstable. So I don't know if that answers your question. I'm sorry I may have wondered a bit.

NTSB: It does to a certain extent. But this vessel obviously was considered in a tender condition.

Dr. Falzarano: For the roll stability, the upright roll stability, yes, sir. That was previously stated I believe by somebody. But like I said there are two types of stability. If the upright roll stability, the capsizing, but it's also the ability of the ship to maintain a straight course, the so called path stability or instability. Which observing the rudder

actions of the quartermaster you can see that the vessel was in fact path unstable which would have been [in audible] by the coupling of the roll motion.

NTSB: So even with the tide coming in, so you have water forces coming in at you, you don't know what forces were on the stern of the vessel as the water was exiting a river in that area where the currents. Would a vessel going into a current or going into an incoming tide have better directional stability than a vessel that is going with it?

Dr. Falzarano: No actually the faster the vessel goes the less path stable that it is. So I believe and again I did not do calculations on the currents versus the speed over the ground, but I believe the vessel would be even path stable because of the flood tide. The current opposing its motion. So the relative flow over the hull would be higher than would be without a current.

NTSB: So essentially once it got into the deeper wider channel the vessel went down by the bow, started to bow squat and then it was – it had increased speed?

Dr. Falzarano: Relative flow speed over the hull. Actually the deeper water actually again reduced the path stability. The shallower water the vessel was more path stable. I mean I actually corrected the calc – I did those various calculations. And so it was a combination of the upright stability I think was the most important thing, it capsized. But it was related to the path stability, the horizontal plane, the turning ability. And again it was something that you know was not a part of the sea trial. So I can only observe what the quartermaster did and make predictions. But I was not able to validate those predictions.

NTSB: Now I've done other investigations where like a vessel is off loading cargo or on loading cargo then all of a sudden it starts to move around back and forth at the dock

and its essentially it's lost stability and sometimes it rediscovers it's stability and will be at a heel. So because this was not due to movement of cargo and interior to the vessel and there was no ballast being moved, no fuel oil being transferred around. Would the vessel, if the port Pilot hatch had been closed to prevent down flooding, would the vessel have eventually stabilized at some point? Or was that – or can that be determined or speculated?

Dr. Falzarano: I mean I really can't say. But I think if you look at the character of the righting arm curve that was presented by Lieutenant [redacted] you can see that it has kind of a snake shape. And so eventually it would be – it would be stable but at a non-zero angle. And that non-zero angle was probably 40 or 50 degrees. So for all practicable purposes you know it was capsized. I mean beyond, yes, sir. Please that would be the slide. If you go back one more slide, go back. Yeah. You can see that the righting arm curve as it, you know it has initial stability, a positive slope, but then it has this decrease, you know almost at 0 or hit 0 and then goes back up. So it would then stabilize beyond, you know beyond – and I did not look at the down flooding of the Pilot door. No, sir I did not.

NTSB: But had things been watertight at least the water had not entered the vessel it would have potentially given the vessel the ability to find its new center of gravity?

Mr. Reisman: Captain Welborn I would like to interject. Dr. Falzarano if you will allow one moment please. I would just like to object on behalf of the Owners and Operators of the ship. Dr. Falzarano has testified he did not study the down flooding effect and I think Captain Flaherty's questions is posed directly to that issue. We now go outside the scope of his testimony.

CAPT WELBORN: I understood Mr. Reisman. Captain Flaherty could you rephrase?

NTSB: I apologize for any confusion. Not so much about the down flooding of the vessel.

CAPT WELBORN: Captain Flaherty if I may interrupt. I believe we've lost our livestream again. We'll just pause for just a moment to see if we can reestablish.

NTSB: Sure.

CAPT WELBORN: Thank you for your patience I appreciate it. Sorry for the interruption. So Captain Flaherty if you would restate your question to conform with the objection.

NTSB: Sure I'll try to do that. It's not so much about the down flooding part of it. Curious about it. The vessel itself when a vessel loses it stability it's in the process of trying to, as it's heeling around and moving, I just want to make sure it's clear to everyone, is it trying to reestablish its center of gravity finding a new position of stability?

Dr. Falzarano: Again the upright stability was only a kind of a side part of what I did. But what might happen is exactly, not the center of gravity, but the – assuming nothing shifted which is a pretty big assumption.

NTSB: Right.

Dr. Falzarano: The vessel might come to another equilibrium. But this equilibrium would be, you know probably further beyond the so called angle of vanishing stability which, you know depicted here. Kind of hard to say I would say. But you know the vessel eventually, you know laid on its side in the mud so it was no longer a floating body anymore.

NTSB: Okay, alright. That's just wanted to get to. Dr. I really appreciate your time, thank you.

Dr. Falzarano: Thank you for your questions. Thank you for your interest.

CAPT WELBORN: Captain Flaherty any follow-on questions?

NTSB: Not at this time.

CAPT WELBORN: Okay. So now we'll move on to our substantially interested States. Mr. Reisman do you have questions for this witness?

Mr. Reisman: Thank you Captain Welborn, yes I have a few questions. Good afternoon Dr. Falzarano.

Dr. FalzaIrano: Good afternoon.

Mr. Reisman: I have a few questions. Thank you. I want to jump back a bit and make sure that we're clear on some of your prior testimony. To start off I think you said better than I would have, but I just want to make sure I understand. You've acknowledge, you are not rules expert, is that correct?

Dr. Falzarano: Yes, sir. I'm not a rules expert. But I am familiar with some of the rules. And like I said I did participate in the ABS maneuvering guide. So I'm not an expert, but I'm a user of rules. Yes, sir.

Mr. Reisman: Understood and fair enough. You understand that the GOLDEN RAY was Flagged in the Marshall Islands, the Republic of the Marshall Islands, is that correct?

Dr. Falzarano: Yes, sir I understand that.

Mr. Reisman: And you would defer to the Marshall Islands to determine whether the ship was in compliance with all mandatory requirements in terms of maneuverability and stability, is that correct?

Dr. Falzarano: Yes, sir. Of course.

Mr. Reisman: And you further understand that the ship was classed during the construction phase by DMVGL and you would defer to the class society with those requirements as well?

Dr. Falzarano: Exactly.

Mr. Reisman: And the ship subsequently became classed with the Korean Register and once again you would defer to the class society in terms of the ship's compliance with all mandatory requirements?

Dr. Falzarano: Yes, sir.

Mr. Reisman: Thank you. So Dr. at the end of the day is it fair to say that you're not offering an opinion as to whether or not the ship violated any mandatory IMO or other requirements with respect to maneuverability or sea trialing or verification of maneuverability, am I correct?

Dr. Falzarano: No, sir. I was only suggesting was, you know whatever data I had to access to. I was able to utilize in my validation and if I, if the other data was not available or did not exist I was not able to use that in order to validate my simulations or to subsequently move forward with that. So that's exactly what I was saying. Is that I did not have access to data because it does not exist or it was not available. So that's fine.

Mr. Reisman: And or it was not required, correct?

Dr. Falzarano: Sure. So I subsequently determined that the Marshall Island did not require a maneuvering booklet, but they did require that the trials data be corrected for the full load draft at even keel. Some of the data was on the maneuvering poster, but it was not everything that I had hoped for in my validation. But I'm not at all suggesting that the vessel did not meet any requirements. That's not really my place to say that. All I'm saying is what I did have access to in order to validate my simulation. That's all I'm saying.

Mr. Reisman: Understood and I appreciate that Dr. I want to move now to the issue of path stability that you raised in your testimony earlier. First question in that regard, did you happen to hear the testimony of the Pilot John Tennant who testified in this proceeding last week?

Dr. Falzarano: I did read his initial – initial interview. I listened to parts of that but not the whole thing. And again that did not affect what I have in my analysis at all.

CAPT WELBORN: Dr. Falzarano if I may. Mr. Reisman, in the subpoenas for each witness they were specifically instructed not to listen to other witness' testimony during these proceedings. So Dr. Falzarano should not be privy to any information that was brought up previous to his testimony.

Mr. Reisman: Captain thank you for that clarification. So then I'll summarize and say it's fair to say then you did not hear the testimony of the Master of the ship Captain Gi Hak Lee, you did not hear the full testimony during this hearing of the Pilot, and you did not hear the testimony of Captain Cliff Gorden who was on board the Moran tug that assisted the GOLDEN RAY both in to Brunswick and then out from its berth, am I correct?

Dr. Falzarano: Sir, I mean like I said I had access to the, you know the initial interviews and all I was trying to do was to understand what happened, what was done beyond, that's all. No so I did not have complete access to any of those things.

Mr. Reisman: So you're not aware of what those witnesses had to say in this proceeding as to whether the ship maintained path stability, whether it handled properly, whether there any issues with maneuvering or handling prior to the casualty itself at Widener 11, am I correct?

Dr. Falzarano: Well, sir, the only thing I was referring to was the NTSB analysis which I had access to, an early draft of the NTSB analysis. And I observed the quartermaster – the rudder commands essentially. So that's what I was referring to, sir. I wasn't referring to anybody's – anybody's, other than that. I mean I try to look at things from a quantitative point of view, objective quantitative point of view and not of any sort of, you know opinions other than you know to see what the initial, the initial interviews, sir.

CAPT WELBORN: Just for clarification the piece from NTSB that Dr. Falzarano is referring to is the transcripts for the initial interviews.

Mr. Reisman: Thank you Captain. So Dr. Falzarano so you got an opinion with respect to path stability of the GOLDEN RAY, apparently based on your review of the VDR data which showed the rudder movement, is that right?

Dr. Falzarano: Yes, sir.

Mr. Reisman: What other ships ----

Dr. Falzarano: [In audible]. Excuse me?

Mr. Reisman: You go ahead. Finish your answer please, I'm sorry.

Dr. Falzarano: I said I could only observe the VDR time history because I did not have access to any sort of sea trial prediction of that. And as you know I tried to obtain that but it did not exist. So that's – observing that I wanted to pursue that but I was not able to pursue that avenue, sir.

Mr. Reisman: Okay, but you did review the VDR for rudder movements. What I'm curious about is did you study the rudder movements of any other ships whether they're pure car truck carriers or bulkers or any other type of ship coming in or out of the Brunswick channel?

Dr. Falzarano: No, sir. Not the Brunswick channel but I have – I participated in a previous investigation of another vessel which was a gas carrier and that was actually the focus of that investigation, was the path stability. That was not the focus of my analysis here.

Mr. Reisman: And I'm just trying to determine how much weight contributed if any, to your opinion today with respect to path stability that your information seems to be contradicted by the live testimony of all the witnesses who testified about the handling and maneuvering of the ship in and out of Brunswick. And you have not done any kind of comparison with other ships that transited through that same area in and out Brunswick. So you're not able to tell us whether this ship handled differently or required more steering, or I think you called it active steering or rudder movements than any other ship of any other nature that's transited that passage. Am I correct?

Dr. Falzarano: I did do calculations of the hydrodynamic forces and based upon my calculations of the hydrodynamic forces I was able to look at the path stability. And that

contributed to my modeling. But I really couldn't say how this vessel compared to other vessels. I really couldn't say.

Mr. Reisman: Thank you Dr. And then in terms of the upright stability issue. I think you put it in your PowerPoint but I want to make sure that I understand this. If the ship had met the IMO and trimming stability guide requirements for stability. Is it your opinion that this capsize event would not have happened?

Dr. Falzarano: What my calculations suggested, and again my initial calculation of the capsizing was validated with the VDR data and then the what if scenario that I suggested is that the roll angle would have been significant – the steady roll angle and the dynamic overshoot roll angle would have been significantly reduced.

Mr. Reisman: So how does that translate into then the likelihood of this capsizing occurring had those what if scenarios, meaning IMO and trim and stability requirements had been satisfied?

Dr. Falzarano: It would obviously be much less likely.

Mr. Reisman: And that's regardless of any issue that may or may not exist with respect to path stability, correct?

Dr. Falzarano: The two, the four degrees of freedom are coupled. Okay. And so my model was a four degree of freedom model. It wasn't just a roll model, it wasn't just a maneuvering model. It was a four degree of freedom model. So I took into account the coupling of the various modes of motion. And all of those things contribute.

Mr. Reisman: Okay. And again I don't want to belabor the point. I hopefully conclude on this, but I just want to make sure. Again that absent this finding that the ship had not

met the stability requirements of the IMO or the trim and stability guide, is it your opinion that this incident would have occurred?

Dr. Falzarano: Like my – as per my conclusion the reduced stability that the vessel more than likely had significantly contributed to the larger roll angle induced by the turn. And so that, you know more than likely contributed, yes.

Mr. Reisman: And to the corollary of that then – the corollary of that then would be that had the ship met the stability criteria it could have been operated safely?

Dr. Falzarano: Yes, sir. I believe that would be a reasonable conclusion to that.

Mr. Reisman: Thank you Dr. that's all the questions I have for you.

Dr. Falzarano: Thank you. I appreciate your attention.

CAPT WELBORN: Thank you Mr. Reisman. Mr. Gilsenan do you have questions for this witness?

Mr. Gilsenan: Captain I don't have questions for this witness. Thank Dr. Falzarano and I would like to mention for housekeeping once Dr. Falzarano's testimony is concluded I would like to revisit an issue we had with the exhibit you mentioned at the outset of the Falzarano proceeding regarding the MSC report from Lieutenant [redacted] We could take that up when this part concludes.

CAPT WELBORN: Yes, sir. We will circle around to that as soon as we conclude with this witness. Dr. Falzarano thank you again for your statement and your testimony today. I just have small point of clarification. As a hydrodynamic hydraulic specialist you talked about path stability, path stableness or path stable in shallow water. So can you compare and contrast the shallow water to the deeper water with specific to – with

specific references to that path stability? Can you tell me how those forces interact on a hull in shallow water compared to deeper water?

Dr. Falzarano: Again this is from my memory of my analysis of this vessel. But typically the vessel becomes more path stable in shallow water, but less path stable in the restricted channel. And then the squat, the bow squat would have reduced the path stability so there's many factors that effect this path stability. And the IMO sea trials basically, you know suggest, it's not, you know that a pull out test or a spiral test be done if you're suspected of being path unstable in deep water. So many factors, I'm not sure if I'm answering your question. But many factors affect the path stability. Not only the water depth but also the channel would also affect that. And the fact that it was initially in a channel it was probably less path stable in the channel. Okay. And then when it came into the Widener, the open area it would actually regain some of that path stability. And the speed and the relative, the vessel slowly accelerated just a bit. But then the fact that there was this flood tide that would effect it. So many things effected it. And again, I mean just to clarify what I talked to Mr. Reisman about, that was, you know a secondary factor. I mean it was obviously the dynamics and the maneuvering dynamics are coupled to the roll dynamics, but only in a coupled sense. So.

CAPT WELBORN: Understood.

Dr. Falzarano: I don't know if I answered your question.

CAPT WELBORN: Dr. Falzarano, I'm sorry, sir. I'm sorry to interrupt. We've lost our live feed again. So I'm talking a short recess until we can regain that.

Dr. Falzarano: Yes, sir.

CAPT WELBORN: Okay I believe we have reestablished our livestream feed. Again Dr. Falzarano thank you for your patience. I withdraw my last question regarding path stability, path stable in shallow water.

Dr. Falzarano: Just to clarify, sir.

CAPT WELBORN: Yes, sir.

Dr. Falzarano: Actually the IMO allows a certain amount of path instability. Most large tankers and bulk carriers are actually path unstable at the design speed in deep water. As they go slower they gain that stability, but also the shallow water, the restriction of the channel all effects that. So it's not a simple answer. The trim also effects it. So withdraw the question is fine, but it's – I have lots of information there, sorry.

CAPT WELBORN: Understood. Yes Dr. Falzarano, thank you very much. Any follow-on questions from our SIS's for Dr. Falzarano. I see none from Mr. Bremer. Captain Flaherty any follow-on questions.

NTSB: No further questions, thank you.

CAPT WELBORN: Thank you Captain Flaherty. Any follow-on questions from our PII's? Mr. Reisman?

Mr. Reisman: No follow-ups Captain.

CAPT WELBORN: Mr. Gilsenan?

Mr. Gilsenan: No follow-ups for this witness.

CAPT WELBORN: Thank you very much. Dr. Falzarano again thank you very for your testimony today. You're subject to recall until we conclude these formal hearings. And again thank you.

Dr. Falzarano: Thank you for the opportunity. Have a nice day.

CAPT WELBORN: Mr. Gilsenan I believe you had an objection to a previously discussed piece of evidence. Now is the time if you want to bring that forward.

Mr. Gilsenan: Yes Captain thank you. And I'm not able to start the video so I'll have just to do without video. Regarding the Marine Safety Center report from Lieutenant [redacted] we submitted a question, it's quite complex on Tuesday September 15th where consideration in the report and it regarded specifically conclusion 3B about the application of counter rudder, it's at page 38 of the MSC report. Lieutenant [redacted]s presentation this morning was very thorough and it did not all address conclusion 3B. So we were believing that conclusion 3B would be removed from the report and that's I didn't ask him about conclusion 3B. And otherwise we certainly would have. We would have presented the question again. But now that at the outset of Dr. Falzarano proceeding the report was introduced into evidence in addition to the PowerPoint presentation that did not address conclusion 3B. And alas conclusion 3B is still in there. And I can read out question into the record. Again it's two pages long. I have forwarded it again to Lieutenant Commander Moore about an hour ago when it was introduced into evidence. And as a result of that conclusion we do have an objection to be spent because this question remains outstanding and unanswered. And we would like Lieutenant [redacted] to address it.

CAPT WELBORN: That question was specifically about the report, but not about the PowerPoint, is that correct, sir.

Mr. Gilsenan: Yes, sir.

CAPT WELBORN: So we will move Exhibit 16B, Lieutenant [redacted]s report into a provisional status until we have such time to review that question after the conclusion of

today's hearing. So if no further objections that piece of evidence again will be provisional until I've had such time to review it.

Mr. Gilsenan: Thank you Captain.

CAPT WELBORN: Thank you, sir. Regarding Dr. Falzarano's testimony we have two pieces of evidence, the PowerPoint that Dr. Falzarano used for demonstrative purposes today will be marked as Coast Guard Exhibit 17A. Dr. Falzarano's full report will be marked 17B. Without any objections we will move those into evidence. Objections from NTSB, Captain Flaherty?

NTSB: No objections.

CAPT WELBORN: Flag State, Mr. Bremer?

Mr. Bremer: No objection Captain.

CAPT WELBORN: PII, Mr. Reisman?

Mr. Reisman: Captain this is David Reisman I do object to the conclusion of the whole report. To my knowledge that has not been made available to the PII's. So as we sit here today I have never seen it. I've only seen the PowerPoint that's been provided that was used in connection with his testimony. I can also say that I further object to the PowerPoint itself that it contains a number of statements and conclusions that he simply backed off of today. I think it would be inappropriate to have those in [in audible] subsequent content.

CAPT WELBORN: Your objection is noted. Mr. Gilsenan do you have objections?

Mr. Gilsenan: No Captain.

CAPT WELBORN: Just in reference to making the exhibits available. I do believe they are available in Homeport. However, we will turn them in again, make those available

to our PII's and SIS's for additional review. And so we'll admit those pieces of evidence provisionally until such time as we have an opportunity to address any further objections for review and possible correction or amendment by the witness. So 17A and 17B are provisionally admitted until such time as we are able to clear up those issues. Anything further? Okay hearing nothing we'll – I did not and I have to apologize we dismissed the witness, but I do not see any questions from KMST for Dr. Falzarano. We're in good shape on that one. The local time now is 1:49. We'll take a 5 minute recess in preparation for a reading and statement from one crewmember next. Again the local time 1:49 we stand in recess for 5 minutes.

The hearing recessed at 1:49, 22 September 2020

The hearing was called to order at 1:59, 22 September 2020

CAPT WELBORN: The local time is 1:59 and we're back on the record for the formal hearing of the capsizing of the Motor Vessel GOLDEN RAY. As stated during last Wednesday's session of the hearing the Chief Officer of the GOLDEN RAY at the time of the incident, Chief Officer Park did not testify at the recommendation of his Korean and U.S. Counsel. We retained an open time slot for Mr. Park to testify until the end of the day, the final session of the hearing. Mr. Park's counsel, Mr. John Ouset Jr. (sic) confirmed that Mr. Park would not be testifying at all. Mr. Ouset (sic) submitted written confirmation of Mr. Park's decision not to testify. Unfortunately Mr. Park is a South Korean national located in South Korea and such I do not have the authority to subpoena his testimony for this formal hearing. We have intended to fill gaps resulting from the lack of Chief Officer Park's testimony through other witness testimony and evidence. We will admit Mr. Ouset (sic) letter as Coast Guard Exhibit 18A unless there

are any objections by substantially interested States or parties in interest. Are there any objections at this time? Hearing none Coast Guard Exhibit 18A, Mr. Ouset (sic) will so be admitted into evidence. In lieu of live testimony our investigation team has identified relevant excerpts of Mr. Parks previously sworn testimony taken on September 11th, 2019 in Brunswick, Georgia. An additional testimony provided to Korean Maritime Safety Tribunal on October 30th, 2019. Both sections have been vetted through the PII's and SIS's and we obtained no objections. At this time ENS Andrew Brown and MST2 Monika Spies will begin reading the excerpts. Lieutenant Commander Moore has previously sworn both of them in. ENS Brown, MST2 Spies please commence.

[The following transcript was read in by ENS Brown and MST2 Spies]

MR. FLAHERTY: Sir, if you could, please state your name?

MR. PARK: Park Hyunjin. Do you need the spelling?

MR. FLAHERTY: Yes. Spelling of your last name, please.

MR. PARK: It's P-A-R-K, H-Y-U-N-J-I-N.

MR. WILLETT: Okay, sir, before we get started talking about the incident, we'd like to know some of your background. How long have you been sailing?

MR. PARK: Sir, around 13 years.

MR. WILLETT: Thirteen years?

MR. PARK: Yes, sir.

MR. WILLETT: And how long have you been a chief officer?

MR. PARK: Ten years.

MR. WILLETT: Okay. And of that 10 years, how long have you been a chief officer on a car carrier?

MR. PARK: Six years.

MR. WILLETT: And what time did you embark on the ship?

MR. PARK: 2019.

MR. WILLETT: Okay.

MR. PARK: In March.

MR. WILLETT: March 2019?

MR. PARK: March 5.

MS. BELL: Okay. And do you -- how were you trained to use that software?

MR. PARK: Training?

MS. BELL: Um-hum.

MR. PARK: This, just to be the chief officer, handover time, he explain how to using like this. But this, all is, almost is fixed just to put in the data, like easy to understand it, how to using this. Normally can password to the computer using, maybe the -- easy to understand.

MS. BELL: It's easy to understand?

MR. PARK: Yes.

MS. BELL: Okay. So did you learn on the job? He shows you when you're --

MR. PARK: Over, handover time.

MS. BELL: Handover.

MR. PARK: Yeah.

MS. BELL: Okay. So about how long did it take you to learn to use the program?

MR. PARK: Programs, we are hand over at the sailing time. I already using this Loadcom because I'm calculating GM. I am reporting to the captain.

MS. BELL: So when you learned how to use it the first time, how long did it take you to learn?

MR. PARK: Only 3 hour, 4 hour.

LCDR MARTIN: So, the last thing I want you to do for me is from when the vessel left the dock in Brunswick, Georgia, up until you were rescued by the Coast Guard in your words, give us that story, please?

MR. PARK: I'm chief officer, the online they go, and the ship is sailing. And the pilot and captain and duty officer and quartermaster onboard. And the captain says, dismissed. Only two members remain. And I am going to up the bridge. And this time, the pilot and the captain ordered the bridge member, his duty, and I speak to the leader, only 10 minute, 5 minute, talking about something problem, no problem. And discussing with the captain. And the captain says, dismiss. I go down in the cabin. And the, I don't know how long time, but 10 minute, 20 minutes between the ship is going through starboard and port. So, I'm just, after direct handling going to the, am I feeling more than 40-degree, 50 degree, like this. I'm just tried to escape. That's all.

LCDR MARTIN: So where were you at when the ship started to list over?

MR. PARK: I'm just lay on my bed.

LCDR MARTIN: Where's your -- you were in your stateroom?

MR. PARK: Yes. I'm in my cabin.

LCDR MARTIN: Where's your cabin on the ship?

MR. PARK: The starboard side.

LCDR MARTIN: Okay. Midship? Starboard side midship, forward, aft?

MR. PARK: Midship the starboard side.

LCDR MARTIN: Okay. How did you --

MR. PARK: Forward. Forward.

LCDR MARTIN: Say that again?

MR. PARK: Forward.

LCDR MARTIN: Okay. Forward again.

MR. PARK: Forward.

LCDR MARTIN: How did you get out of the ship?

MR. PARK: This on the, the ship is going to the starboard side, so or something I attempt, or going down through the door side, over the barriers, then one by one I'm finding, I find the telephone and the watching. And the one by one take out and try to open the door, very small. And I try to escape. So, everything was fell, and I was blocking the passage. So, you just clapped to the small, portion of the door. And he escaped through the door.

UNIDENTIFIED SPEAKER: That didn't sit.

UNIDENTIFIED SPEAKER: Did you get your life jacket out of your stateroom or --

MR. PARK: No taking this. No sense.

UNIDENTIFIED SPEAKER: It was too, too fast or --

MR. PARK: I am feeling something accident coming. So, I, the first thinking is this area escape, first time, no thinking lifejacket, no one, no thinking. Just I escape.

UNIDENTIFIED SPEAKER: Was it completely dark?

MR. PARK: Yes.

UNIDENTIFIED SPEAKER: Okay. Did you have a flashlight?

MR. PARK: I take flashlight.

MR. WILLETT: March 5, 2019. Okay. So what is a normal day for you on the vessel? What are some of your jobs and duties that you do?

MR. PARK: On most the ships, on most the ships, the operation is I involve the -- something, the supervising, like there is something, car operation and operation with control, something provision, and almost to the captain order, I follow the captain order.

MR. WILLETT: So does the captain give you standing orders?

MR. PARK: Yes.

MR. WILLETT: Does that change any or is it daily; is it weekly? Does he tell you every day what to do?

MR. PARK: No.

MR. WILLETT: No?

MR. PARK: This is the just fixed.

MR. WILLETT: Okay. So during, like, cargo operations, what would you normally be doing?

MR. PARK: Normally we checking the storage plan, how many loading, discharging, how many weights, and the lashing condition, and which portion loading and which portion discharging, checking the storage plan, and the other general something damaging or something problem We making the damage reports, like this. The cargo operation is just that.

MR. WILLETT: Where are you normally located physically during cargo operations?

MR. PARK: Normally the -- what?

MR. WILLETT: Where would you actually be standing or where would you be present during cargo operations, loading and unloading of vehicles? Would you be in the ballast control room? Would you be in your office?

MR. PARK: This not fixed. Sometimes I am going to the cargo hold, actual check. Sometimes I'm going to the ship's office. And sometimes I'm needed heeling adjust.

MR. WILLETT: Okay.

MR. PARK: Yeah.

MR. WILLETT: Where is the heeling adjustment?

MR. PARK: The ship's office.

MR. WILLETT: Okay. So the ship's office has the ballast control?

MR. PARK: Yes, ship's office.

MR. WILLETT: Okay.

MR. PARK: But we, the ballast control is the bridge compartment, ship's office compartment, engine room compartment.

MR. WILLETT: So the engine room, ship's office and the bridge?

MR. PARK: Yes.

MR. WILLETT: So you can control ballast --

MR. PARK: Normally, I control the ship's office.

MR. WILLETT: Okay. So normally that's where you would be if you wanted to control ballast?

MR. PARK: Yes.

MR. WILLETT: Okay. So how many hours do you normally work a day?

MR. PARK: This one depends on cargo operation.

MR. WILLETT: Okay. So in the last, you know, maybe month, have you ever had to work more than the STCW hours? Have you ever busted your hours?

MR. PARK: You may say that again?

MR. WILLETT: Work more than 77 hours a week?

MR. PARK: No. No more than 77 hours.

MR. WILLETT: So you've never had to go over?

MR. PARK: No over.

MR. WILLETT: Never? Okay.

MR. PARK: Okay.

MR. McRAE: Okay. Tell me about that. Were there any instructions given to you for this ship from a charterer as to how to load?

MR. PARK: They sending to the ship the pre-storage plan. They planning this loading, which deck, like this with the ship. I understand which side loading they chartering. He sending to the email, the storage plan.

MR. McRAE: And who was that, that sent you that?

MR. PARK: This Hyundai Glovis.

MR. WILLETT: Okay. So during, like, cargo operations, what would you normally be doing?

MR. PARK: Normally we checking the storage plan, how many loading, discharging, how many weights, and the lashing condition, and which portion loading and which portion discharging, checking the storage plan, and the other general something damaging or something problem. We making the damage reports, like this. The cargo operation is just that.

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MR. WILLETT: Where would you actually be standing or where would you be present during cargo operations, loading and unloading of vehicles? Would you be in the ballast control room? Would you be in your office?

MR. PARK: This not fixed. Sometimes I am going to the cargo hold, actual check. Sometimes I'm going to the ship's office. And sometimes I'm needed heeling adjust.

MR. WILLETT: Okay. So do you check -- you have your assistants check every vehicle to make sure they're lashed?

MR. PARK: You mean that I am checking the lashing condition?

MR. WILLETT: Or you have one of your assistants?

MR. PARK: My officer, sir. Yes, check and he reporting to me.

MR. WILLETT: Do you ever let your assistants adjust ballast or --

MR. PARK: Can pass work.

MR. WILLETT: Who would you allow?

MR. PARK: All officers can pass.

MR. WILLETT: Now on this vessel, do you allow the other officers to adjust the ballast?

MR. PARK: Can possible.

MR. WILLETT: Possible?

MR. PARK: Yes.

MR. WILLETT: Okay. How do you determine how much you take on and how much you discharge?

MR. PARK: About 1,000 to 500.

MR. WILLETT: I know but how do you know that's how much you did?

MR. PARK: This -- the system is, the monitoring system have --

MR. WILLETT: And that works perfectly?

MR. PARK: Yes. Correct. And we, two methods of using.

MR. WILLETT: Okay.

MR. PARK: One is the monitoring, and the one is the actual sounding.

MR. WILLETT: The soundings?

MR. PARK: Okay.

MR. WILLETT: And so, you sound -- every time you conduct ballast operations, you watch on the monitor?

MR. PARK: Yes.

MR. WILLETT: And then who do you have go out and sound?

MR. PARK: The quartermaster.

MR. WILLETT: The quartermaster?

MR. PARK: Yes.

MR. WILLETT: And they write everything down?

MR. PARK: Yes.

MR. WILLETT: And they give it --

MR. PARK: No. No writing. Just reporting.

MR. WILLETT: Oh, so he talks?

MR. PARK: Yeah. He can password through the transceiver.

MR. WILLETT: Okay. And then, but do you type it in or you just look

MR. PARK: I compare the actual sounding and the monitor sounding, compare.

MR. WILLETT: Okay.

MR. PARK: Then I the recording.

MR. WILLETT: So do you record it?

MR. PARK: Yes.

MR. WILLETT: Okay. Has the sounding in the last month or two ever differed from what you saw on your monitor? Have you got different readings before?

MR. PARK: Different reading, I check, but I no experience different reading.

MR. WILLETT: You never have?

MR. PARK: Yes.

MR. WILLETT: For Hurricane Dorian --

MR. PARK: Yes.

MR. WILLETT: -- did that change the way you were having to load anything?

MR. PARK: You mean, sir, the --

MR. WILLETT: Because you guys had to --

MR. PARK: -- the hurricane?

MR. WILLETT: Yes.

MR. PARK: Dorian Hurricane, we avoiding the hurricane, the east to Mexico sea.

MR. WILLETT: Okay.

MR. PARK: So we, drifting and this instruction come from the (indiscernible) office. They say, maybe just now a little dangerous, that navigation, so everything is more better, like (indiscernible).

MR. WILLETT: Okay.

MR. PARK: Okay. We do everything and we adjusting the schedule.

MR. WILLETT: Do you have different ballast conditions for severe weather?

MR. PARK: Yes.

MR. WILLETT: So did you alter the ballast or the heel for Hurricane Dorian?

MR. PARK: We lower the ballast to the 1,000 to 500, I think. The figure is, I'm not --

MR. WILLETT: That's fine. That's fine. And you did that because of the Hurricane?

MR. PARK: Yes.

MR. WILLETT: Okay. So how long would you normally stay in that condition?

MR. PARK: The deck condition?

MR. WILLETT: Yeah, the storm condition?

MR. PARK: Storm condition, we know in place the hurricanes.

MR. WILLETT: Okay. So as the hurricane passed, did you discharge ballast?

MR. PARK: Yes.

MR. WILLETT: And do you remember approximately --

MR. PARK: The same, same --

MR. WILLETT: You took --

MR. PARK: -- loading ballast here and discharging.

MR. WILLETT: So when you got to the ST buoy in Brunswick, you didn't take any ballast between Jacksonville and Brunswick?

MR. PARK: Yes.

MR. WILLETT: No ballast?

MR. PARK: No touching the ballast tank.

MR. WILLETT: Okay. So you went to the Port of Brunswick, discharged cargo?

MR. PARK: Yes.

MR. WILLETT: Took on cargo.

MR. PARK: Yes.

MR. WILLETT: Did you conduct any ballasting at all?

MR. PARK: No discharging, no loading.

MR. WILLETT: Did you have to take on any ballast or adjust the ballast in Jacksonville?

MR. PARK: No. No, taking ballast.

MR. WILLETT: Did you discharge ballast?

MR. PARK: No discharging ballast.

MR. WILLETT: So when you got to the ST buoy in Brunswick, you didn't take any ballast between Jacksonville and Brunswick?

MR. PARK: Yes.

MR. WILLETT: No ballast?

MR. PARK: No touching the ballast tank.

MR. WILLETT: Okay. So you went to the Port of Brunswick, discharged cargo?

MR. PARK: Yes.

MR. WILLETT: Took on cargo.

MR. PARK: Yes.

MR. WILLETT: Did you conduct any ballasting at all?

MR. PARK: No discharging, no loading.

MR. WILLETT: Did you do any heel adjust?

MR. PARK: Heeling tank increase, normally three tanks we're using.

MR. WILLETT: So, did you adjust the heel in Brunswick?

MR. PARK: Yeah. Only adjusting heeling.

MR. WILLETT: Do you ever let your assistants adjust ballast or --

MR. PARK: Can pass work.

MR. WILLETT: Who would you allow?

MR. PARK: All officers can pass.

MR. WILLETT: Now on this vessel, do you allow the other officers to adjust the ballast?

MR. PARK: Can possible.

MR. WILLETT: Possible?

MR. PARK: Yes.

MR. WILLETT: Did you have to transfer any ballast-only tanks?

MR. PARK: Heeling tanks.

MR. WILLETT: Heeling tanks?

MR. PARK: Yes.

MR. WILLETT: Do you remember how much you transferred?

MR. PARK: Don't remember.

MR. WILLETT: Don't remember. Okay. So, during the loading and unloading in Jacksonville, did you experience any unusual list, greater than 10 degrees?

MR. PARK: Unusual?

MR. WILLETT: Like did it list at all when you were loading and --

MR. PARK: Just upright.

MR. WILLETT: What was that?

MR. PARK: Upright. This meaning is --

MR. WILLETT: Upright?

MR. PARK: Upright.

MR. WILLETT: So why did you adjust your heel in Jacksonville?

MR. PARK: Why I adjusting heel?

MR. WILLETT: Yes.

MR. PARK: This depend on cargo operation. We put -- cargo is loading port side, we heeling going to the port side.

MR. WILLETT: Yeah.

MR. PARK: Car discharging port side, we going to the starboard. Just depend on cargo operations.

MR. WILLETT: And that happened in Jacksonville?

MR. PARK: What?

MR. WILLETT: In Jacksonville --

MR. PARK: Yes.

MR. WILLETT: -- did you adjust your heel?

MR. PARK: Yes.

MR. WILLETT: Okay.

MR. PARK: Every port.

MR. WILLETT: Every port?

MR. PARK: Yes.

MR. WILLETT: So you sit in the control room or do you sit in the ship's office?

MR. PARK: Yes.

MR. WILLETT: While the cars are being loaded and unloaded, and if it starts to heel --

MR. PARK: Yes.

MR. WILLETT: -- you would -- you transfer --

MR. PARK: The ballast.

MR. WILLETT: Okay. Into the heel tanks?

MR. PARK: Yes.

MR. WILLETT: To make sure it's upright?

MR. PARK: Yes.

MR. WILLETT: So what do you --

MR. PARK: This (indiscernible) I cannot speak to any kind upright because I am thinking about the cargo loading portion or discharging portion, and the heeling going to the -- if we heeling going to the starboard side, I thinking, that we list not upright. Neither port side is better.

MR. WILLETT: Okay.

MR. PARK: Because discharging after we're going to the starboard side, maybe like this, I saw continuous I'm not adjust heeling. Just sometimes too much going like this, maybe dangerous, I thinking, I'm going to the heeling adjust, like this.

MR. WILLETT: What is your limit, like 5 degrees, 10 degrees?

MR. PARK: This limit, this -- I'm limit is 2 degrees.

MR. WILLETT: Two degrees?

MR. PARK: Yes.

MR. WILLETT: Okay. Two degrees. All right. Are you the only one that willadjust the heel on the ballast?

MR. PARK: Two heeling tanks.

MR. WILLETT: But in Brunswick, did it significantly list during loading?

MR. PARK: Yes.

MR. WILLETT: Like what, to what degree do you think during loading and unloading?

MR. PARK: Not too much. About 1 degree.

MR. WILLETT: One degree?

MR. PARK: Yes.

MR. WILLETT: Okay. And before you depart, do you verify the GM of the vessel to make sure its stable?

MR. PARK: Yes.

MR. WILLETT: And in your -- what do you use for that? Do you have like a manual that says your GM has to be between these two numbers prior to departure?

MR. PARK: Sorry?

MR. WILLETT: What was your GM at departure?

MR. PARK: 2.45.

MR. WILLETT: Okay. Is that a good GM?

MR. PARK: Yes. This is the -- our -- the Loadcom.

MR. WILLETT: Yeah.

MR. PARK: This printing, the printout, this -- if the something no good, this article is not okay, like this.

MR. WILLETT: Okay.

MR. PARK: But I'm looking the paper and at this condition all okay or not. Checking after I develop (indiscernible).

MR. WILLETT: So a computer tells you --

MR. PARK: Yes.

MR. WILLETT: -- if your GM is okay?

MR. PARK: Yeah, computer tell me the GM is okay.

MR. WILLETT: What parameters does it use to know that it's – the stability is okay? Does it have the draft, the heel?

MR. PARK: Yeah, this -- the programing already this, Loadcom programing, this already are approval to the class approver.

MR. WILLETT: Right.

MR. PARK: And I am just put inside the cargo unit and the weight.

MR. WILLETT: Okay.

MR. PARK: And deck.

MR. WILLETT: Yeah.

MR. PARK: And the ballast and fuel and the fresh water. And all put in the data and then I printout.

MR. WILLETT: How do you know what the, where the fuel -- what levels the tanks are?

MR. PARK: Just looking for the monitor.

MR. WILLETT: So you don't get a report from the engineers?

MR. PARK: No. No, (indiscernible).

MR. WILLETT: Okay. So you use the monitor --

MR. PARK: Yes.

MR. WILLETT: -- to tell you? Okay. And is that the potable water tank as well?

MR. PARK: Yes.

MR. WILLETT: And the sewage tank?

MR. PARK: What?

MR. WILLETT: The sewage tank?

MR. PARK: The sewage tank is --

MR. WILLETT: Is it too small or --

MR. PARK: -- cannot monitor.

MR. WILLETT: Okay, okay. So, you can monitor the larger tanks on the vessel? You know what height the weight is on each deck?

MR. PARK: Yes.

MR. WILLETT: You would input that, and the computer says your GM is okay?

MR. PARK: This all programing is either the capacity.

MR. WILLETT: Yes.

MR. PARK: And put inside how much, how much here or the programing.

MR. BREMER: The load computer, your stability computer that was on the Golden Ray, have you worked with that software on previous vessels?

MR. PARK: Different software.

MR. BREMER: Different software?

MR. PARK: Yes.

MR. BREMER: Was the function similar, different?

MR. PARK: Almost similar.

MR. BREMER: Very similar?

MR. PARK: Yeah.

MR. BREMER: Okay. As far as your draft readings --

MR. PARK: Yes.

MR. BREMER: --how were those calculated? How were those taken? How were the draft readings taken?

MR. PARK: This -- the (indiscernible) the draft and I compare the actual draft.

MR. BREMER: Okay. So you have --

MR. PARK: So I'm comparing the actual draft.

MR. BREMER: Okay. So you have gauges, draft gauging, and then you also verify --

MR. PARK: Yeah. There's three kind. The first is gauging, and then I am actual reading the draft, and then this -- the system that calculate draft.

MR. BREMER: Okay.

MR. PARK: Three kind.

MR. BREMER: Okay. So from the loading computer based on the salinity, everything else that's input?

MR. PARK: Yes.

MR. BREMER: Okay. And do you remember to the best of your recollection, did what the computer calculated for your -- what the draft should be based on the loading conditions, was that fairly close to the actual draft?

MR. PARK: Almost close.

MR. BREMER: They were close?

MR. PARK: Not too much difference.

MR. BREMER: When you say not much, do you remember how much? Was it, you know, .1 meter? And if you don't remember, it's not --

MR. PARK: This one, I'm recording this: the gauge draft, actual draft, how many different, and also the system draft, actual draft, how many different, and GM. On every port, arrival, departure, I'm recording.

MR. BREMER: Okay. And it's -- so the calculations from the computer versus your actual draft were fairly close? They were close together?

MR. PARK: Almost to the close.

MR. BREMER: Almost the same?

MR. PARK: Um-hum.

MR. BREMER: Okay. And the vessel at departure was sitting even, so your port and your starboard drafts were the same? She was level, zero degrees?

MR. PARK: The upright and leaving?

MR. BREMER: Yes.

MR. PARK: Yes.

[End of transcript read into the record].

CAPT WELBORN: Thank you MST2 Spies and ENS Brown. At this time we'll transition to the report obtained October 30th in Korea by KMST.

[The following transcript was read by ENS Brown and MST2 Spies].

KMST: Please state your name and position.

MR. PARK: I am Chief Officer Park Hyun-jin of the Golden Ray.

KMST: After entering the Port of Brunswick, when did you receive the stowage plan?

MR. PARK: I received the pre-stowage plan before we reached port. I did not receive the final stowage plan before leaving port.

KMST: Please fully explain the process through which cars were loaded onto the ship this time at the Port of Brunswick, including receiving the stowage plan and entering changes in ballast water quantity and/or cargo shipment into the LOADCOM.

MR. PARK: At the Port of Brunswick, apart from transferring water between port and starboard heeling tanks, there was no increase or decrease in the quantity of ballast water. The bunker and water quantity can be checked on the IMACs computer, based on which the relevant numbers are entered into the LOAD COM. The data for the stowage plan was entered into the LOAD COM based on the pre-stowage plan. Usually stowage data is entered after loading is completed. At the Port of Brunswick, because we didn't receive the final stowage plan before leaving port, we estimated the data values based on the pre-stowage plan.

KMST: Were there any differences between the pre-stowage and final stowage plans?

MR. PARK: Usually, there is little difference, if any. This was also true at the Port of Brunswick.

KMST: How did you calculate the average weight?

MR. PARK: At the Port of Brunswick, I did not receive a final stowage plan. Instead, I was given the pre-stowage plan. Because I had access to only the number of cars and did not know the car type, I calculated the total weight based on the average weight of the given number of cars. In general, based on my experience, a small car weighs 1.3 tons, and a mid-sized car weighs about two tons. After the cars are loaded onto the ship, the actual weight is usually very similar to my initial calculation. Regarding the difference between the entered values for the LOAD COM data used for the safety inspection (for things such as the ship's stability) before entering port based on the pre-

stowage plan and the entered values for the LOAD COM data based on the pre-stowage plan before leaving port, the weight of the cargo was the same. However, there may be some differences in the values for ballast water, bunker, water, etc. The numbers of loaded and unloaded cars specified in the pre-stowage plan that we received upon entering port and the numbers upon leaving port were almost identical. Therefore, I don't think that there was any substantive difference between the total weight of the cars (based on average weight per car) and the actual total weight. Also, the draft was almost exactly the same upon both leaving and entering port.

[End of transcript read into the record].

CAPT WELBORN: Thank you very much ENS Brown and MST2 Spies I do appreciate your reading of these two documents. So during this, we have a little bit of housekeeping information or things to take care of. Mr. Gilsenan regarding your objection to 16B Lieutenant [redacted]'s final report I'm going to go ahead and admit 16B into evidence. And we will address your concerns and your specific question in the final report. Thank you, sir. Mr. Reisman concerning your objection to 17A and 17B, Dr. Falzarano's PowerPoint and final report I'm going to administratively admit these into the record and address, excuse me, your objection is on the record and we will address your objections and any excerpts that we need, possibly, that we may possibly use of Dr. Falzarano's report in the final report of the investigation hearing. We will address those issues in the final report alongside your objections.

Mr. Reisman: Thank you Captain.

CAPT WELBORN: So during this final session of the hearing, we heard from LT Ian [redacted], naval architect with the U.S. Coast Guard's Marine Safety Center. Lieutenant

[redacted] presented slides as to his conclusions regarding the stability of the GOLDEN RAY, including her stability on the capsize voyage and her preceding voyages. Lieutenant [redacted] discussed the righting arm curve theory and the 2008 IMO Intact Stability Code (also known as the IS Code), including an explanation of technical terms such as metacentric height. In addition, Lieutenant [redacted] spoke about his computer model development at the Marine Safety Center and discussed the GOLDEN RAY's stability during the turn right before she capsized. Lieutenant [redacted] analyzed the additional ballast on the GOLDEN RAY during her preceding voyages compared with the capsize voyage and the GOLDEN RAY's varying drafts. Additionally, Lieutenant [redacted] testified regarding downflooding with respect to the GOLDEN RAY's pilot door. We entered this presentation as Coast Guard Exhibit A and provisionally entered Lieutenant [redacted]'s Final Report as Coast Guard Exhibit B along with objections. We also heard testimony from Dr. Jeffrey Falzarano. Dr. Falzarano presented slides as to his hydrodynamic assessment of the incident. He discussed the maneuverability of the GOLDEN RAY and referred to IMO Resolution MSC 137 and IMO Resolution 601. Dr. Falzarano also spoke about his steady turning model validation compared to other cases and maneuverability trials on the GOLDEN RAY's sister ship, the SILVER RAY. Dr. Falzarano testified regarding the generic behavior of a ship rolling in a turn and discussed the simulation of the incident, including the predicted effect of GM on a rolling motion in a vessel's turn. We entered this presentation as Coast Guard Exhibit A, Dr. Falzarano's Report and PowerPoint, excuse me, yes 17B and C, excuse me, 17A and 17B along with objections. In addition, ENS Brown and MST2 Spies made relevant excerpts, read relevant excerpts from the Chief Officer of the GOLDEN RAY, Mr. Park's

previous sworn testimony before the Coast Guard in September 2019 and before KMST in October 2019. We entered these excerpts as Coast Guard B and Coast Guard Exhibit C, respectively. Actually that's incorrect. We have not entered those as of yet. 18A, Mr. Ouset (sic) was entered. And previously stipulated from the Coast Guard testimony and the KMST testimony will be entered at Coast Guard Exhibit 18B and 18C. It is worth noting that the Investigation Team obtained both the Loadcom and IMACS computer based systems from onboard the capsized GOLDEN RAY. The IMACS system monitors ship's operations and conditions aboard the ship, while the Loadcom aids in calculating vessel stability. These systems were referenced throughout this hearing in various witness's testimonies. While information from the IMACS computer was available for investigators to probe, the Loadcom was damaged during the ship's capsizing. The Loadcom was sent to multiple US agencies and private entities in an attempt to recover the information contained therein. Unfortunately, the system was ultimately determined unrecoverable due to extensive water damage. Before I move into the final closing portion of the statement we'll take a quick 5 minute recess to assess – to correct a couple things here in the space and make sure that we're ready to close out the hearing. So the local time is 2:37, we'll take 5 minutes. We stand in recess.

The hearing recessed at 2:37, 22 September 2020

The hearing was called to order at 2:43, 22 September 2020

CAPT WELBORN: The local time is 2:43. We're back on the record for the formal hearing of the capsizing of the Motor Vessel GOLDEN RAY. I will now move on to the closing stage of this hearing. As we have heard from all of witnesses and presented the

relevant evidence, we are now transitioning into the analysis phase of this Formal Investigation. This means that the Investigation Team, with the backing of the joint effort of the Republic of the Marshall Islands, the U.S. National Transportation Safety Board, and the Korean Maritime Safety Tribunal, will begin to coalesce the information we have garnered to write the final Report of Investigation.

Although there is always a chance that a short hearing session could be reconvened if new witnesses or information are identified as the report is being written, I believe we have gathered the factual evidence necessary to proceed with our analysis. However, the members of the Formal Investigation will continue to collect and review any evidence submitted in the future, including submissions to the USCGGoldenRay@gmail.com email address. This email address is solely intended for submissions regarding the public hearing or the investigation not the response efforts.

As I have previously emphasized, the purpose of this investigation is to discover what caused and contributed to the GOLDEN RAY capsizing, with the goal of preventing similar casualties in the future. I would like to take this opportunity to sincerely thank the Republic of the Marshall Islands and Mr. Thomas Bremer, the NTSB and Captain David Flaherty, KMST personnel Joeng Choerlag, Choi Hedong, Jeongil Hwang, all parties in interest, government agencies, maritime organizations, company representatives, Merchant Mariners and individual witnesses who dedicated their time and resources to date to this significant endeavor.

All collective expertise of those involved have helped to clarify various matters throughout these proceedings. In turn, the members of this Formal Investigation have a

clear direction for our analysis and recommendations to prevent similar casualties in the future.

I have also been inspired throughout these proceedings by the flexibility, cooperation, and support of all those involved and impacted by this incident. Your feedback and suggestions have aided the process, and your comment, excuse me, commitment to preventing similar casualties is greatly appreciated.

On a personal note, my close association with this investigation has reaffirmed the strong cooperative spirit within the maritime community as a whole. Ship's crew, the pilots, local mariners, responders, and salvors worked together to evaluate the injured and evacuate those that were ambulatory, and rescue the trapped crew, in some cases, accepting significant personal risk to save others. Although not specifically addressed in this hearing, crews labored to prepare for and respond to oil spills and protect the public from the ship and the ship from the public. The more I learned about those involved and their actions, I was impressed by the communal cohesiveness where members directly labored for the betterment of all. Local businesses supported the rescued crew members in the initial days ashore and our investigation team members over the past several months. I thank you and commend this community for rallying around those impacted by – those impacted by and responding to this significant accident. If not for the selfless, quick and committed actions of some, this incident would most certainly have been more catastrophic.

In closing, I want to emphasize that the members of this Formal Investigation have diligently worked to identify the causes and contributing factors of the GOLDEN RAY's capsizing and in our final report will make any recommendations necessary to enhance

maritime safety. Even though the public side of this investigation is coming to an end, the members of this Formal Investigation will continue to work tirelessly as the report is drafted and the recommendations are established. I am confident that broadcasting the proceedings on LiveStream and making them available to the public on the Internet has helped to identify important safety issues that will be addressed around the world.

I thank you for your time and your commitment. The time is now 2:47 local. This hearing stands adjourned.