National Transportation Safety Board

Sinking of Cargo Vessel *El Faro* Atlantic Ocean, Northeast of Acklins and Crooked Island, Bahamas October 1, 2015

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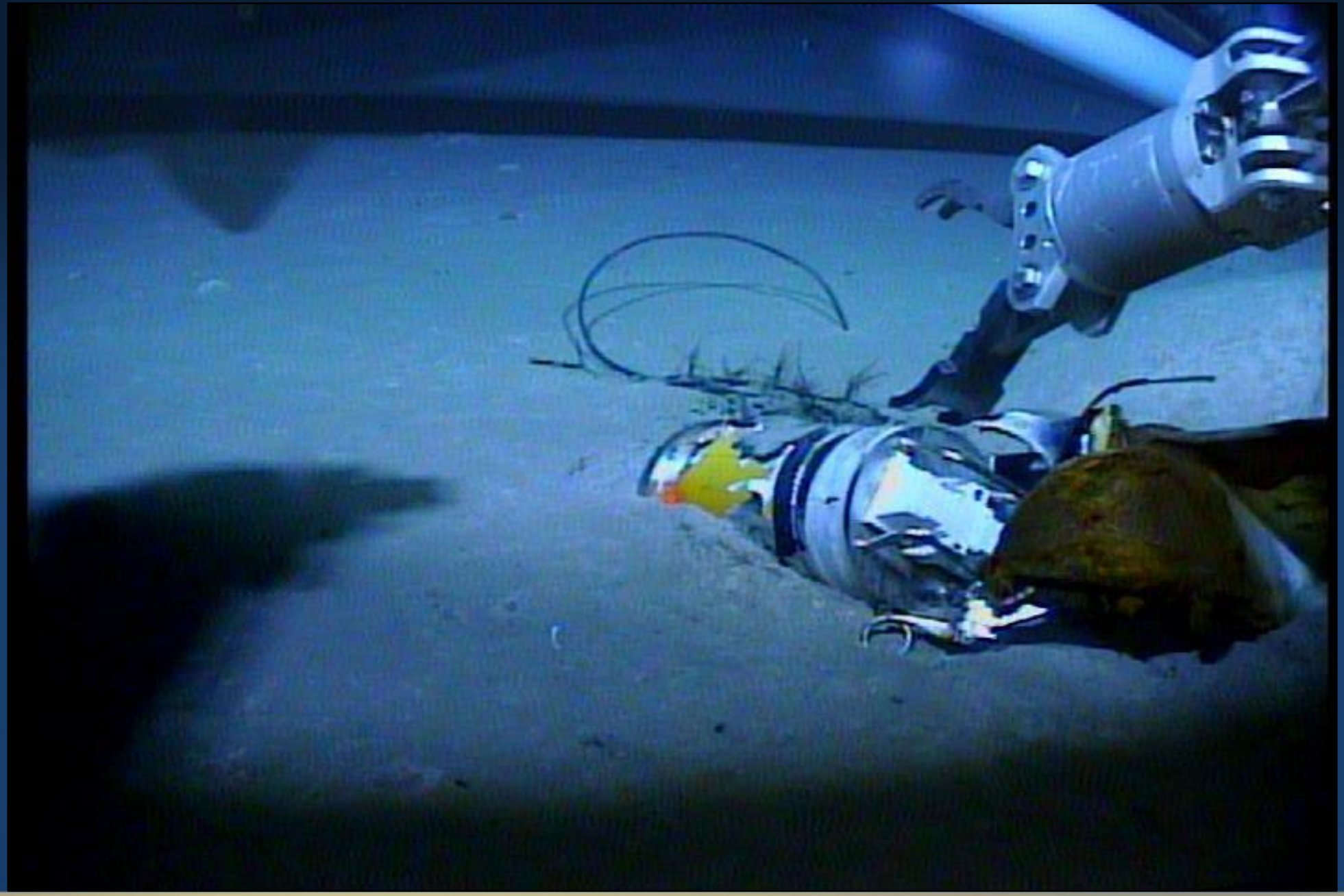
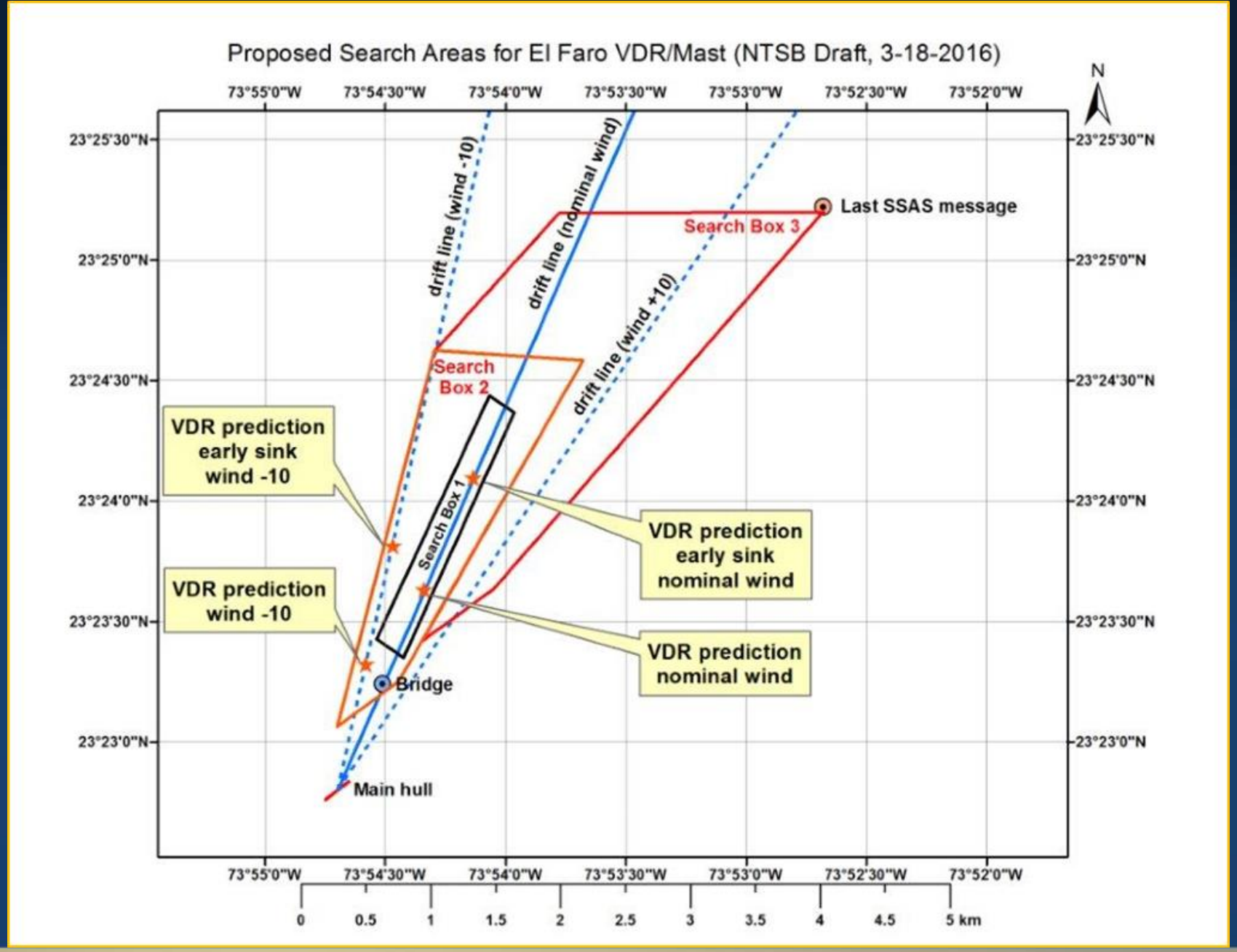
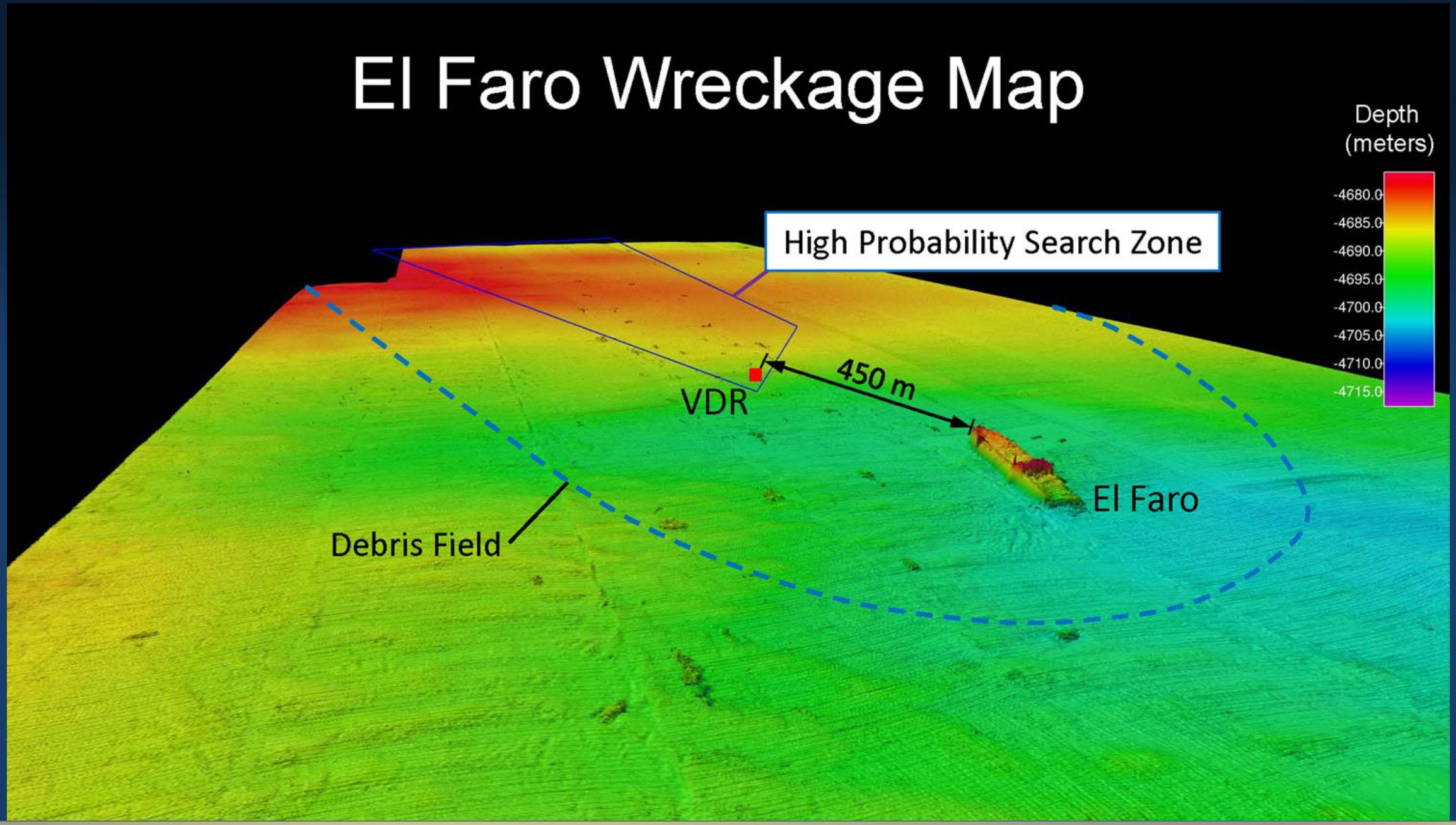
Recovery of *El Faro*'s Voyage Data Recorder

Brian Curtis
Director, Office of Marine Safety







Organizations Assisting in VDR Recovery

- Department of the Navy
  - Supervisor of Salvage and Diving
  - Military Sealift Command
- United States Coast Guard
- American Bureau of Shipping
- National Oceanic and Atmospheric Administration
- National Science Foundation
- Woods Hole Oceanographic Institution
- TOTE Services, Inc.
- University of Rhode Island
  - Inner Space Center

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Sinking of Cargo Vessel *El Faro* Atlantic Ocean, Northeast of Acklins and Crooked Island, Bahamas October 1, 2015

Brian Young
Investigator-in-Charge

National Transportation Safety Board

Accident Overview
Sinking of Cargo Vessel *El Faro*

Brian Young
Investigator-in-Charge

Investigation

National Transportation Safety Board

Accident Narrative: Sinking of Cargo Vessel *El Faro*

On Scene Team

- Board Member Dinh-Zarr
- Office of Marine Safety
- Office of Research and Engineering
- Office of Highway Safety
- Office of General Counsel
- Office of Chief Information Officer
- Office of Safety Recommendations and Communications
  - Transportation Disaster Assistance Division
  - Government Affairs
  - Media Relations

Investigation Team

- Brian Young – Investigator-in-charge/Engineering
- Eric Stolzenberg – Naval architecture
- Michael Kucharski – Nautical operations
- Carrie Bell – Human factors
- Mike Richards – Meteorology
- Jon Furukawa – Survival factors
- Doug Mansell – Voyage data recorders
- Sean Payne – Voyage data recorders
- Charlotte Cox – Writer/editor

Staff that Supported Team

- Monica Mitchell – Writer/editor
- Andrew Ehlers – Writer/editor
- William Tuccio – Voyage data recorders
- Chris Babcock – Voyage data recorders
- Dennis Crider – Vessel stability
- Xiaohu Liu – Cargo lashing analysis
- Loren Groff – Research and engineering
- Greg Smith – Research and engineering

Staff that Supported Team

- Katherine Chisom – Family assistance
- Stephanie Matonek – Family assistance
- Alice Park – Animation
- Carl Schultheisz – Animation
- Christy Spangler – Vessel graphics
- Ed Kendall – General counsel
- Peter Knudsen – Media relations

Parties to the Investigation

- United States Coast Guard
- TOTE Services
- American Bureau of Shipping
- National Weather Service
- Herbert Engineering
- Palfinger Marine

Investigation

- Interviews
- Document collection / review
- Marine Board of Investigation hearings
- Independent analytical reports

Investigation – *El Yunque*

Safety Issues

- Loss of propulsion
- Flooding in cargo holds
- Downflooding through ventilation closures
- Need for damage control plan
- Lack of suitable survival craft
- Late decision to muster the crew

Safety Issues

- Inadequate company oversight
- Company's safety management system
- Ineffective bridge resource management
- Use of noncurrent weather information
- Captain's actions

Other Issues

- Alternate Compliance Program
- Voyage data recorders
- Expanded use of automatic identification system

Presentations - Morning

Engineering factors	Brian Young
Flooding of cargo holds	Eric Stolzenberg
Damage control and stability information	Michael Kucharski
Survival factors	Jon Furukawa

Presentations - Afternoon

Electronic data	Sean Payne
Onboard weather information and weather reporting from vessels	Mike Richards
Human performance factors	Carrie Bell
Captain’s decision-making and actions	Michael Kucharski

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Engineering Factors

Brian Young
Investigator-in-Charge

Overview – Engineering Factors

- Vessel history
- Major conversion
- Inspections
- Exclusions
- Loss of propulsion

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Vessel History

Brian Young
Engineering Group Chairman

El Faro

Major Conversion Determination

- Major vessel conversions:
  - Substantially alter stability characteristics, dimensions, or carrying capacity of vessel
  - Change the type of vessel
  - Substantially prolong the vessel's service life

- Major conversions require the vessel to be updated to current safety standards

Major Conversion Determination

- *El Faro's* lengthening in 1993 was a major conversion
  - Added 90-foot mid-body section
- *El Faro's* conversion from Ro/Ro to Ro/Con in 2005-2006
  - Added capacity for 1,414 containers
  - Increased draft/lowered freeboard over 2 feet
- After request for reconsideration from company, Ro/Con modification not designated as a major conversion

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Alternate Compliance Program

Brian Young
Engineering Group Chairman

Alternate Compliance Program

- *El Faro* enrolled in ACP since 2006
- ACP avoids redundancies in Coast Guard and authorized classification society (ACS) inspections and surveys
- Coast Guard issues Certificate of Inspection (COI) after ACS verifies compliance with applicable standards
- “US supplement” bridges gap between Coast Guard and ACS standards
- Annual Coast Guard oversight examinations of ACP vessels to confirm ACSs are enforcing compliance

Alternate Compliance Program

- No qualification level required and no formal training program for the Coast Guard ACP examiners
- Communications between Coast Guard and ACSs lacking
- Lack of resources to complete “US supplement” reviews
- Review of targeted ACP vessels that had successfully completed ACS surveys found safety deficiencies; lacked deficiency records

Exclusions

Brian Young
Engineering Group Chairman

Exclusions

- Not factors in accident:
  - Boilers, steering, and electrical systems
  - Riding gang
  - Medical conditions and medication use
  - Structural failure
  - Rogue wave

Exclusions

- Not factors in initial list of vessel:
  - Lashing failure
  - Cargo shift

- Insufficient evidence to determine:
  - Fatigue
  - Drug or alcohol use

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Loss of Propulsion

Brian Young
Engineering Group Chairman

Loss of Propulsion

0440/0513 – Chief Engineer reported oil levels affected by list

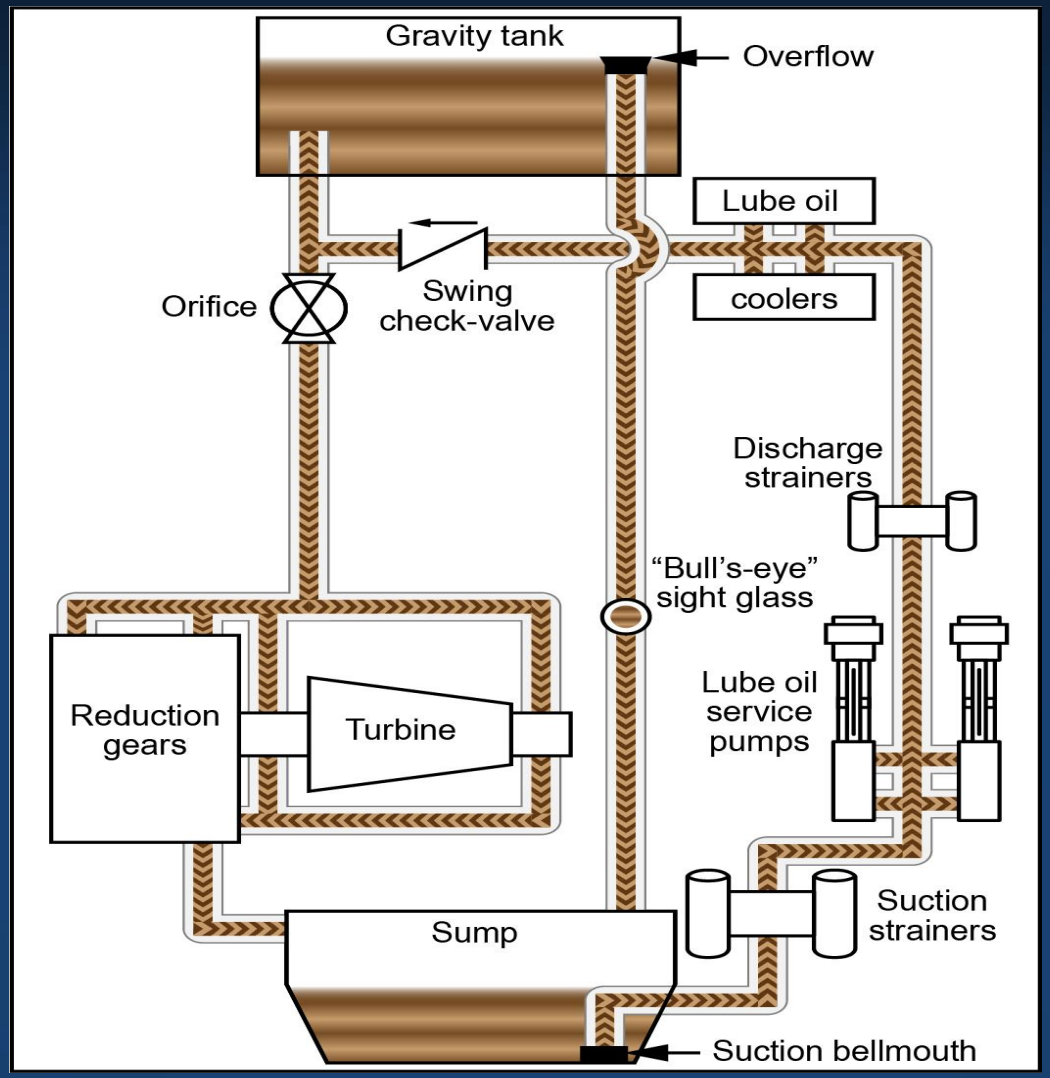
0554 – Captain turned *El Faro* to port

After 0600 – Vessel began losing speed

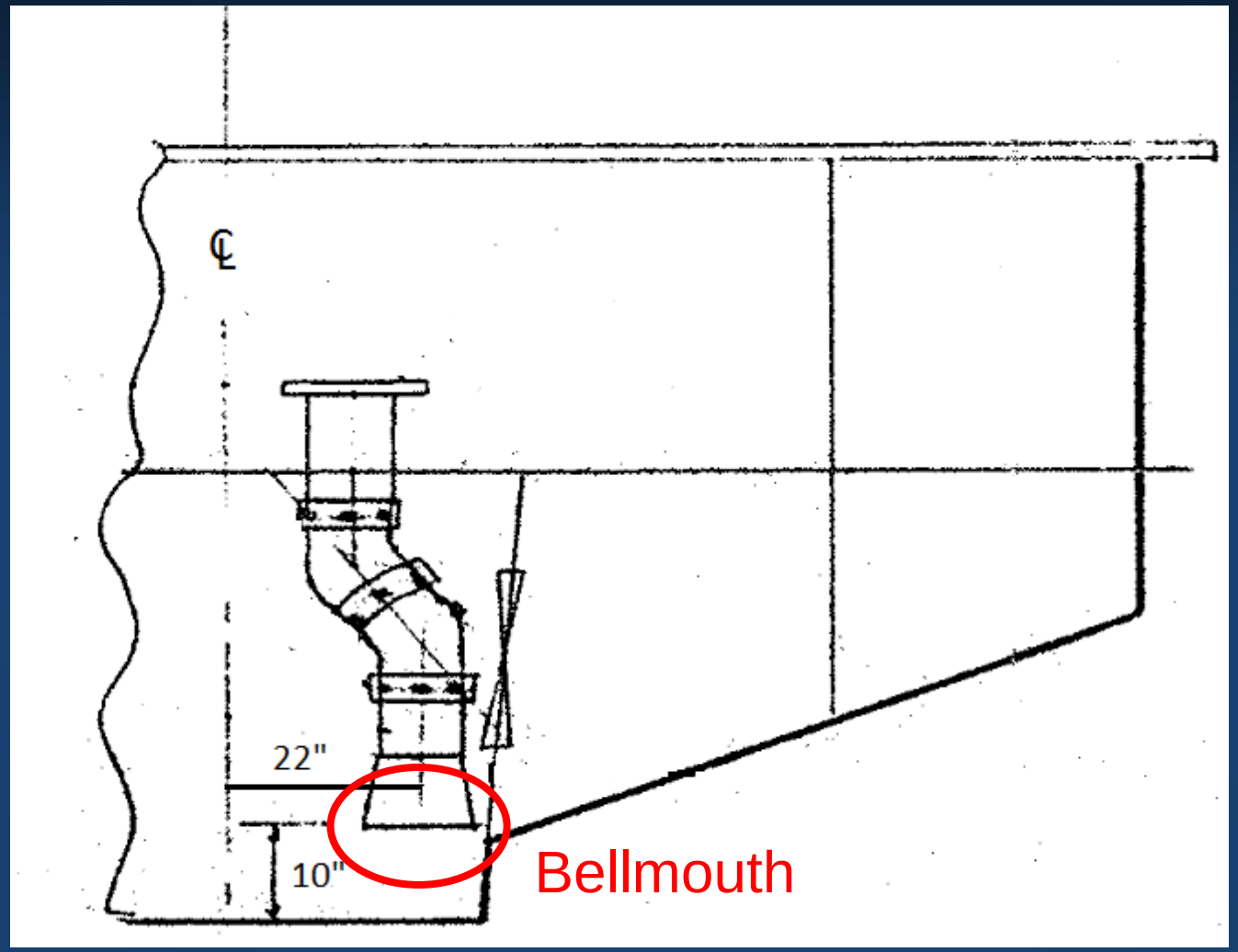
0616 – Bridge notified of loss of propulsion

Lube Oil System

Lube Oil System



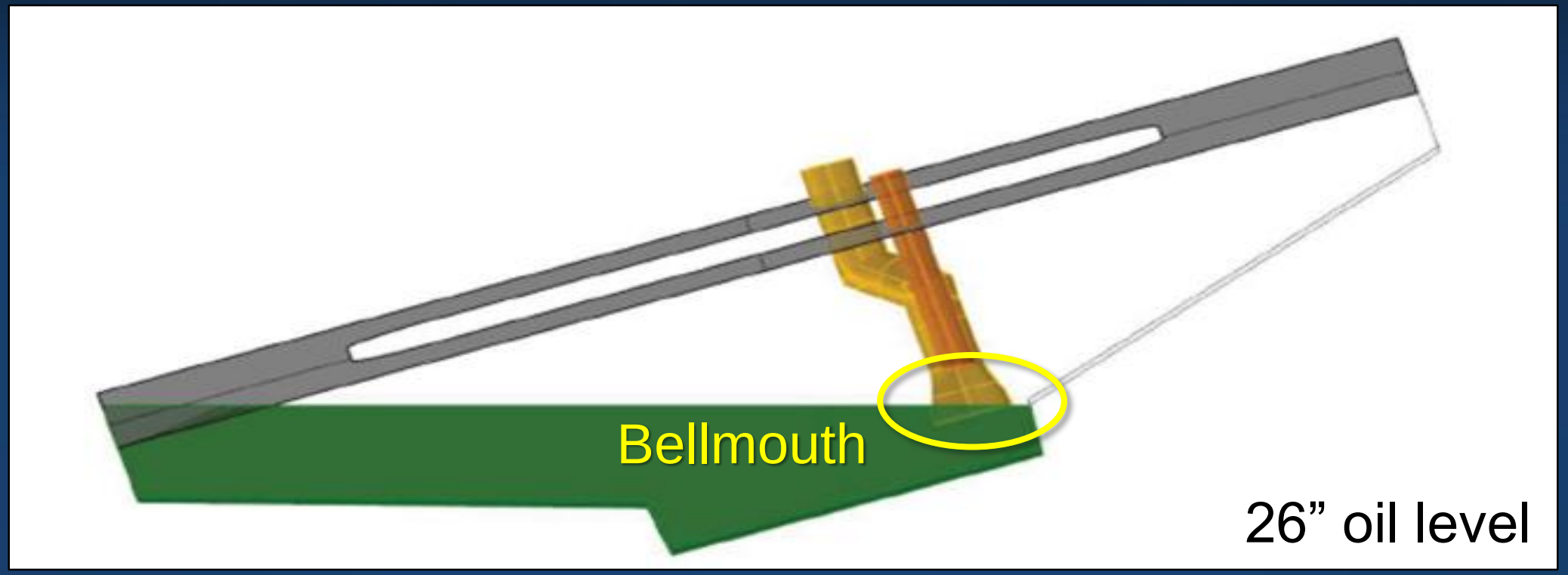
Lube Oil System



Design Standards

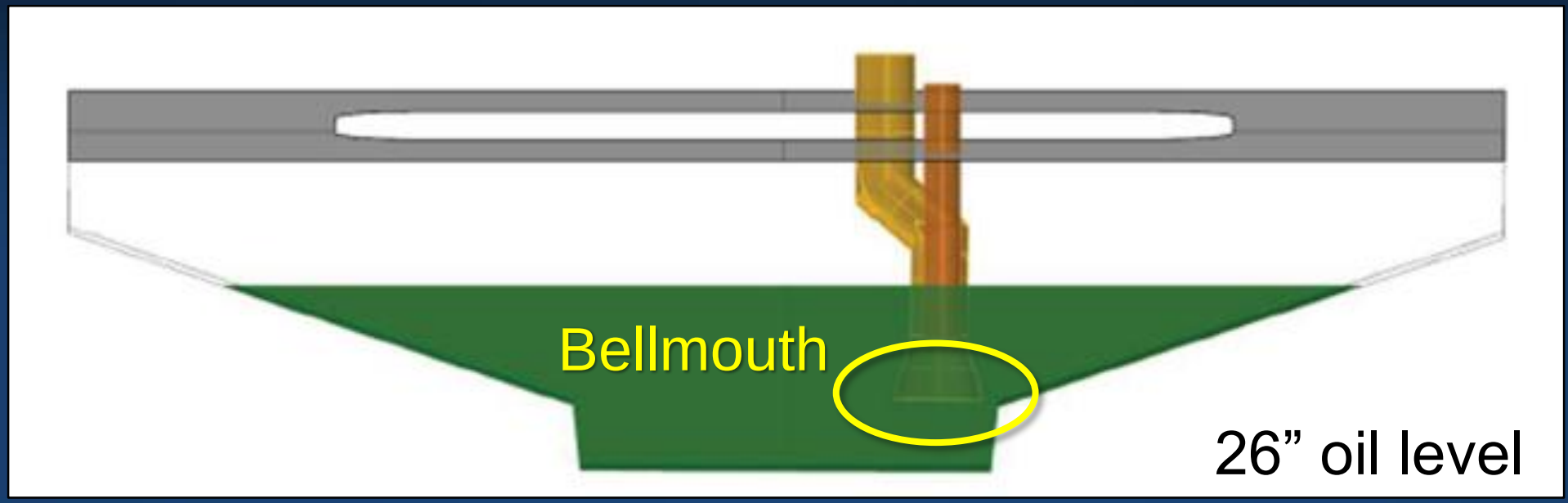
Extreme list to port

Design Standards



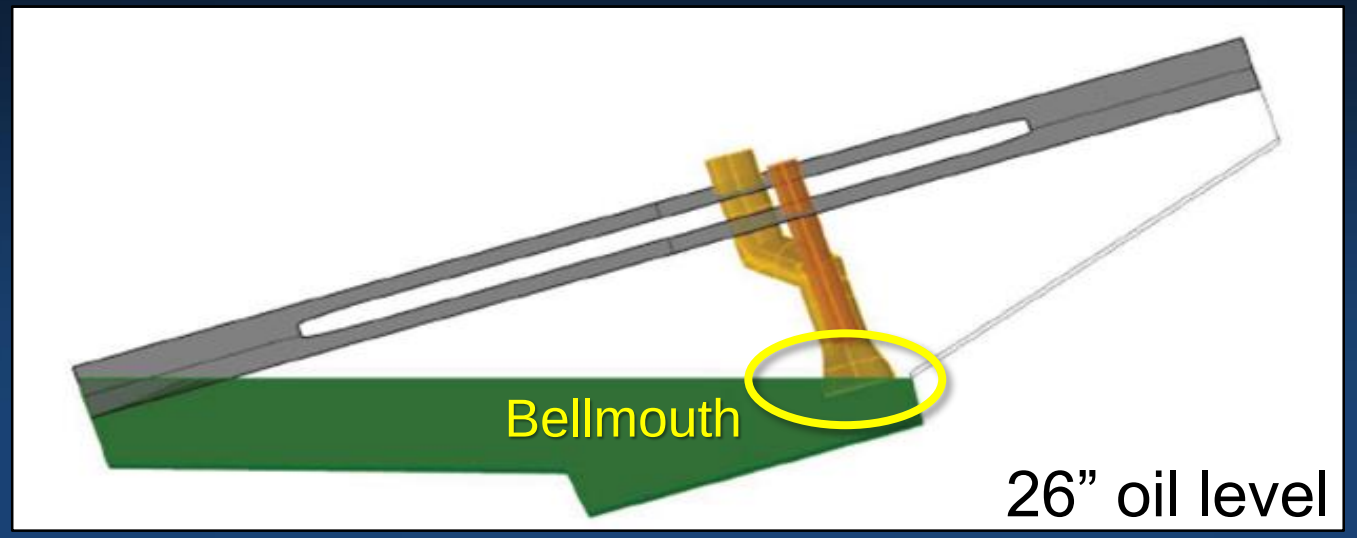
18° list to port – looking forward

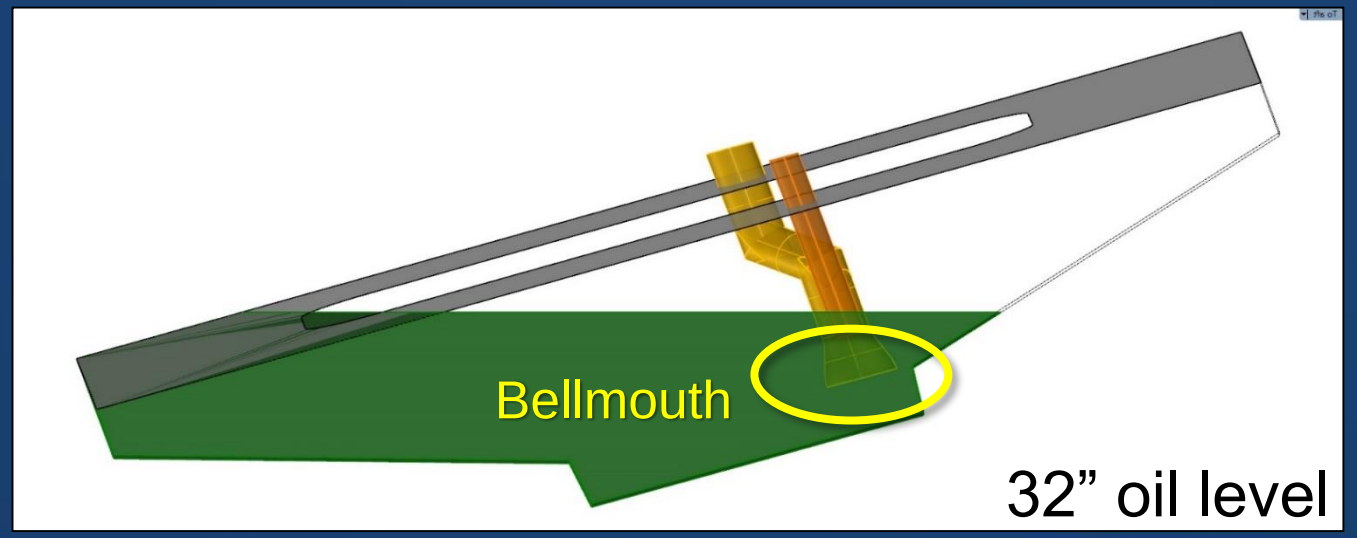
Oil Level in Sump



25” = 1,255 gallons
26” = 1,346 gallons
27” = 1,436 gallons

18° List to Port





Summary – Engineering Factors

- Findings
- Recommendations

National Transportation Safety Board

Flooding of Cargo Holds

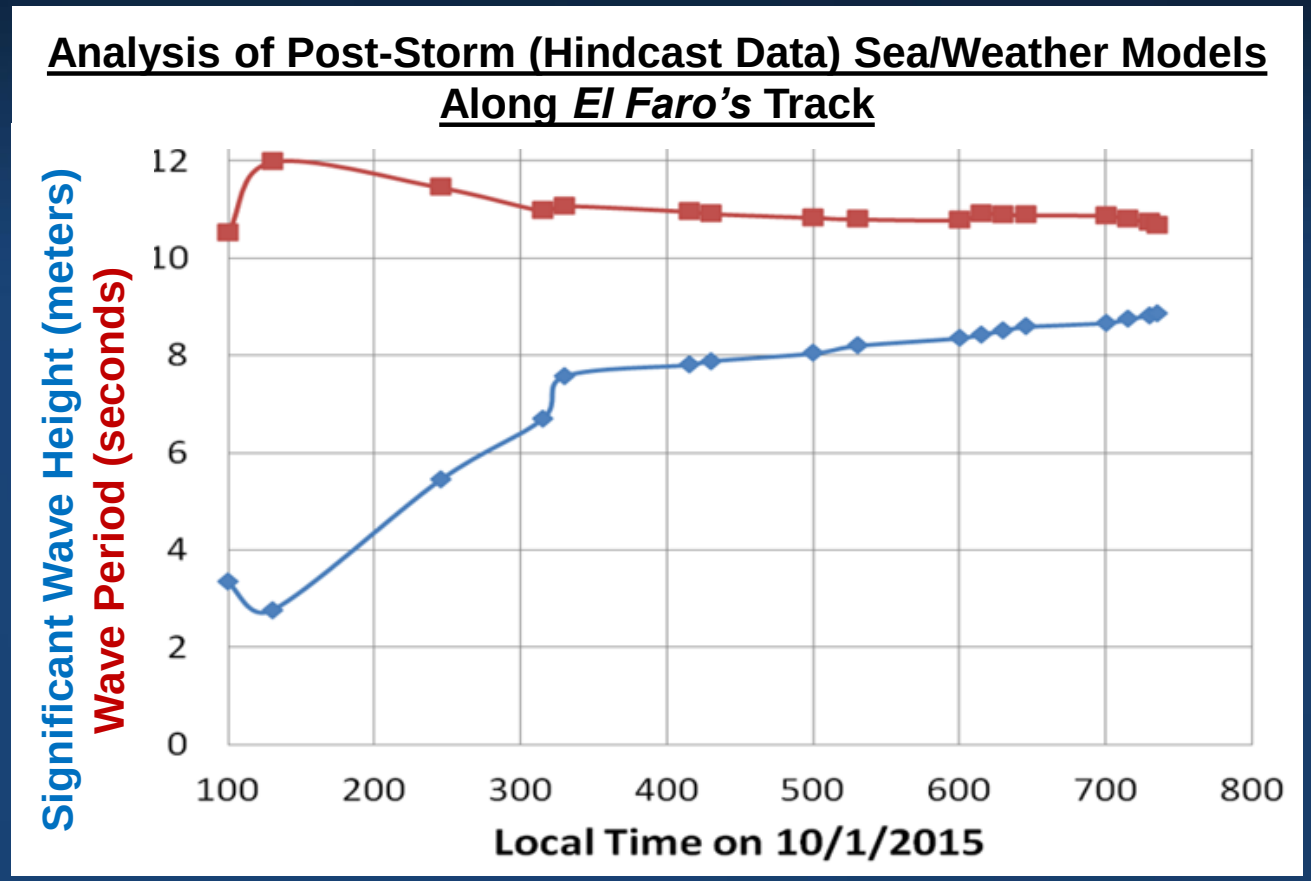
Eric Stolzenberg
Naval Architecture Group Chairman

Overview

- Increasing seas and waves, resultant windheel
- Flooding sources
- Car lashings
- Bilge pumping
- Bilge high-level alarms in cargo holds
- Watertight hatch open/closed indicators
- Cargo hold ventilation closures
- Hull wreckage examination

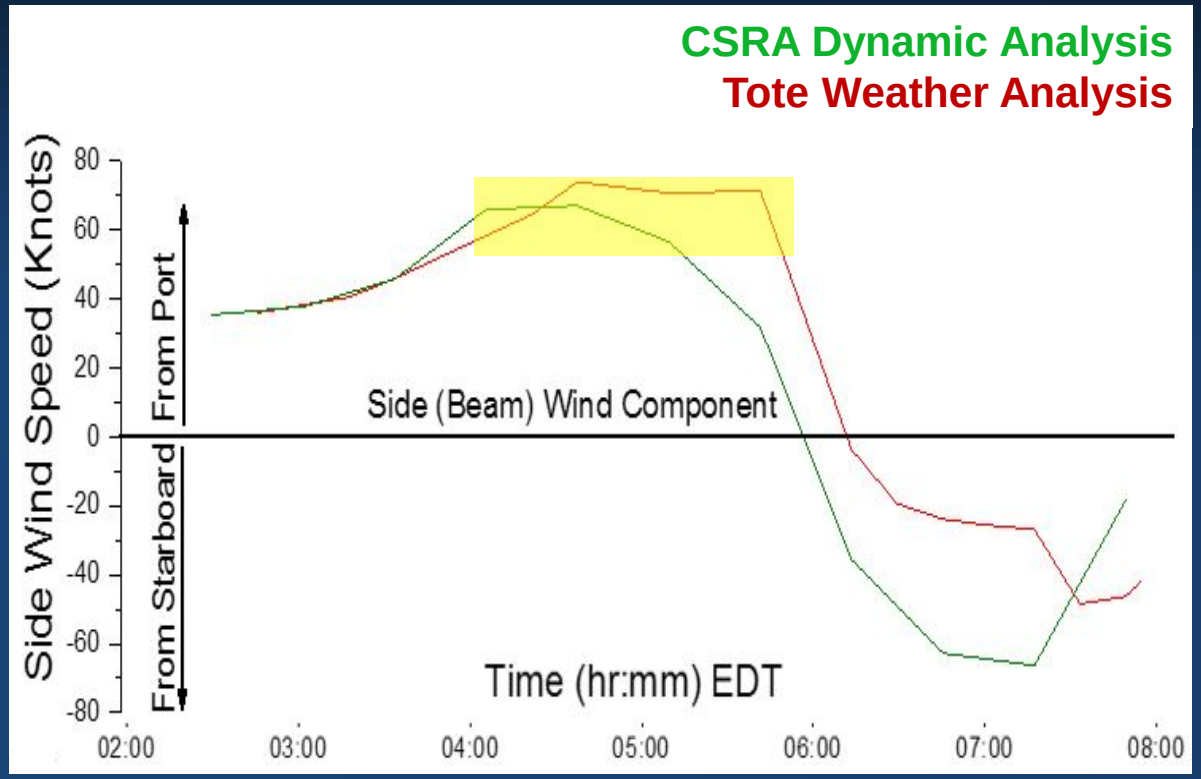
Increasing Seas

- Seas increase rapidly after 0130
- Over 7 meters (23 feet) by 0300
- Build to 9 meters (30 feet)
- Wave period of 11 seconds

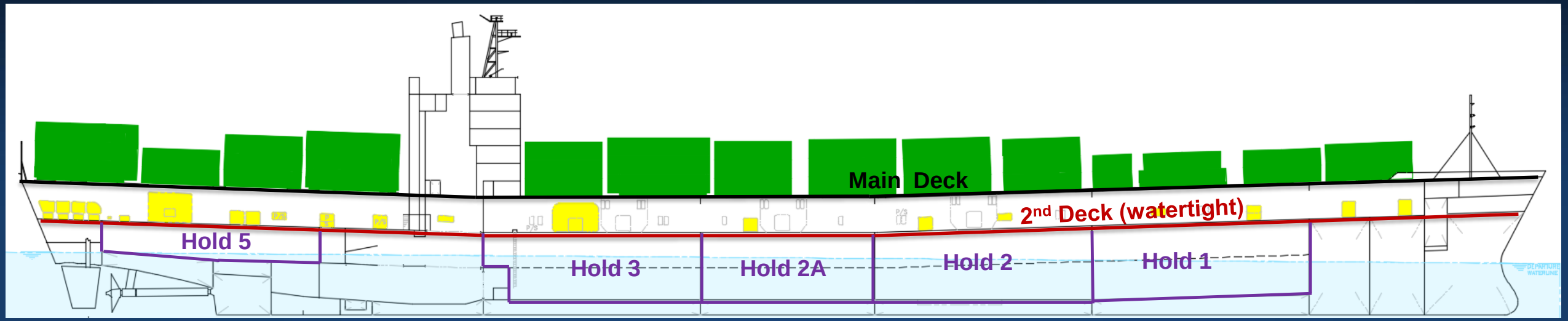


Sustained Windheel

- Increasing winds after 0200 on vessel's port beam
- Wind near 70 knots by 0400
- Effect: increasing and sustained heel (windheel) to starboard
- Hydrostatic analysis shows heel from 5º to 8º for winds 60 to 80 knots on beam

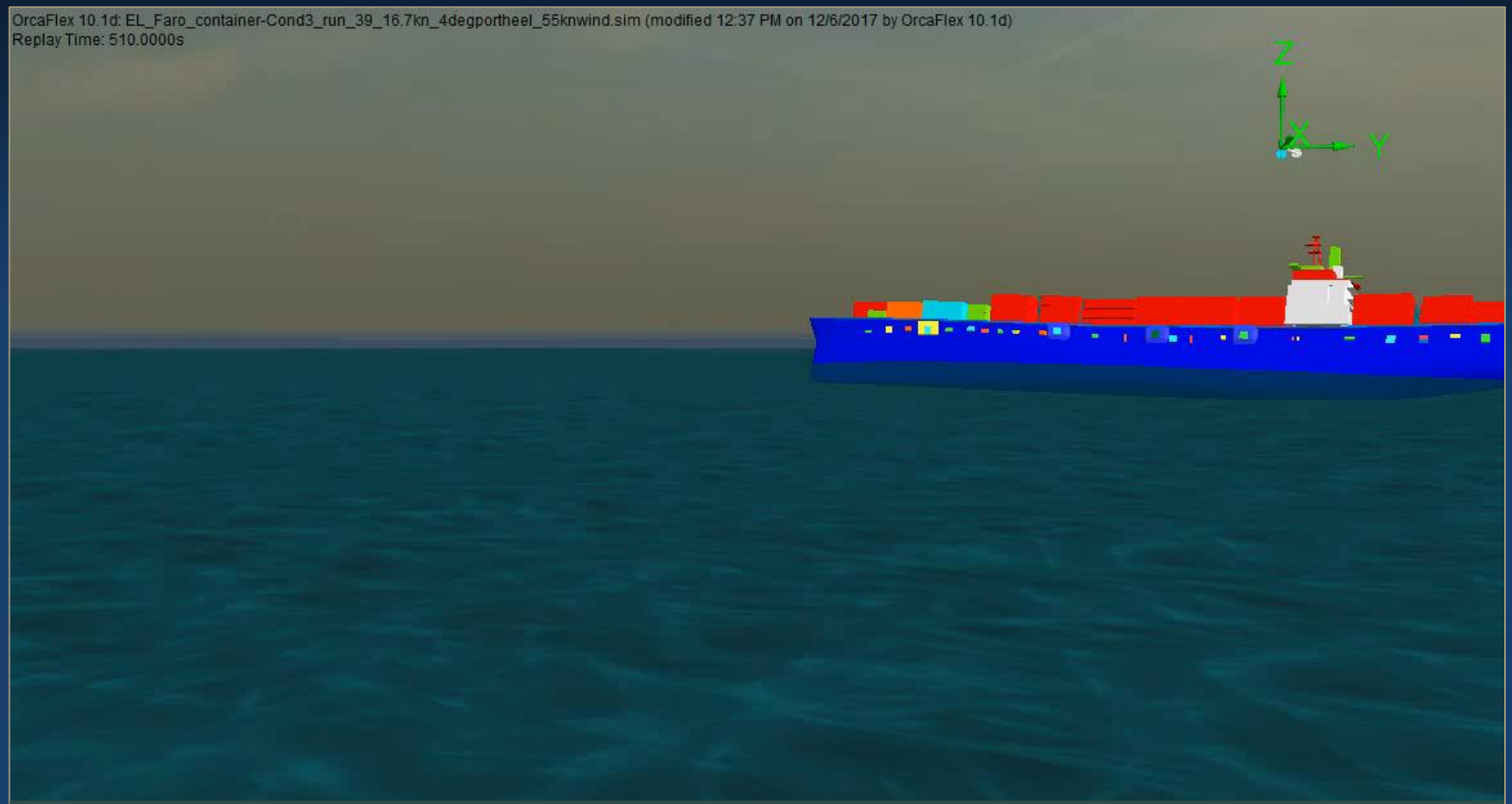


Watertight Deck



- Boarding seas (green water) was known to enter onto 2nd deck in past
- Partially enclosed 2nd deck was watertight

Dynamic Analysis



Simulation at 0330 hours

Fixed 4^{o} heel, ship speed 16.7 knots, 55 knot wind, 25-foot seas

Downflooding from Watertight Scuttle (Deck Hatch)

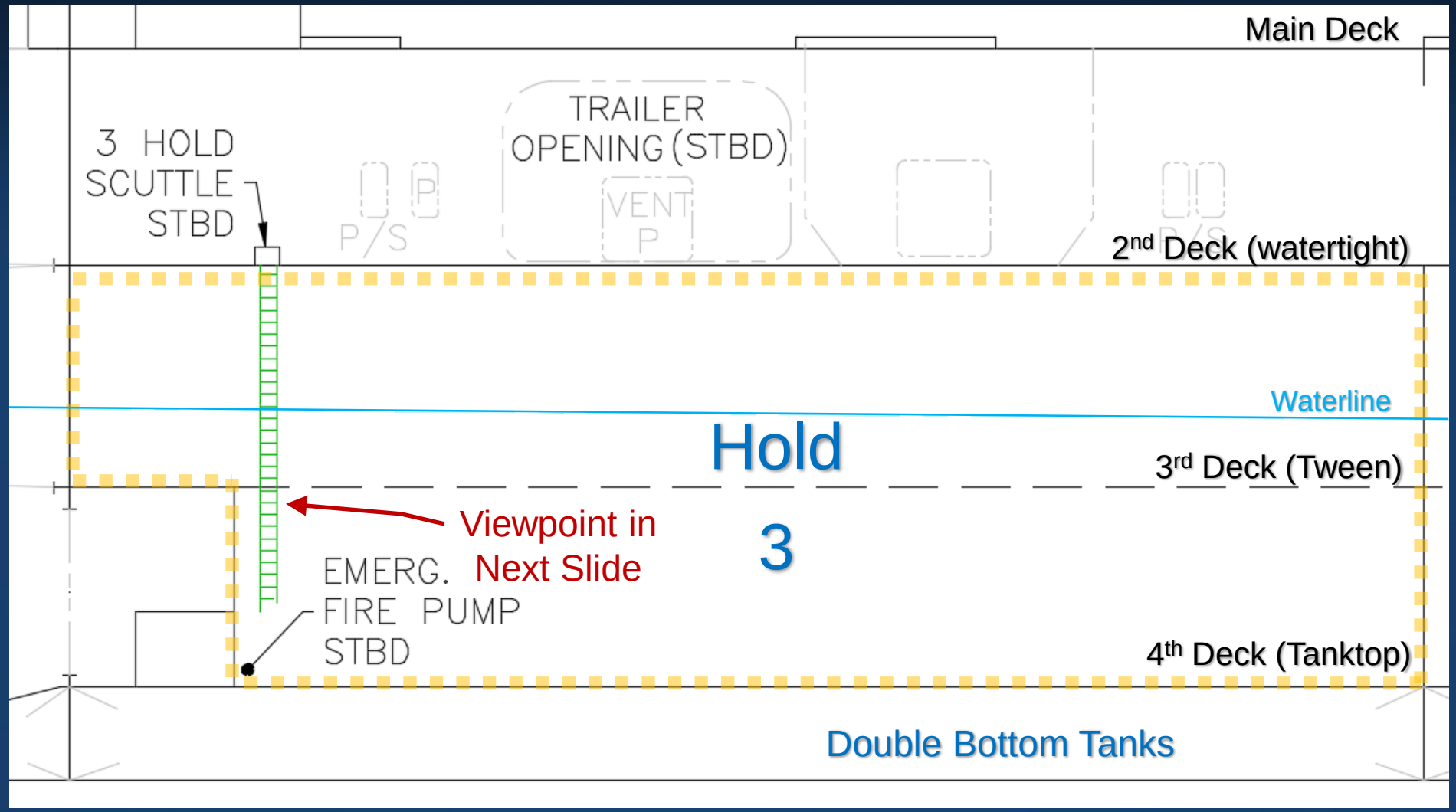
- Hold 3 was flooding at 0543 per VDR
- Small watertight deck hatch (scuttle) to cargo hold 3 on second deck was open
- Open scuttle allowed downflooding through ship's watertight envelope

Unsecured Scuttle to Hold 3

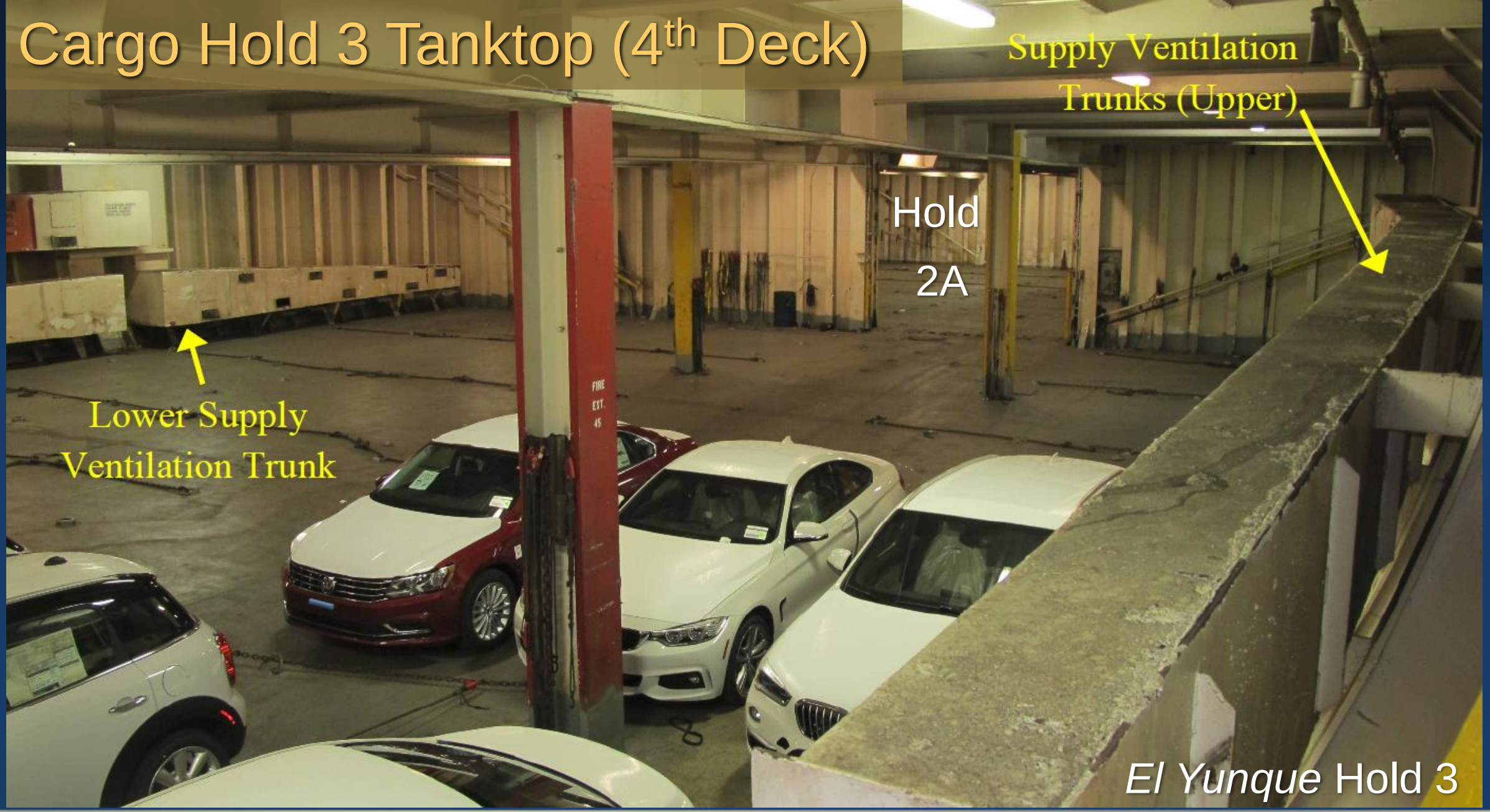
- Crew did not know when or how scuttle to hold 3 opened
- If bridge had open/close indicator, crew would have known scuttle was open

El Faro Scuttle

El Faro Cargo Hold 3

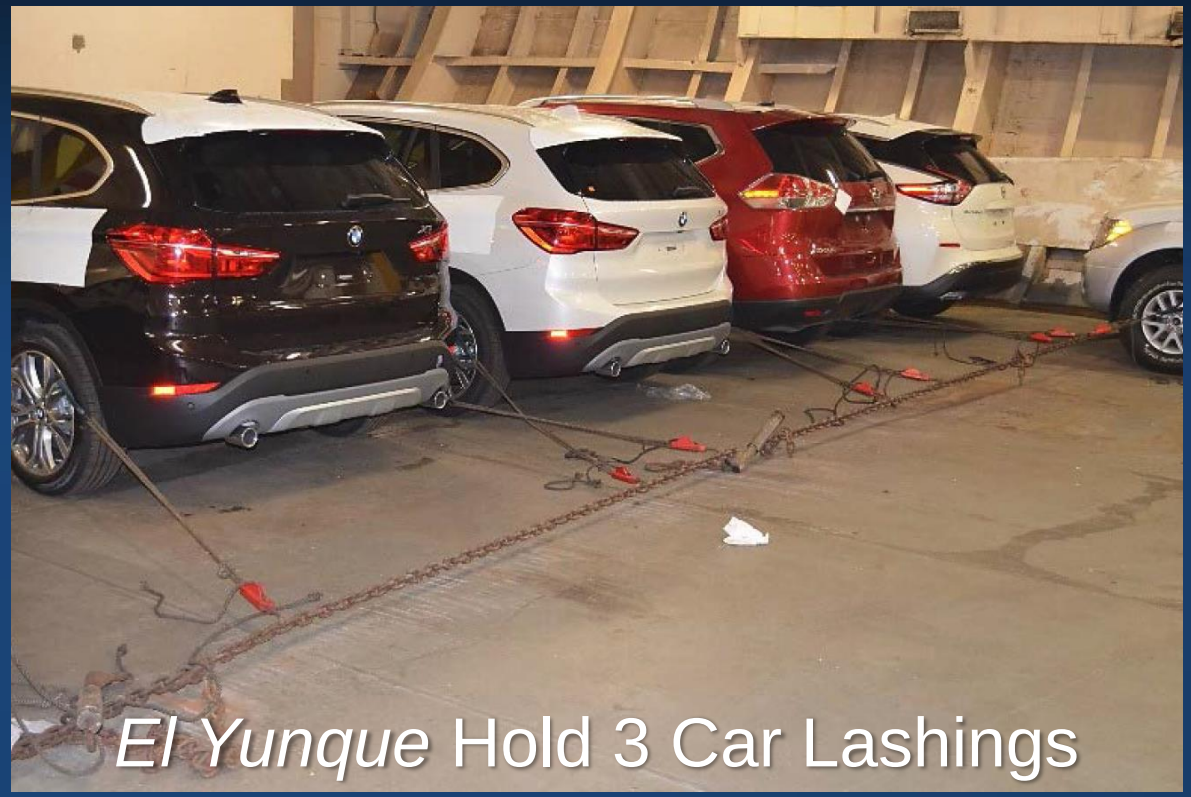


Cargo Hold 3 Tanktop (4th Deck)



Automobile Lashings in Hold 3

- Automobile lashings did not conform to cargo-securing manual
- Cars were more likely to shift during heavy weather



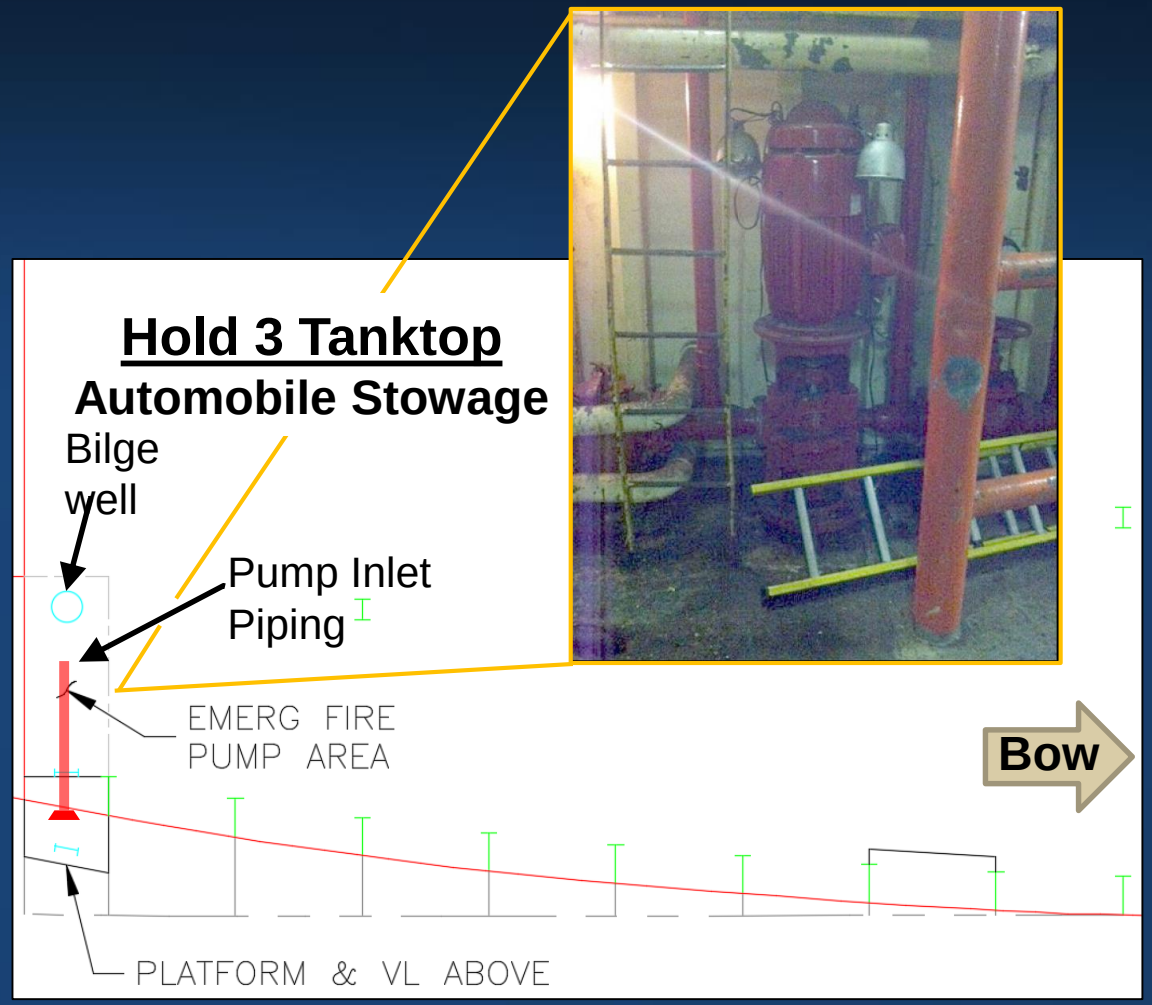
El Yunque Hold 3 Car Lashings

Flooding Effect on Car Lashings

- Adverse effects:
  - Small amount of water decreases friction
  - Rising water begins to float cars
  - Mass of sloshing water acts on cars
- Crew said cars were loose
- Water plus vessel's motion loosened cars

Seawater Inlet Piping to Emergency Fire Pump

- Cars loose in hold 3 at 0544
- Bilge pumps already running
- Scuttle secured about 0600, but hold 3 still flooding
- Piping to fire pump possible source of flooding
- Loose cars could have struck piping to fire pump



Hold 3 Flooding Effect

- Damaged piping potentially flooded hold 10% to 20% by 0716
- MSC hydrostatic analysis
  - Beam-to 80-knot wind after loss of propulsion
  - Hold 3 flooded 10% to 30%
  - Rolling about sustained windheel
  - Vessel susceptible to capsizing
- Damage to seawater piping in hold 3 most likely led to flooding in the hold, which significantly compromised vessel's stability

Bilge Pumping

- Two bilge wells per cargo hold (port and starboard)
- Bilge system operated continuously from at least 0544
- Flooding in hold 3 exceeded design capacity of bilge pumps
- Water level continued to rise despite pumping

El Yunque Bilge Well, Hold 3

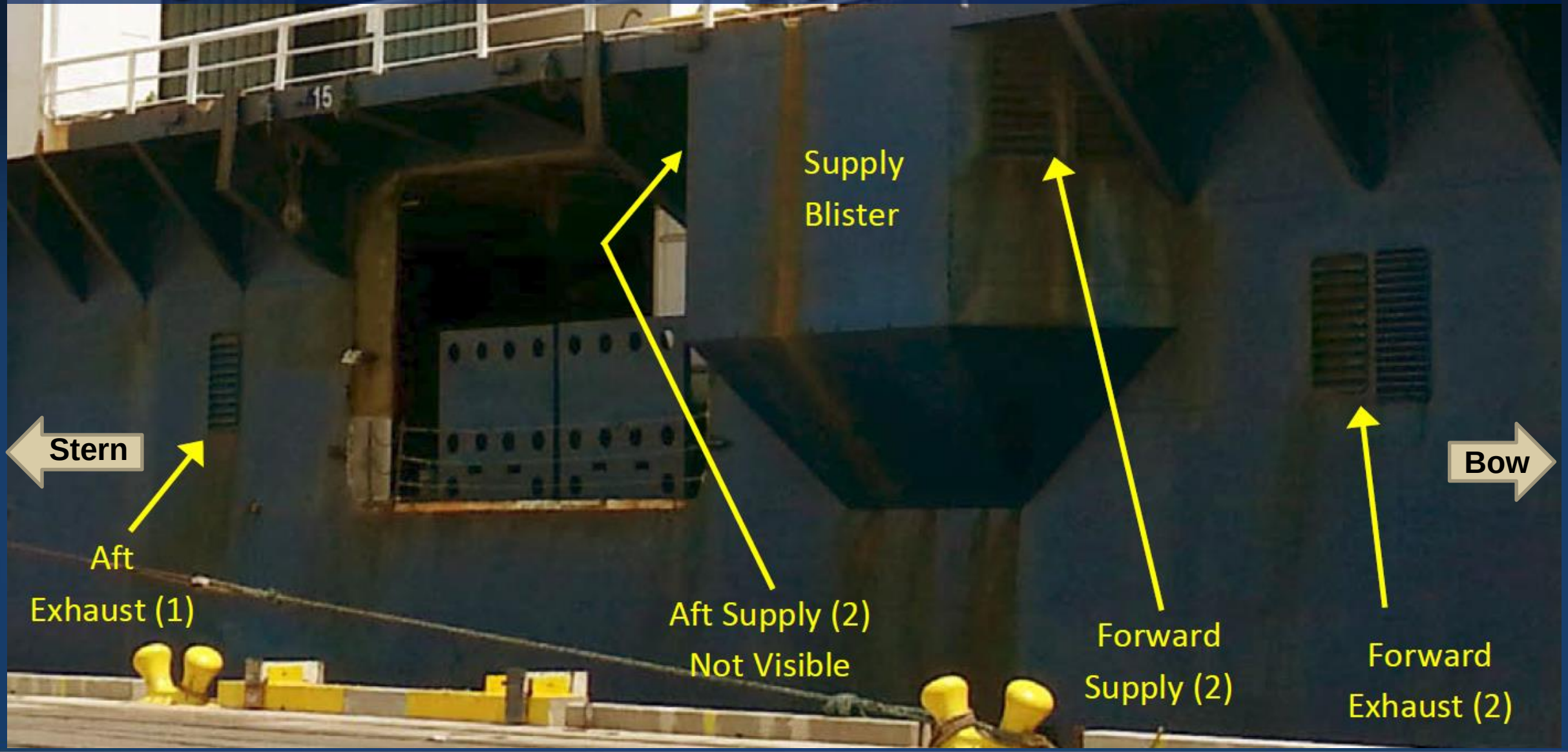
Bilge Alarm System

- Visible and audible alarms in engine room only
- Hold 3 alarms typically investigated by engineering watch
- No evidence of how flooding in hold 3 detected
- Discussion on VDR of hold 2A alarm
- Crew most likely alerted to water in hold 3 by bilge alarm system

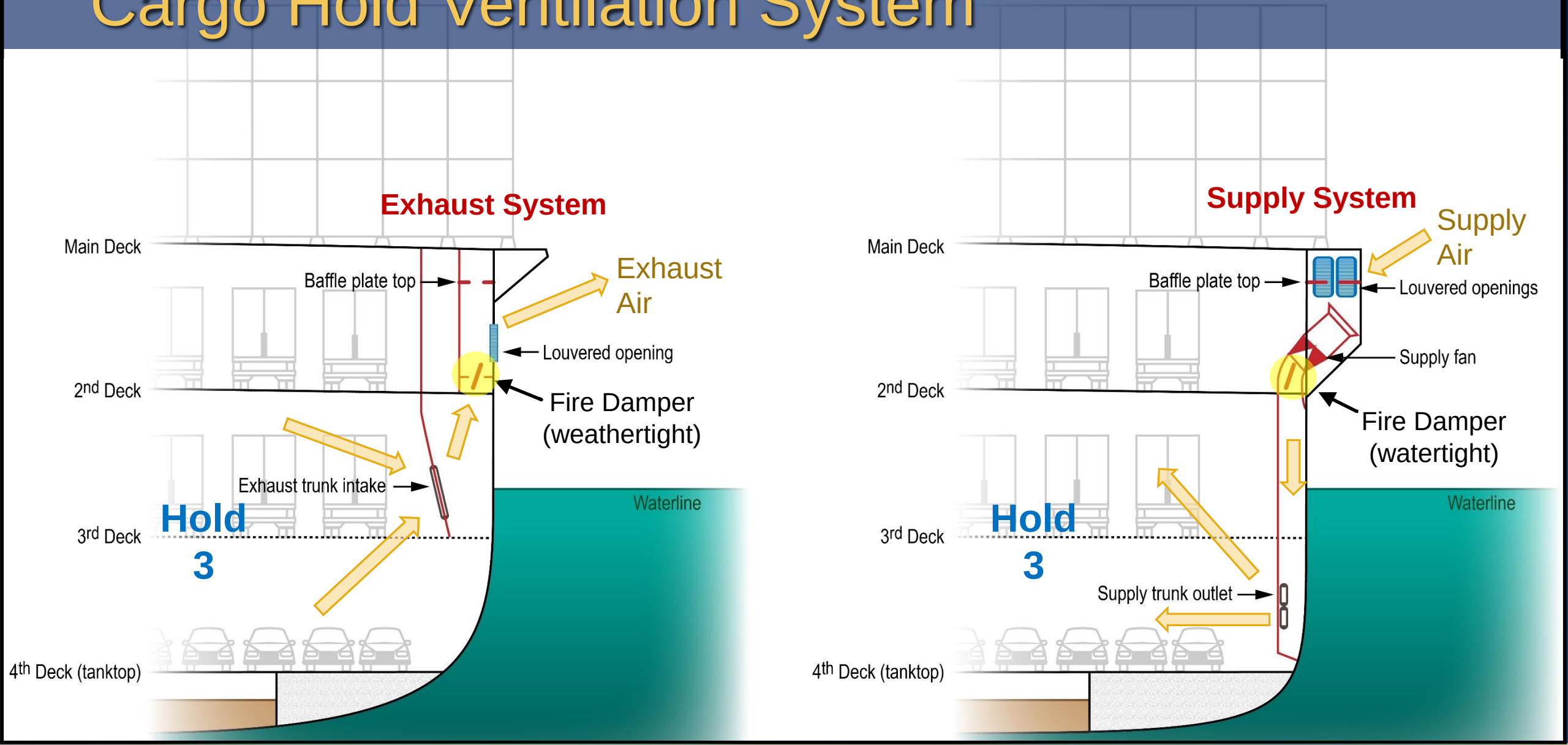
Bilge Alarm Requirements

- Alarms quickly identify flooding
- Alarms not required on cargo vessels
- Cargo vessels should be equipped with bilge alarms

Cargo Hold Ventilation System



Cargo Hold Ventilation System

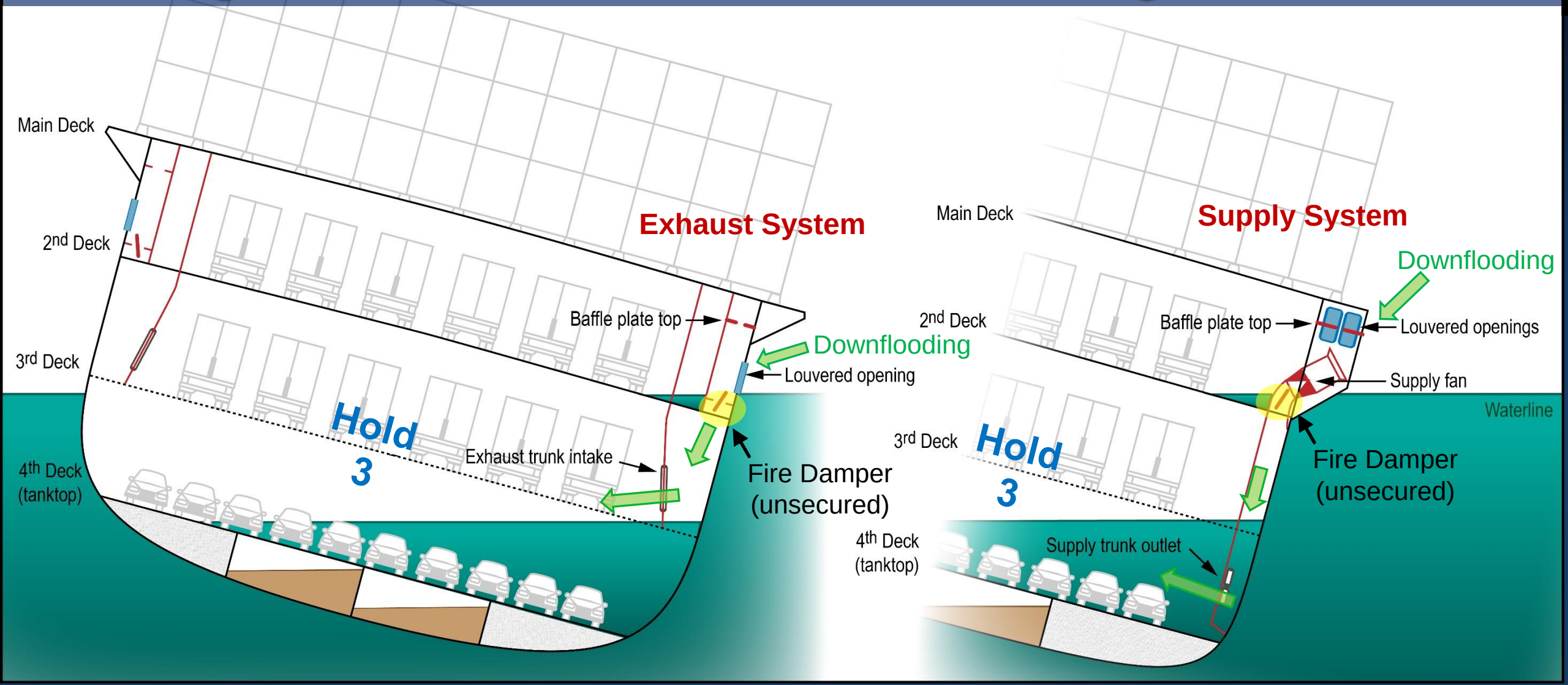


Schematics based on Coast Guard Marine Safety Center Analysis

Cargo Hold Ventilation Closures

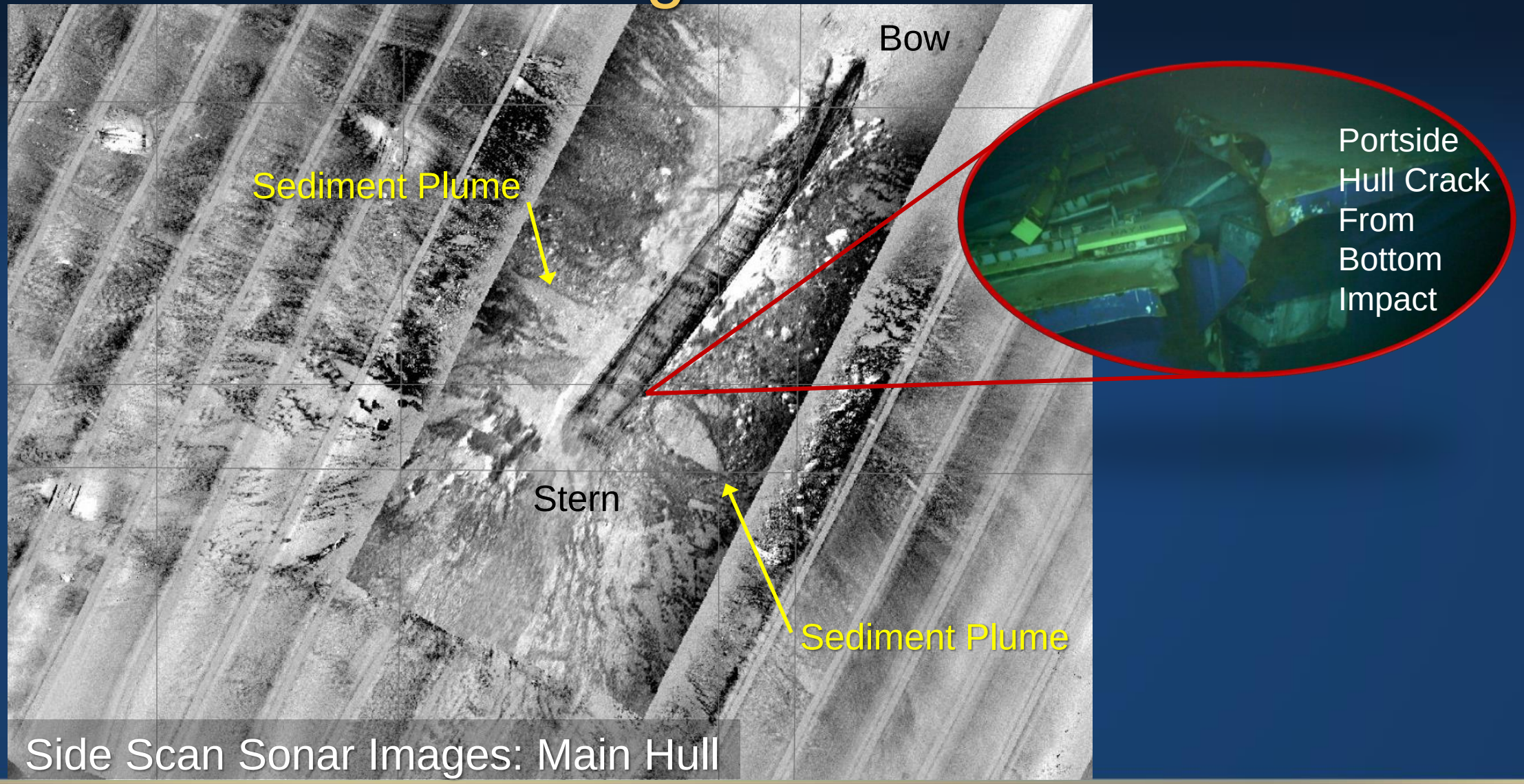
- Ventilation closures most likely remained open throughout sinking
- COI required ventilation of holds at sea
- Intact and damage stability standards consider ventilation openings to be closed
- Vessels should not have conflicting requirements

Cargo Hold Ventilation Downflooding

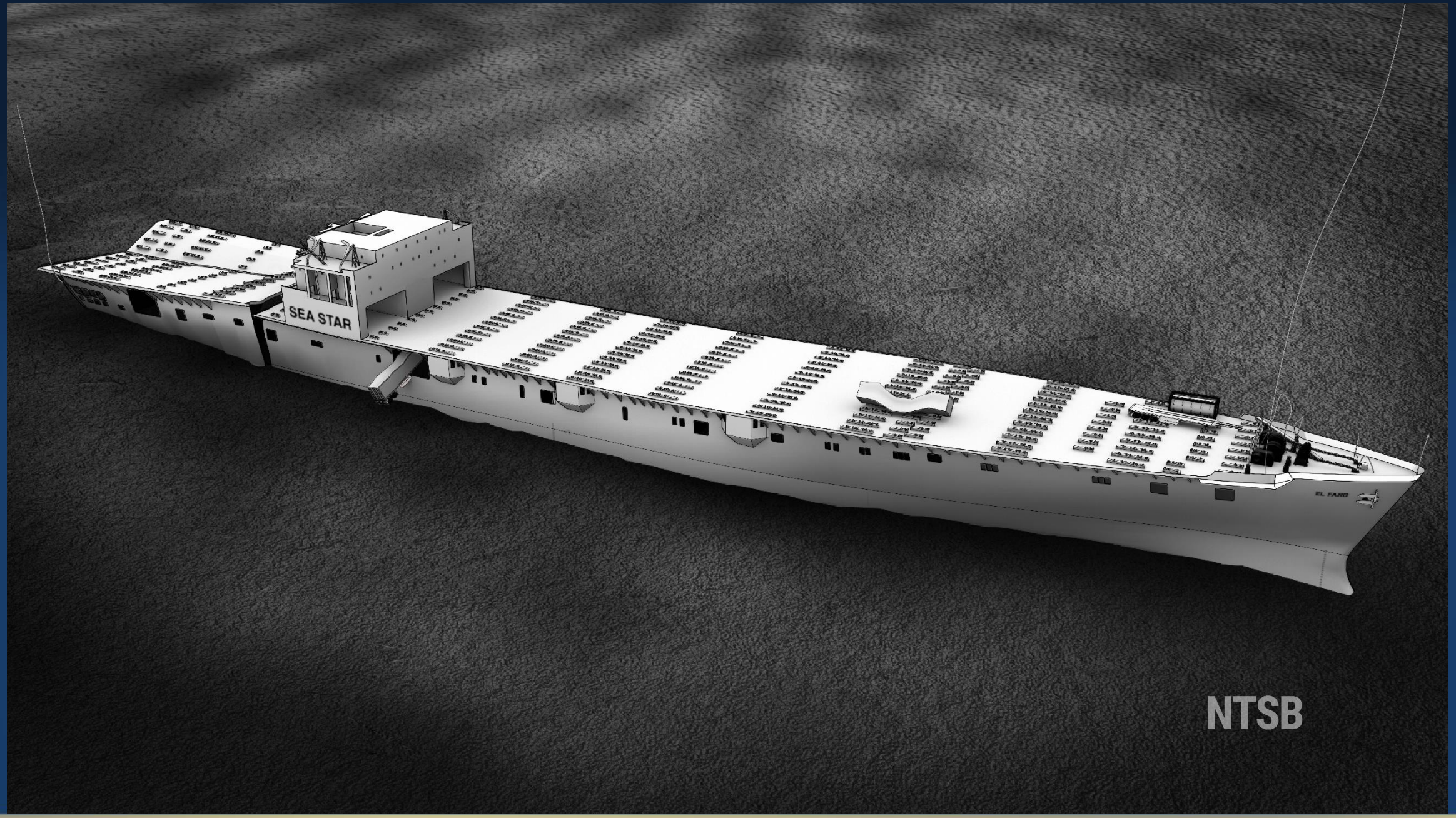


Schematics based on Coast Guard Marine Safety Center Analysis

Examination of Wreckage



Side Scan Sonar Images: Main Hull



Summary – Flooding of Cargo Holds

- Findings
- Recommendations

National Transportation Safety Board

Damage Control and Stability Information

Michael J. Kucharski
Nautical Group Chairman

Overview

- Damage control plan and booklet
- Stability book
- Computer program damage stability module

Damage Control Information

- Clear information on ship's watertight subdivision
- Equipment related to maintaining boundaries and effectiveness of subdivision
- Proper precautions to take to prevent progressive flooding through openings
- Effective action that can be taken to quickly mitigate and, where possible, recover ship's loss of stability

Damage Control Plan and Booklet

- Ship's watertight boundaries
- Means to correct list

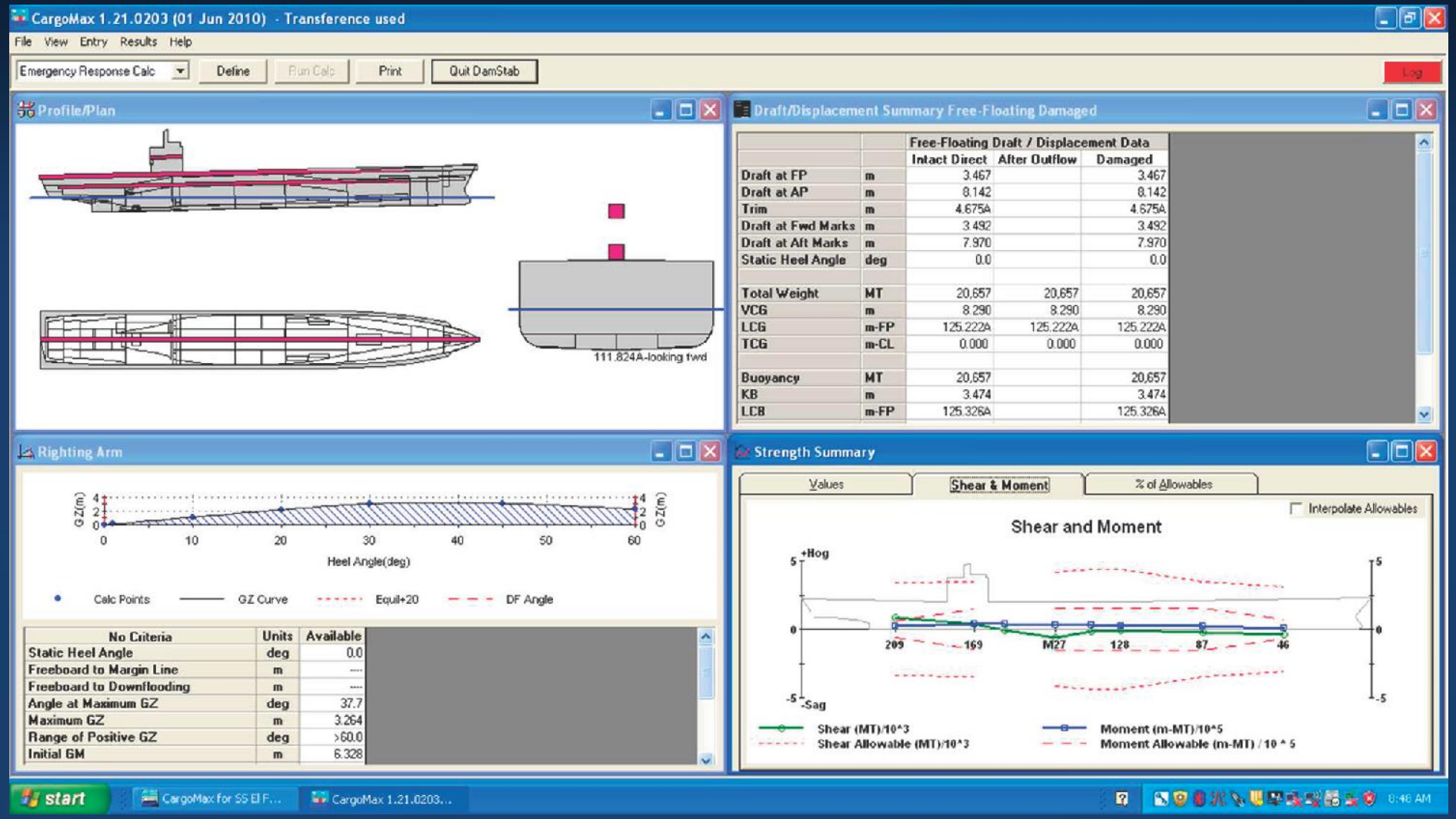
Damage Control Plan and Booklet Information

- Watertight and weathertight closures
- Pump capacities and piping diagrams
- Advice to master to obtain shore assistance
- Visual guidance to master

Damage Control Plan and Booklet

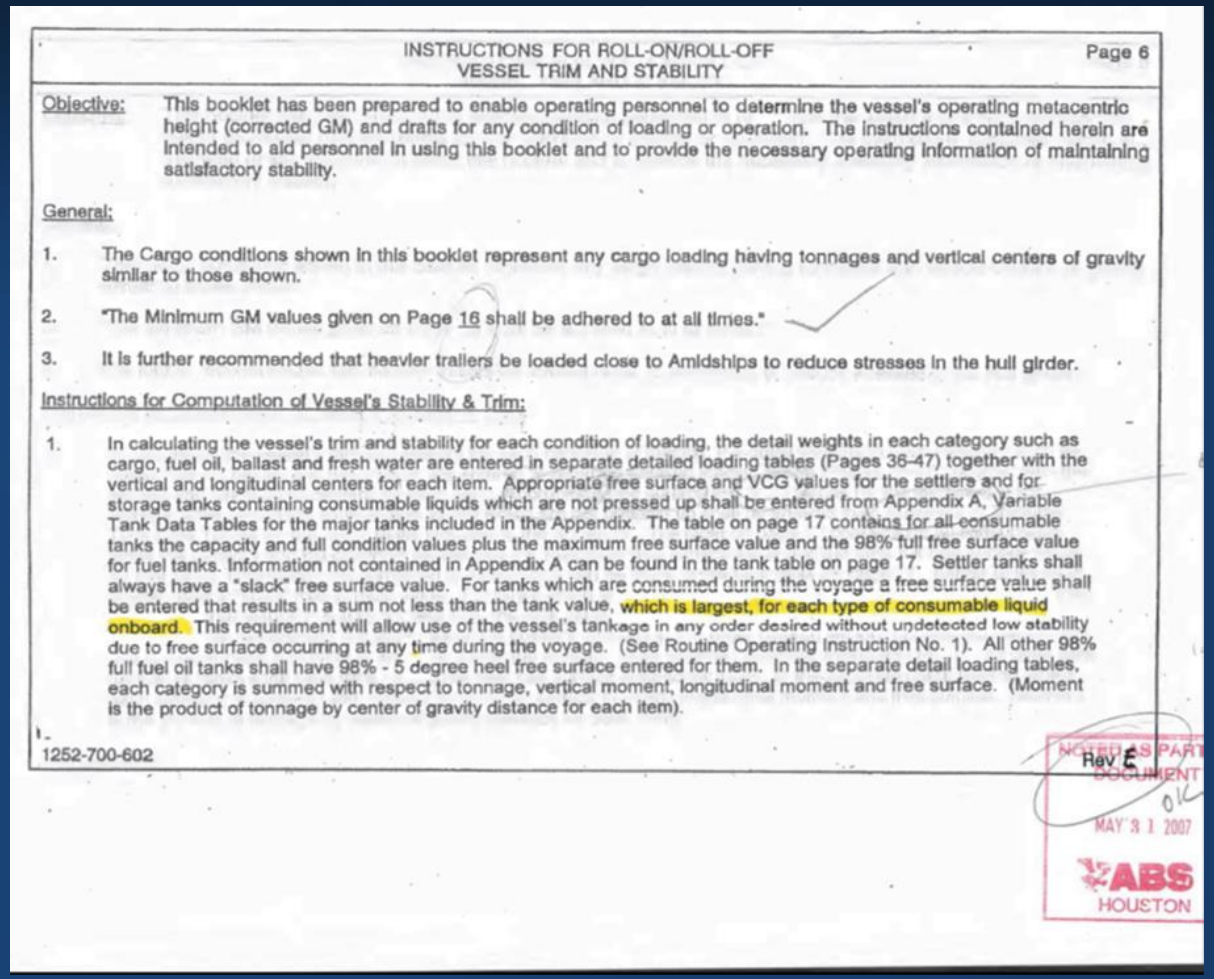
- Assist in planning for and addressing flooding
- All cargo vessels should have
- Classification societies should review and approve
- Available from computer software

Damage Control Module to CargoMax



Stability Book

- Must contain sufficient information to master
- Unintentional flooding and operation during emergency situations to be “considered”



INSTRUCTIONS FOR ROLL-ON/ROLL-OFF
VESSEL TRIM AND STABILITY

Page 6

Objective: This booklet has been prepared to enable operating personnel to determine the vessel's operating metacentric height (corrected GM) and drafts for any condition of loading or operation. The instructions contained herein are intended to aid personnel in using this booklet and to provide the necessary operating information of maintaining satisfactory stability.

General:

1. The Cargo conditions shown in this booklet represent any cargo loading having tonnages and vertical centers of gravity similar to those shown.
2. "The Minimum GM values given on Page 16 shall be adhered to at all times."
3. It is further recommended that heavier trailers be loaded close to Amidships to reduce stresses in the hull girder.

Instructions for Computation of Vessel's Stability & Trim:

1. In calculating the vessel's trim and stability for each condition of loading, the detail weights in each category such as cargo, fuel oil, ballast and fresh water are entered in separate detailed loading tables (Pages 36-47) together with the vertical and longitudinal centers for each item. Appropriate free surface and VCG values for the settlers and for storage tanks containing consumable liquids which are not pressed up shall be entered from Appendix A, Variable Tank Data Tables for the major tanks included in the Appendix. The table on page 17 contains for all consumable tanks the capacity and full condition values plus the maximum free surface value and the 98% full free surface value for fuel tanks. Information not contained in Appendix A can be found in the tank table on page 17. Settler tanks shall always have a "slack" free surface value. For tanks which are consumed during the voyage a free surface value shall be entered that results in a sum not less than the tank value, which is largest, for each type of consumable liquid onboard. This requirement will allow use of the vessel's tankage in any order desired without undetected low stability due to free surface occurring at any time during the voyage. (See Routine Operating Instruction No. 1). All other 98% full fuel oil tanks shall have 98% - 5 degree heel free surface entered for them. In the separate detail loading tables, each category is summed with respect to tonnage, vertical moment, longitudinal moment and free surface. (Moment is the product of tonnage by center of gravity distance for each item).

1252-700-602

Rev E

NOTED AS PART OF DOCUMENT
MAY 31 2007
ABS HOUSTON

Stability Book

- VDR crew statements relating to:
  - The vessel “hanging” to one side
  - The sail area of the vessel
  - The angle at which downflooding would occur on the vessel

Stability Book

- The stability book did not identify:
  - Downflooding points
  - The angle of downflooding
  - Windheel criteria information and unintentional flooding due to list

- These items would have been useful for decision-making

Summary – Damage Control and Stability Information

- Findings
- Recommendations

National Transportation Safety Board

Survival Factors

R. Jon Furukawa
Survival Factors Group Chairman

Overview

- Search and rescue (SAR)
- Position formatting (latitude/longitude)
- Emergency position indicating radio-beacons (EPIRBs)
- Personal locator beacons
- Survival craft requirements

Search and Rescue (SAR) – Coast Guard

- Critical to get assets on scene
- Joaquin prevented search and rescue efforts for two days
- During first two days, Coast Guard positioned assets

Assets Utilized During Search Efforts

U.S. COAST GUARD

SAR Position Formatting Error

Source	Format	Position
Inmarsat-C	DD.MM	23.28N, 73.48W
Traditional	DD°MM’	23°28’N, 073°48’W
but SAROPS interpreted	DD.dd	23.28N, 73.48W
and converted to	DD-MM.mmm	23-16.800N, 073-28.800W 23 NM error

SAR Latitude/Longitude Formatting

Source & Format		Source Format
Navigation	DD°MM.m’	23°28.0′N, 073°48.0′W
Inmarsat-C	DD.MM	23.28N, 73.48W
SSAS	DD:MM.mm	23:25.39N, 073:52.51W
USCG	DD-MM.mmm	23-28.000N, 73-48.000W

Emergency Position Indicating Radio-Beacon (EPIRB)

- Automatic alert
- Indicates location
- Float-free
- Automatic activation
- Detectible anywhere
- 406 MHz frequency
- Non-GPS or with GPS

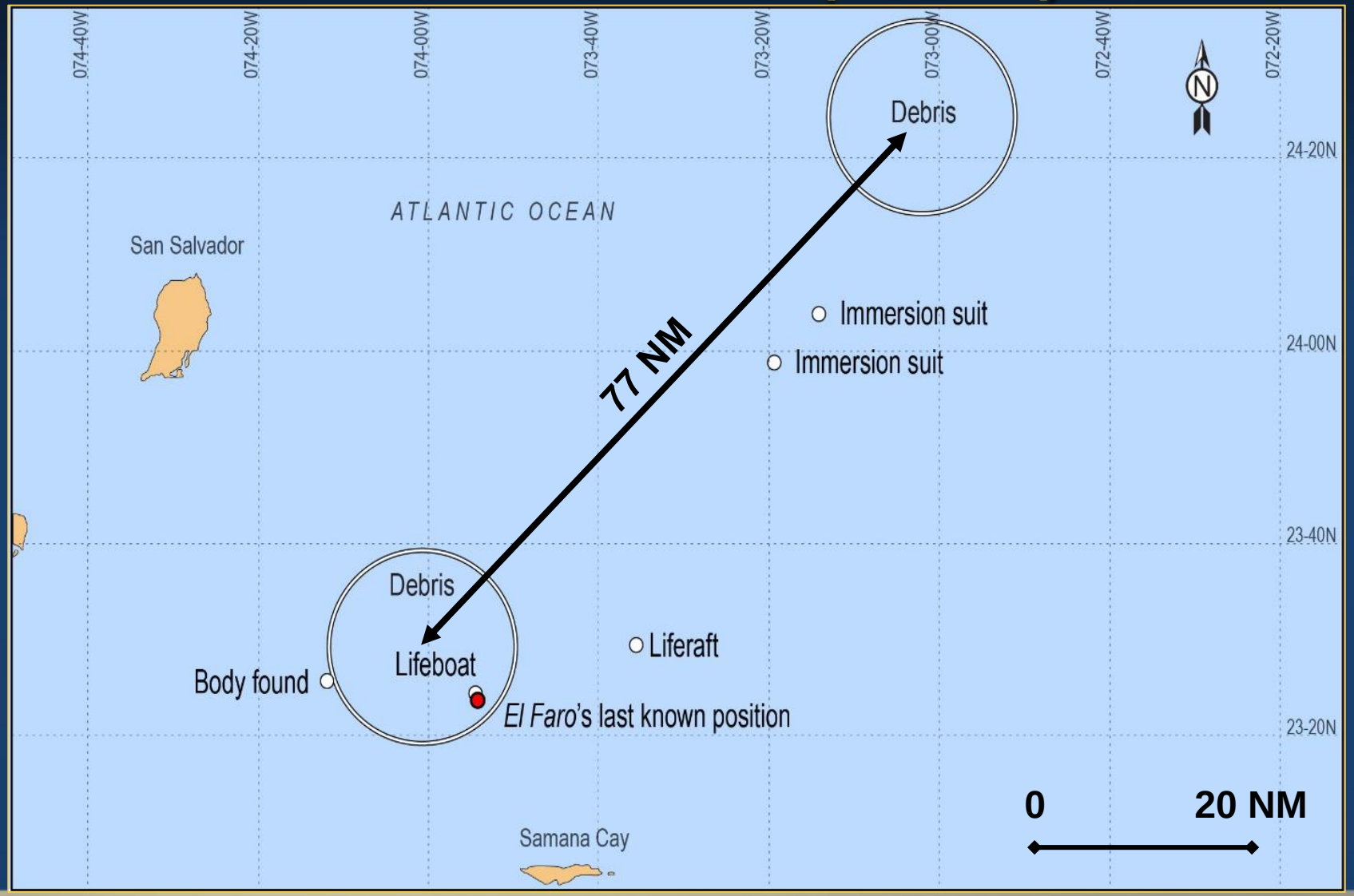
Emergency Position Indicating Radio-Beacon (EPIRB)

- *El Faro*'s EPIRB
  - Detected at 0736
  - Location not determined
- GPS-enabled EPIRB – sends an accurate position with the first transmission
- *Lady Mary* accident in 2009
  - 6 of 7 crew perished
  - Delayed sending SAR assets

Personal Locator Beacons (PLBs)

- Portable
  - Small manual EPIRB
- GPS input capable
- *Trinity II* accident in 2011
  - Crew evacuated
  - 3 days to rescue
  - Drifted 150 miles
  - 4 of 10 crew lost

Personal Locator Beacons (PLBs)



Survival Craft – Open Lifeboats

- 1980s: recognized as inadequate
- Does not protect crew from elements
- Not allowed on new vessels since 1986
- Allowed to remain if maintained

Open Lifeboats

Enclosed Lifeboats

Side-launched

Stern-launched Freefall

Inflatable Liferafts

Stowed Liferafts

Inflated Liferaft

Inflatable Liferafts

- Survivors swim to liferaft through
  - Floating containers
  - Mountainous seas
  - Sea-foam from winds
- Then board liferaft

Review of Regulatory Standards

- Major modification/conversion
  - Opportunities to update
- No modifications – no review
- Advances in lifesaving benefits crew

Review of Regulatory Standards

- Average vessel lifespan is 20 to 30 years
  - El Faro was 40 years old
  - Open lifeboats superseded by enclosed 30 years ago
- To review and upgrade – 5 years or an important regulatory or class event
- Maximum 20 years to upgrade to new standards

Summary – Survival Factors

- Findings
- Recommendations


MAKING TRANSPORTATION SAFER
NATIONAL TRANSPORTATION SAFETY BOARD
E PLURIBUS UNUM
1967
2017
YESTERDAY ★ TODAY ★ TOMORROW

National Transportation Safety Board

Electronic Data and Audio

Sean Payne
Electronic Data and Audio Group Chairman

Overview

- Voyage data recorder (VDR) transcription issues
- Inadequate performance testing for VDRs
- Global maritime distress and safety system (GMDSS) user entered position errors
- Automatic identification system (AIS) emerging standards

Voyage Data Recorder Audio Quality

- Poor audio quality prevented a complete transcription
  - Use of monoaural audio channels to record multiple microphones
  - Noise pollution
  - Microphone placement

VDR Annual Performance Testing

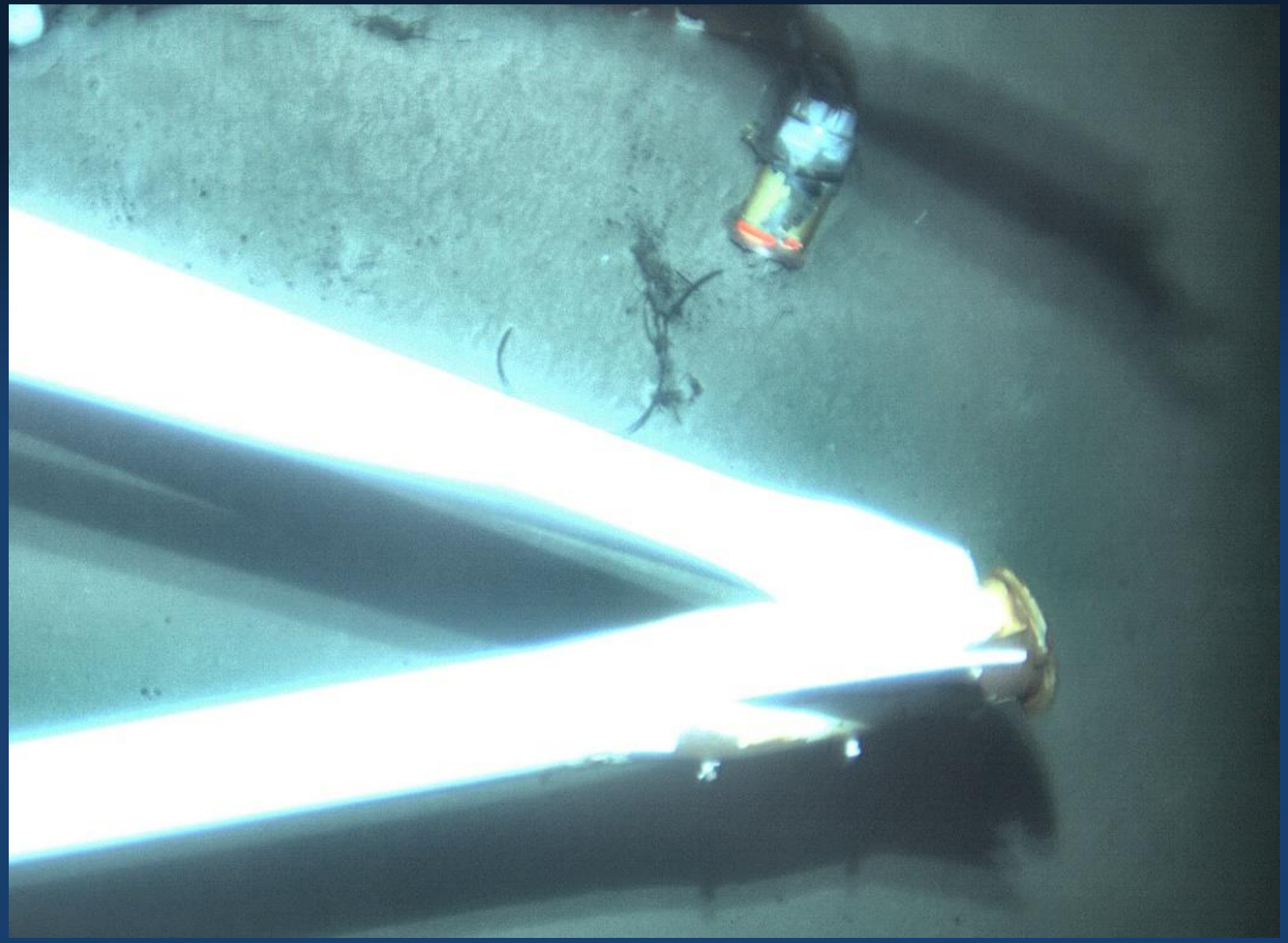
- Inadequate annual performance testing
  - IMO definition of “normal operations” inadequate
  - Ability of VDR audio system to perform while the ship is underway at sea, using main source of propulsion

Recording of Internal and External Ship's Communications

- Internal communications not recorded
  - Calls to/from engine room
  - Calls to/from the captain's stateroom
  - Calls to/from other portions of the ship
- External (VHF) communications not recorded
  - *El Faro* VHF radio recorded through ambient noise

VDR Annual Performance Testing

- Expired locator beacon battery
- VDR capsule recovery hampered

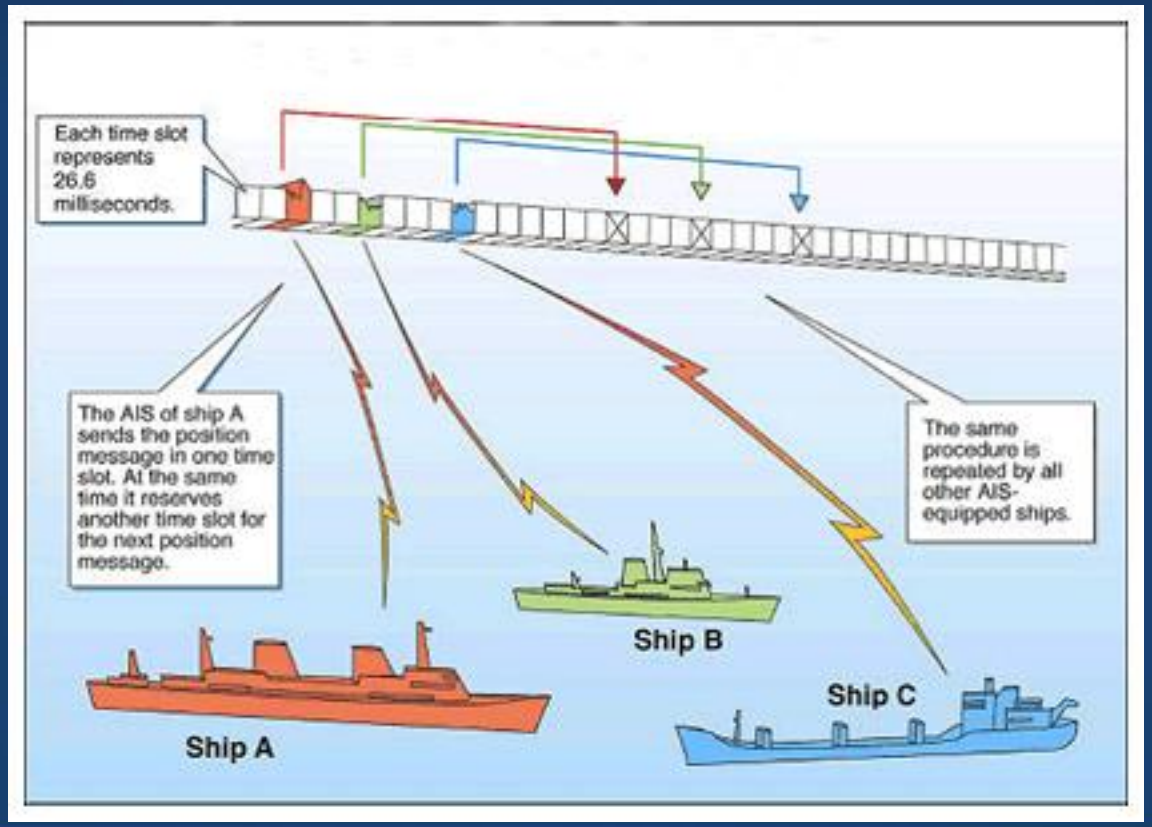


GMDSS Formatting Issues

- GMDSS – Global maritime distress and safety system
  - Inmarsat-C distress alert interface
  - User modifiable distress position
  - System does not update distress position at time of sending

Expanding AIS – Benefits and Limitations

- Automatic identification system (AIS) can be overloaded with application specific messages (ASM)



Expanding AIS – Frequency Allocation

- Effort to separate AIS and ASM messages under VHF data exchange system (VDES)
- VDES frequencies not allocated by United States
- Frequencies currently licensed by private corporation
- License will expire in 2018

Summary – Electronic Data and Audio

- Findings
- Recommendations

National Transportation Safety Board

Onboard Weather Information
Weather Reporting from Vessels

Mike Richards
Meteorology Group Chairman

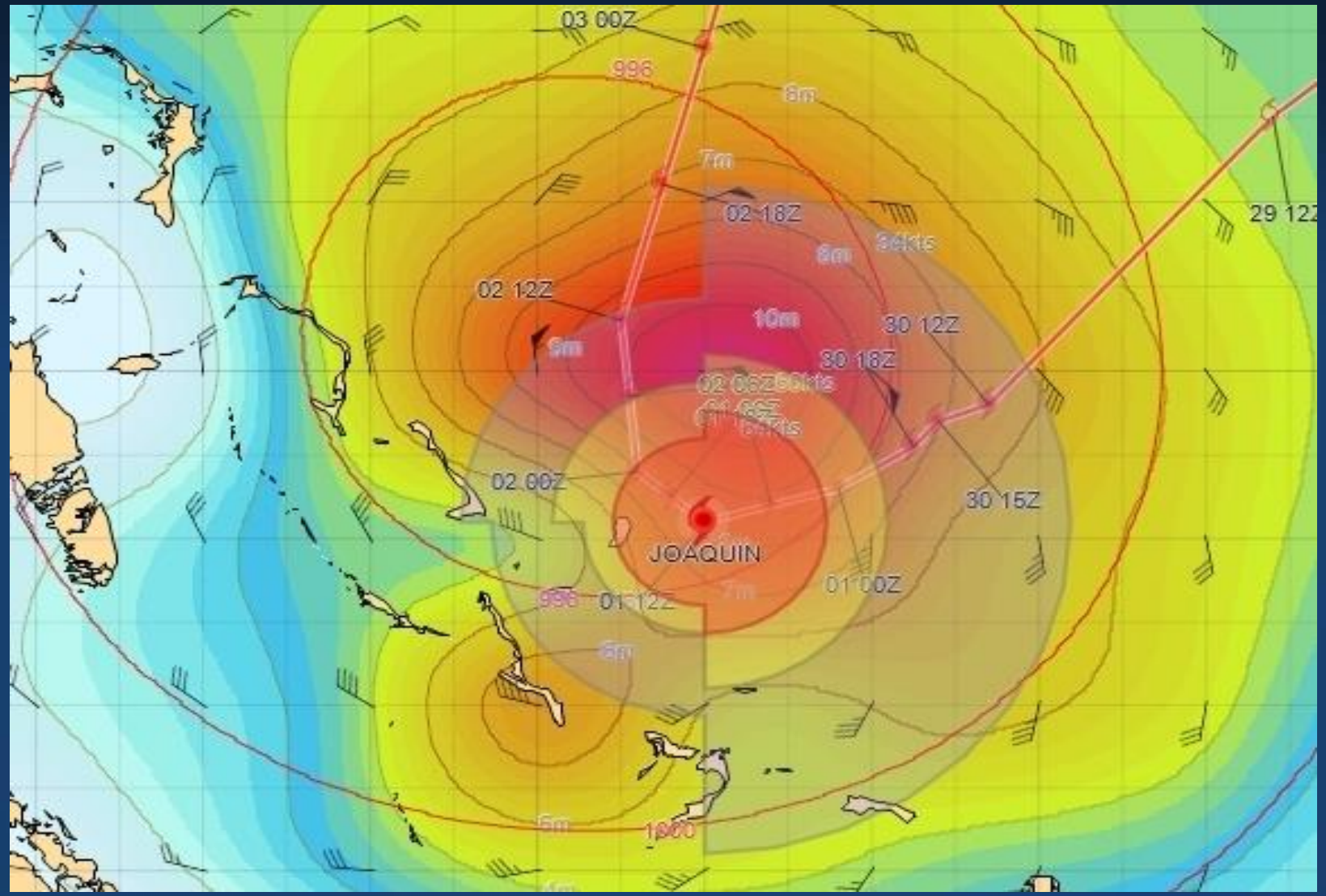
Onboard Weather Information

- Primary sources of weather guidance:
  - SAT-C
  - BVS
- Different delivery methods
- Different formats
- Conflicting information on storm location

SAT-C

```
EGC Message  --- MET Navarea Warning or MET Forecast ---
Message Sequence No. : 12704
LES                  : Vizada (NOR)
Priority             : Urgent
Size                 : 2191 characters
Receive Date & Time  : 16-10-16  20:46 (UTC)

Eik LES 16-OCT-2016 20:44:15   069791


NTNT25 KNHC 162043
TCMAT5 AOW 2043

HURRICANE NICOLE FORECAST/ADVISORY NUMBER  51
NWS NATIONAL HURRICANE CENTER MIAMI FL       AL152016
2100 UTC SUN OCT 16 2016

THERE ARE NO COASTAL WATCHES OR WARNINGS IN EFFECT.

HURRICANE CENTER LOCATED NEAR 39.7N  45.6W AT 16/2100Z
POSITION ACCURATE WITHIN  30 NM

PRESENT MOVEMENT TOWARD THE NORTHEAST OR  45 DEGREES AT   8 KT

ESTIMATED MINIMUM CENTRAL PRESSURE  960 MB
EYE DIAMETER  70 NM
MAX SUSTAINED WINDS  70 KT WITH GUSTS TO  85 KT.
64 KT....... 60NE  80SE  80SW  70NW.
50 KT.......130NE 150SE 180SW 130NW.
34 KT.......380NE 330SE 330SW 380NW.
12 FT SEAS..480NE 660SE 960SW 720NW.
WINDS AND SEAS VARY GREATLY IN EACH QUADRANT.  RADII IN NAUTICAL
MILES ARE THE LARGEST RADII EXPECTED ANYWHERE IN THAT QUADRANT.

REPEAT...CENTER LOCATED NEAR 39.7N  45.6W AT 16/2100Z
AT 16/1800Z CENTER WAS LOCATED NEAR 39.4N  45.9W

FORECAST VALID 17/0600Z 40.5N  44.5W
MAX WIND  65 KT...GUSTS  80 KT.
64 KT... 60NE  80SE  80SW  70NW.
50 KT...130NE 150SE 180SW 130NW.
34 KT...400NE 360SE 360SW 420NW.

FORECAST VALID 17/1800Z 42.6N  42.5W
MAX WIND  65 KT...GUSTS  80 KT.
64 KT... 50NE  70SE  70SW  60NW.
50 KT...130NE 150SE 160SW 110NW.
34 KT...420NE 400SE 380SW 480NW.

FORECAST VALID 18/0600Z 46.3N  39.6W...POST-TROP/EXTRATROP
MAX WIND  65 KT...GUSTS  80 KT.
64 KT... 50NE  70SE  70SW  60NW.
50 KT...130NE 140SE 120SW  90NW.
34 KT...450NE 450SE 400SW 550NW.

FORECAST VALID 18/1800Z 51.3N  37.3W...POST-TROP/EXTRATROP
MAX WIND  65 KT...GUSTS  80 KT.
50 KT...130NE 130SE  80SW  60NW.
34 KT...480NE 510SE 430SW 650NW.

FORECAST VALID 19/1800Z 59.6N  32.7W...POST-TROP/EXTRATROP
MAX WIND  55 KT...GUSTS  65 KT.
50 KT...120NE 240SE   0SW   0NW.
34 KT...360NE 400SE 420SW 600NW.
```

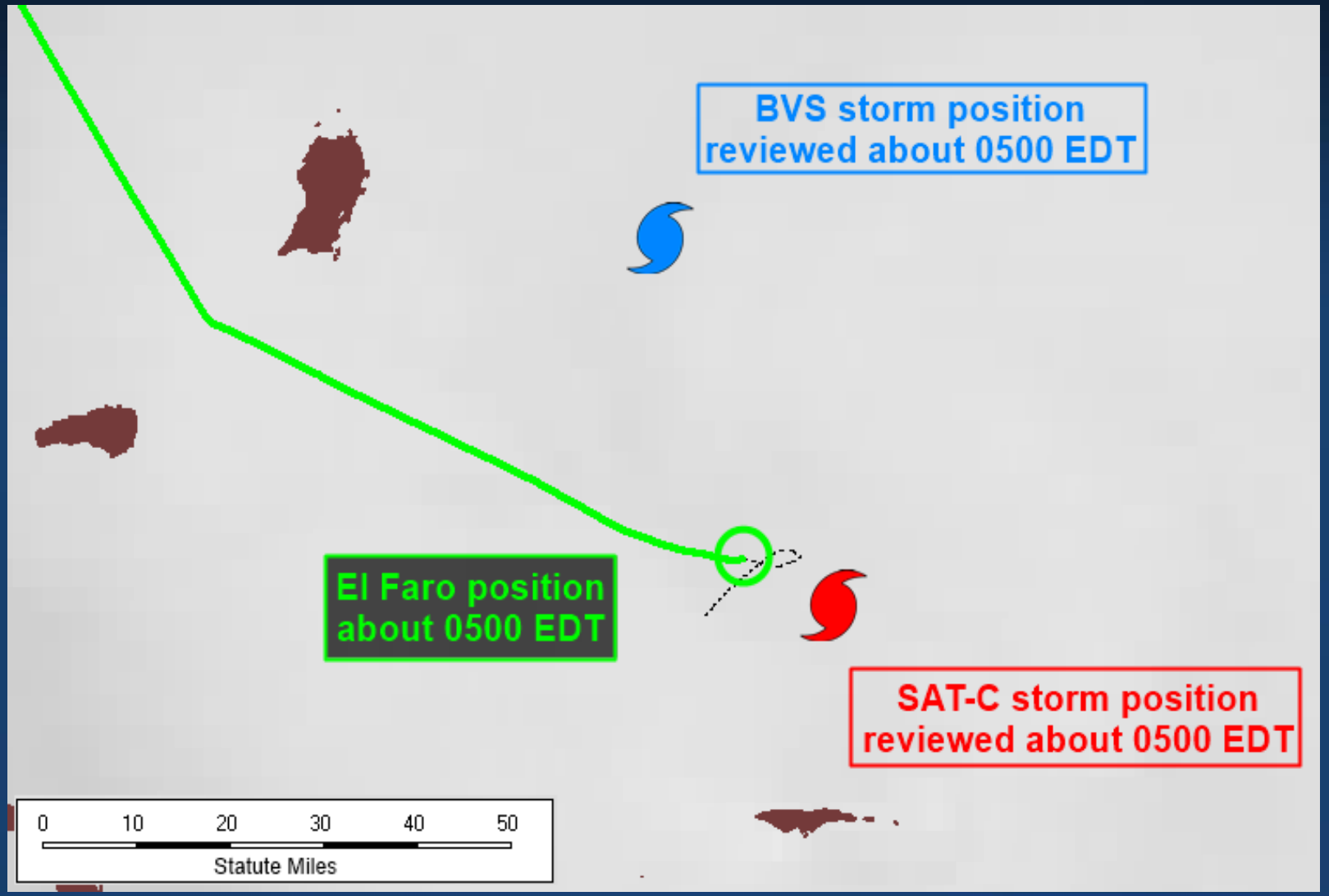
BVS



Onboard Weather Information

- BVS provided a storm position and forecast track 6 hours behind SAT-C
- Old storm information was due to processing limitations at the vendor
- Mitigation options were published by the vendor but not acted upon

Onboard Weather Information Delay



Weather Reporting from Vessels

- In June 2017, NTSB issued 10 recommendations to NOAA, National Weather Service, and the Coast Guard
  - Addressed tropical cyclone forecasting and weather products for mariners
  - Staff is currently reviewing addressee responses
- Additional findings regarding weather reporting from vessels at sea to improve mariner safety

Summary – Weather Reporting from Vessels

- Findings
- Recommendations

National Transportation Safety Board

Human Performance Factors

Carrie Bell
Human Factors Group Chairman

Overview

- Bridge resource management
- Company oversight
  - Safety management system
  - Training
  - Safety culture
- Coast Guard training
  - Bridge resource management
  - Meteorology

Captain's Experience

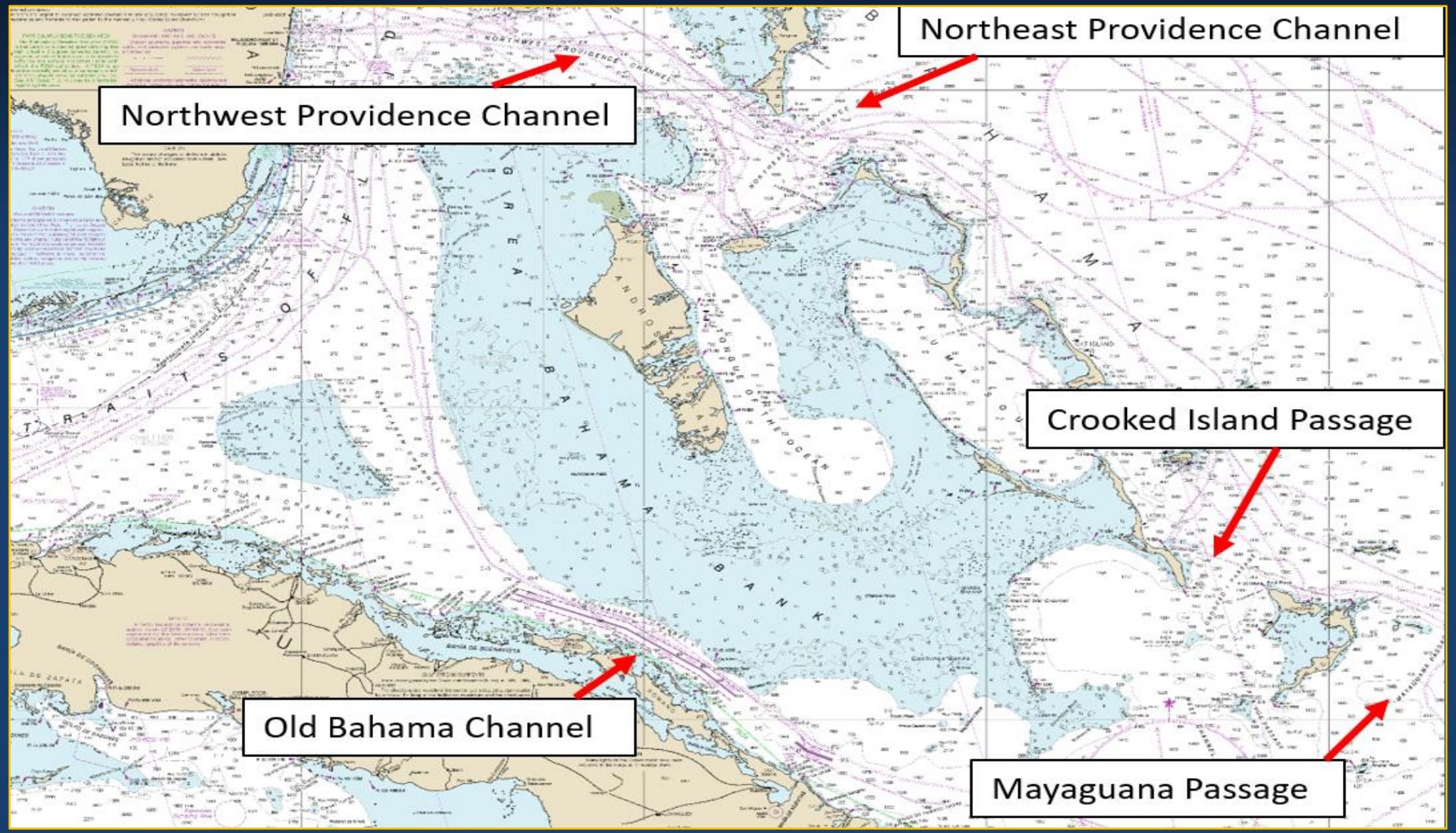
- All officers were qualified and credentialed mariners
- Captain
  - 24 years of experience
  - 6 years with TOTE
  - In May 2014, named captain of *El Faro*
- Captain's responsibilities
  - Safe operation and navigation
  - Company's representative on board

Officers' Experience

- Deck Officers
  - Captain, chief mate, second mate, third mate
- Experience
  - Deck: Employed at TOTE for over 10 years
  - Sailed primarily on same route
  - Chief mate was newest member of team
- Engineering Officers
  - Chief, 1st, 2nd, three 3rd engineers
  - Senior engineers 6–12 years experience with TOTE steam ships

Opportunities to Change Course

Passages Available along *El Faro*'s Route



Captain’s Reluctance to Change Course

- Why did the captain not take action against the impending danger?
  - Experience
  - Normalization of risk
    - Experience can cloud judgement
  - Confirmation bias
    - Ignore information that conflicts with beliefs

Crew's Reluctance to Challenge Captain

- Why did the crew not challenge the captain?
  - Confidence in his abilities
    - Reluctant to question
  - Hierarchical structure
    - Power distance
  - Poor implementation of BRM
    - Starts at leadership level

Bridge Resource Management

- Effective BRM
  - Cohesive team
  - Manages risk and maintains shared mental model
  - Cooperatively monitors vessel progress
  - Acquires and exchanges information
  - Anticipates dangerous situations
  - Open environment to challenge

Bridge Resource Management

- Power Distance
  - Unequally distributed power between officers
  - Can be created by hierarchy
  - Subordinates do not feel empowered to challenge
  - Often characterized by mitigated speech

Bridge Resource Management Effectiveness

- Assertiveness
  - Challenging in a hierarchical environment
  - Fear of reprimand
  - Uncertain outcome of the situation
  - Reluctance to speak up

Bridge Resource Management Summary

- Loss of situation awareness
  - Inability to have shared mental model
- Limited information passed between watch officers
- High power distance

Company Oversight

- Preparing crew for heavy weather
- Monitoring ships at sea
- Shoreside communications with *El Faro*
- Training
- Assessment of officer performance

Safety Management System

- Did not address securement of cargo
  - Lashings, watertight doors, and hatches
- Lack of heavy weather checklists
- Minimal guidance for preparing crew for heavy weather

Safety Management System

- Communication with vessel during accident voyage was minimal
  - Two routine voyage messages
  - E-mail requesting change to northbound voyage
- Risk to vessel on this voyage was not addressed

Safety Management System

- Bridge Resource Management
  - Quarterly BRM training required onboard
  - BRM section marked “deleted” in SMS
  - Company did not follow through to ensure training was completed

Company Oversight

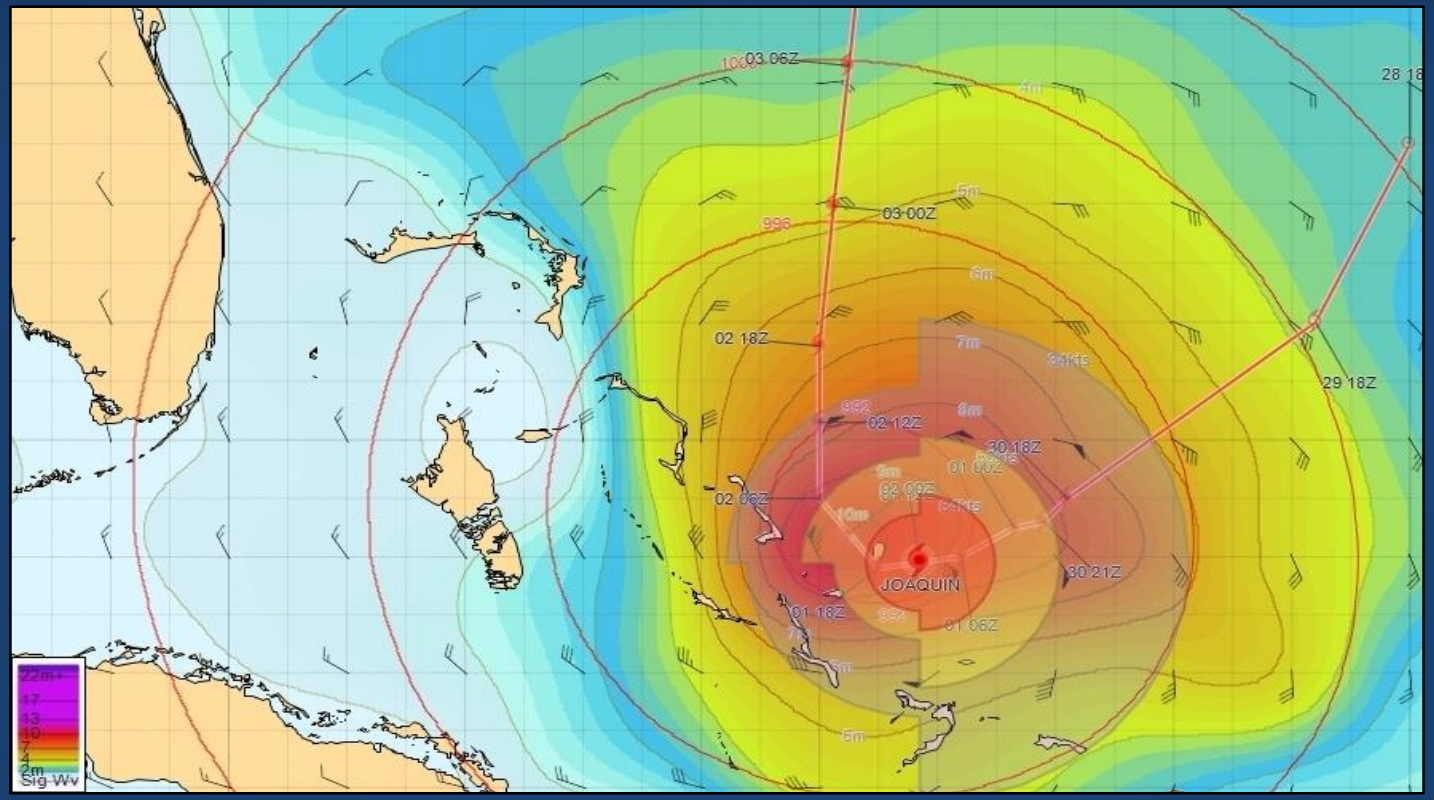
- No training department
  - Various training logged in separate departments
- Scenarios not specific to heavy weather
  - Shoreside drills did not include flooding
- Minimal accountability of work/rest records

Company Oversight

- Evaluating officer performance
  - Measurement of competency
  - Incomplete performance evaluations
  - Personnel files not comprehensive
    - No documentation of known issues
    - Statements from management not reflected
    - No background on resignation with previous employer

Bon Voyage System (BVS) Training

- No requirement for formal training in weather information provided on bridge



Safety Culture

- Oversight not adequate
- Ineffective training
- No support for storm avoidance and heavy-weather preparations
- No risk assessment

Training

- Bridge resource management
  - Recurrent training
    - Updated concepts
    - Allow for lessons learned
  - Enhance course to include scenario-based training
- Advanced meteorology and shiphandling
- Captain was exempted

Summary – Human Performance Factors

- Findings
- Recommendations

National Transportation Safety Board

Captain's Decision-making and Actions

Michael J. Kucharski
Nautical Group Chairman

Overview

- Decisions and actions
  - Leaving port
  - Original route
  - Sufficiency of weather information
  - Reliance on outdated information
  - Storm avoidance
  - Late mustering and abandoning ship

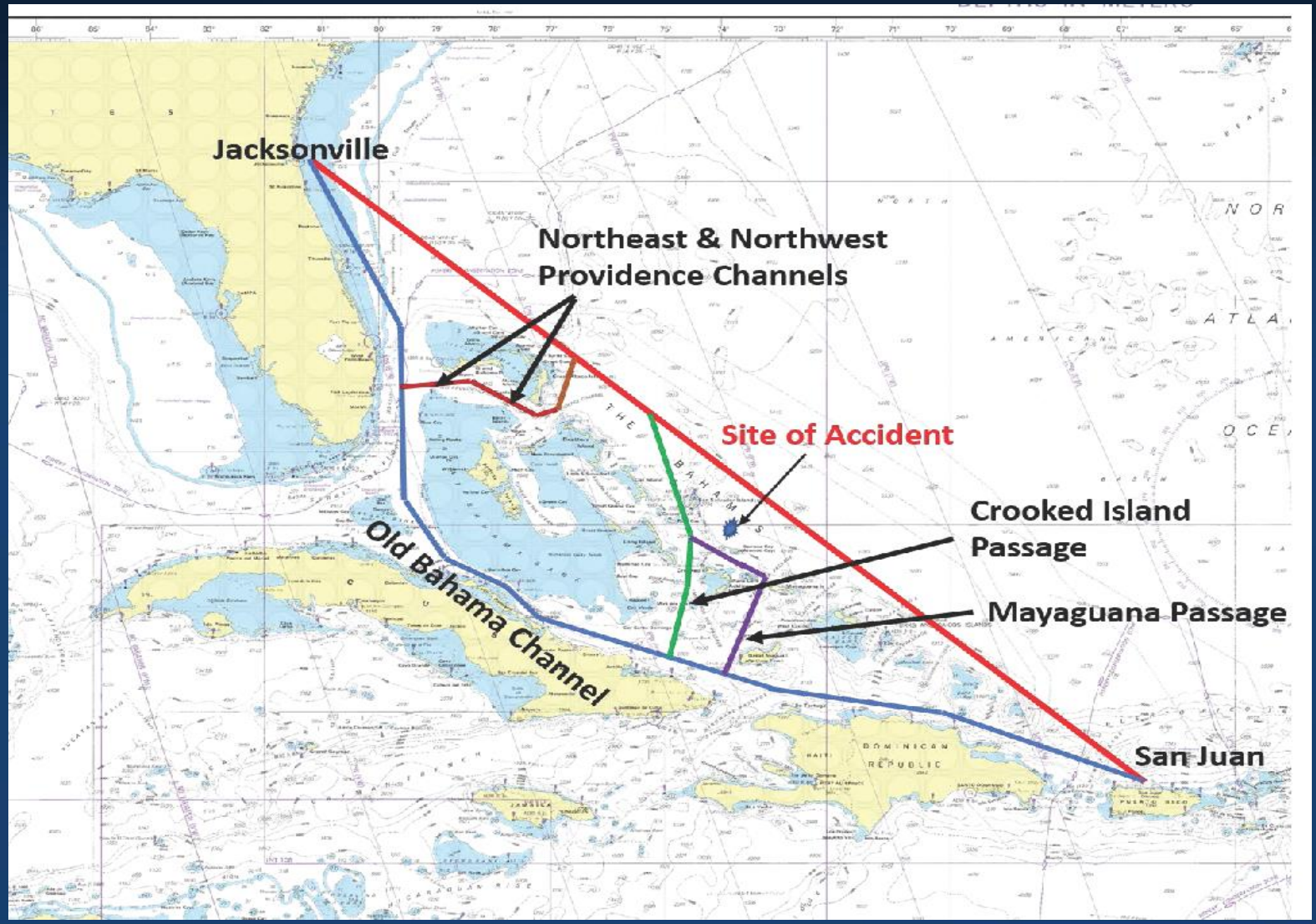
Overview

- Tools to assist in decision-making
  - Stability instrument training
  - Rapid Response Damage Assessment training
  - Anemometer
  - Company support for storm avoidance and preparation

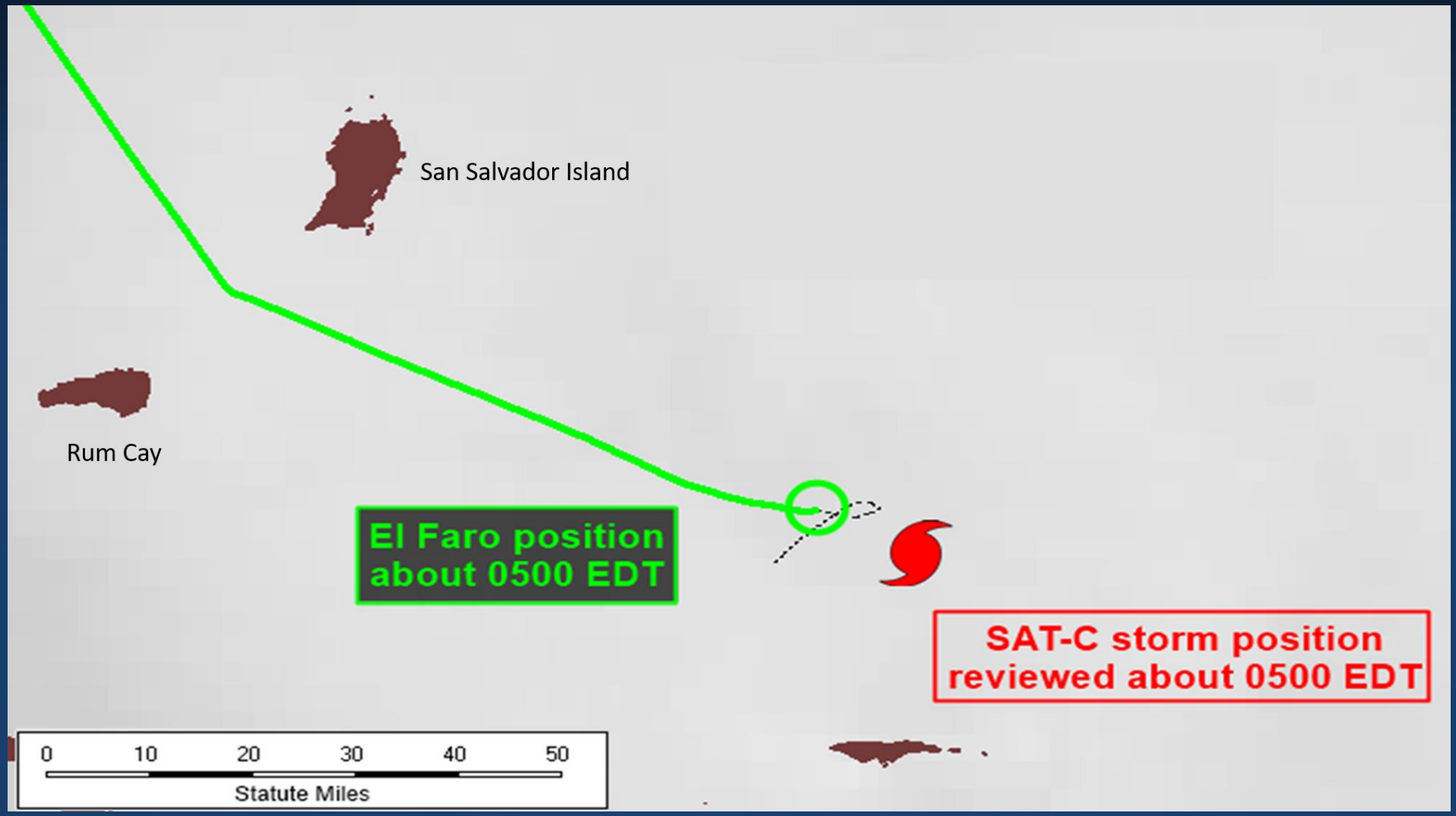
Captain's Decisions and Actions

- Leaving port was reasonable
  - Low risk
  - Options available
- Original passage plan brought vessel into storm's path
- Vessel received sufficient weather information
- The captain did not use up-to-date weather information

Routes from Jacksonville to San Juan



Actual Track of *El Faro*



Captain’s Decisions and Actions

- Storm Avoidance
  - Brought vessel close to hurricane eye
  - Put crew in peril
- Late decision to muster and abandon ship
  - Events should have prompted mustering
  - Late mustering and abandoning reduced possible mitigation attempts and survival

Tools to Assist in Decision-making

- Training for onboard tools – stability instrument and Rapid Response Damage Assessment (RRDA)
- Properly working anemometer
- Weather routing service

Tools to Assist in Decision-making

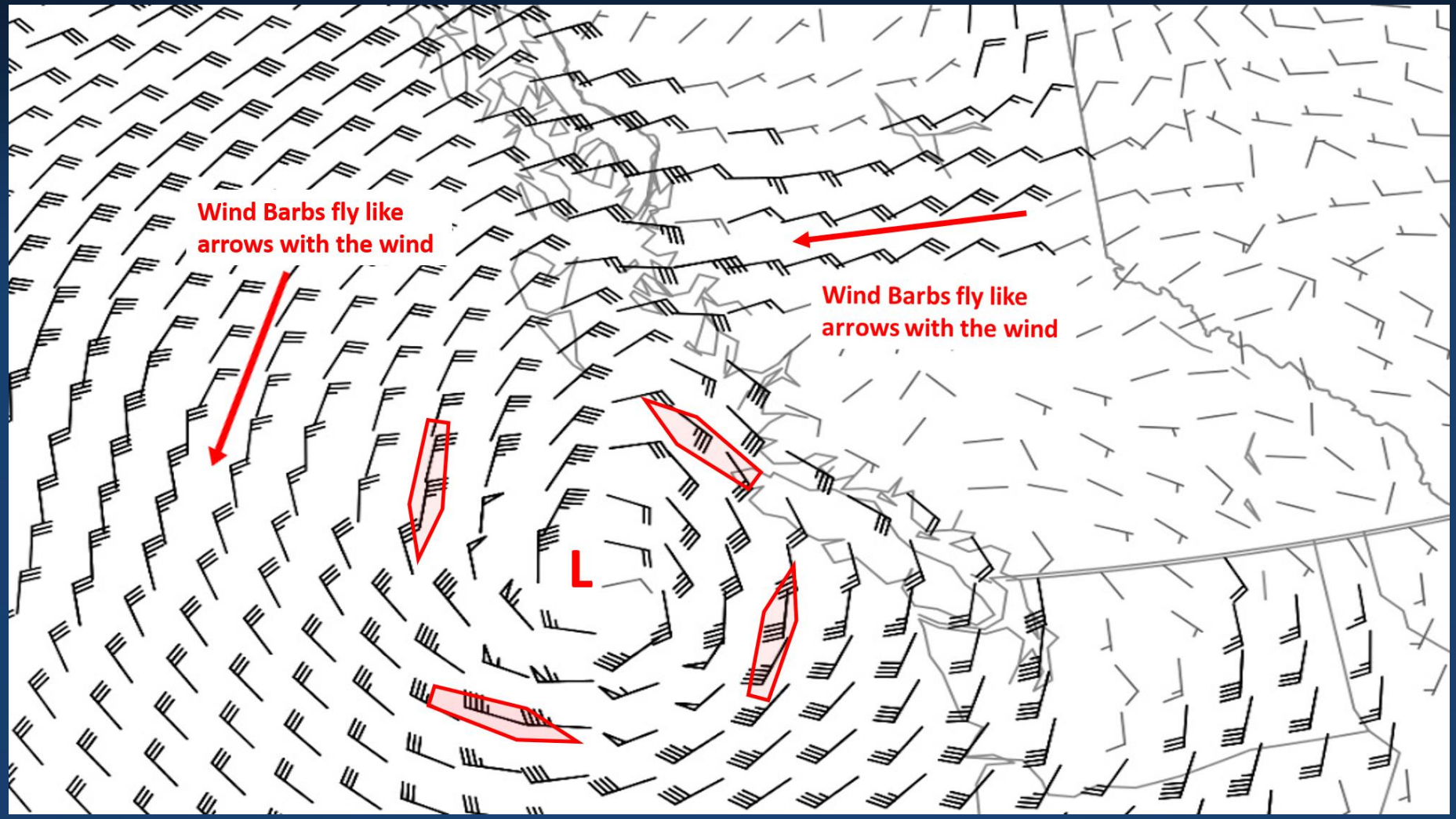
- Training in the use of onboard tools
  - Stability instrument training
  - Rapid Response Damage Assessment Service (RRDA) training

El Faro Anemometer Wind Sensors

Tools to Assist in Decision-making

- Anemometer
  - Wind direction and shift are best guides to a storm's position and movement
  - Crew statements about "white out" conditions
  - *El Faro* did not have a properly functioning anemometer

Locating the Low



Tools to Assist in Decision-making

- Storm avoidance and heavy-weather support
  - Monitoring and contacting vessel
  - Providing contracted weather routing service
  - Heavy-weather support through dialogue and policy

Summary – Captain's Decision-making and Actions

- Findings
- Recommendations


MAKING TRANSPORTATION SAFER
NATIONAL TRANSPORTATION SAFETY BOARD
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