Forensic Regulatory Stability Analysis

F/V SCANDIES ROSE Sinking

Andrew Lawrence, P.E.

Presentation Outline

- Education and Background
- Regulatory Stability (46 CFR Subchapter C)
  - Computer Modeling
  - Stability Test
  - Loading Condition Evaluation
- Conclusions
  - Computer Modeling Differences
  - Stability Test Differences from 1988 to 2019
  - Sample Loading Condition Evaluations
  - Casualty Loading Condition Evaluation
  - Regulatory Icing

Background and Education

- Naval Architect Advisor of the Salvage Engineering Response Team (SERT) at USCG Marine Safety Center
- Licensed Professional Engineer of Naval Architecture and Marine Engineering in the Commonwealth of Virginia and Washington State
- Commercial marine salvage experience including fishing vessel salvage projects throughout the PNW and Alaska
- Previous USCG experience as Staff Naval Architect at Marine Safety Center and on USCG Icebreaker
- M.S. Mechanical Engineering (Pennsylvania State University)
- B.S. Mechanical Engineering (USCG Academy)

Regulatory Stability for Commercial Fishing Vessels

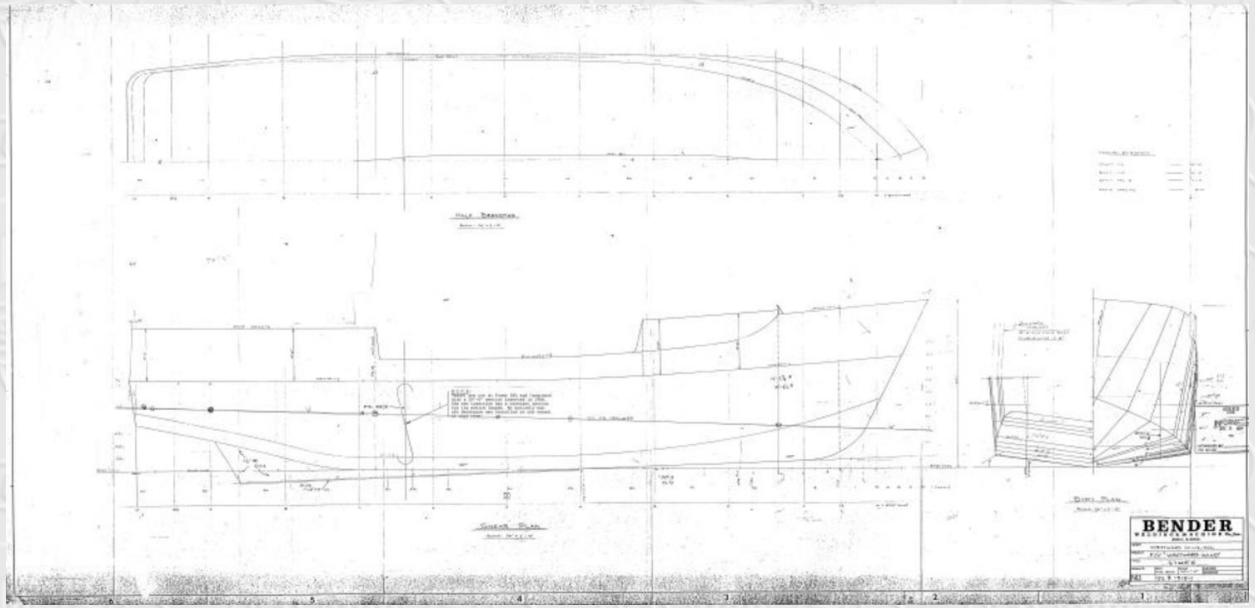
- Stability Requirements in 46 CFR Part 28, Subpart E
  - Calculations completed by a "Qualified Individual" selected by the owner (§28.505 and §28.510)
  - Establish weight and center of gravity of the ship through an inclining test (§28.535)
  - Evaluate all conditions of operation and loading for:
    - §28.565 Water on Deck
    - §28.570 Intact Righting Energy
    - §28.575 Severe Wind and Roll
  - Coast Guard review of these calculations is not required by the regulations. All MSC work described here is post-casualty, as requested by the Marine Board of Investigation

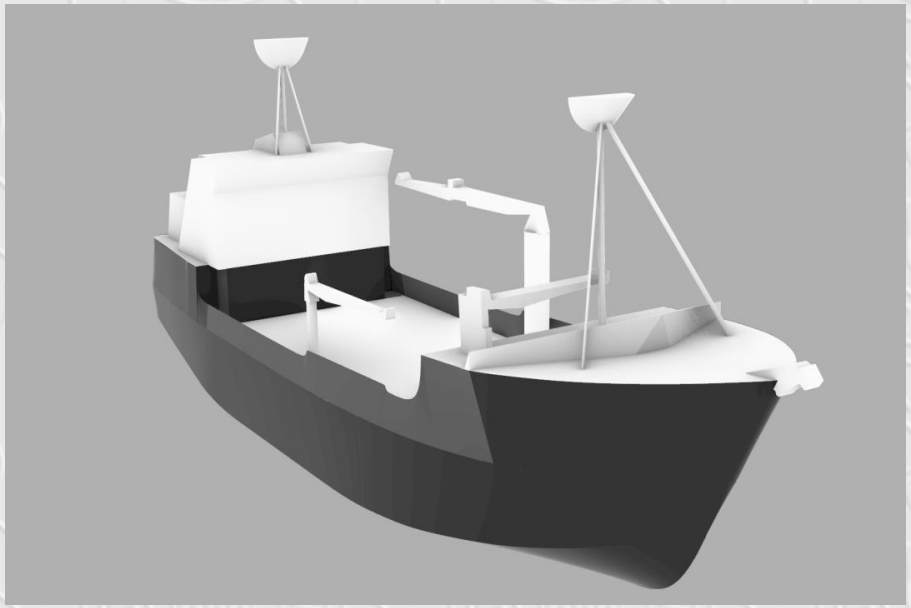
Regulatory Stability for Commercial Fishing Vessels

- Stability Requirements in 46 CFR Part 28, Subpart E
  - To complete these required calculations, the procedure is:
    1. Computer Modeling
    2. Inclining (Stability) Test
    3. Evaluate Operating Conditions and Develop Stability Instructions

Regulatory Stability: Computer Modeling

- Buoyant Volumes Modeled from Lines Plan
- Tanks Modeled from Tank and Capacity Plan
- Windage Modeled from Profile Drawings or Pictures





Regulatory Stability: Stability Test

- Used to define ship's light weight and center of gravity
- Recommended to use ASTM F 1321: "Standard Guide for Conducting a Stability Test"
- Occurs in two parts:
  - Lightweight (Deadweight) Survey
    - Identification of weights onboard that are fixed vs. variable
    - Physical measurement of vessel drafts and freeboards to calculate weight and longitudinal center of gravity
  - Inclining Experiment
    - Shifting of weights to make the ship heel over
    - Measurement of heel angles to establish vertical center of gravity
- For small ships, self-weight is usually the largest weight

Regulatory Stability: Operating Conditions

- "Stability instructions which provide the master or individual in charge of the vessel with loading constraints and operating restrictions which maintain the vessel in a condition which meets the applicable stability requirements of" 46 CFR Part 28, Subpart E

Required Criteria:

- Stability with Water on Deck
- Intact Stability
- Severe Wind and Roll Stability

Prescribed Constraints:

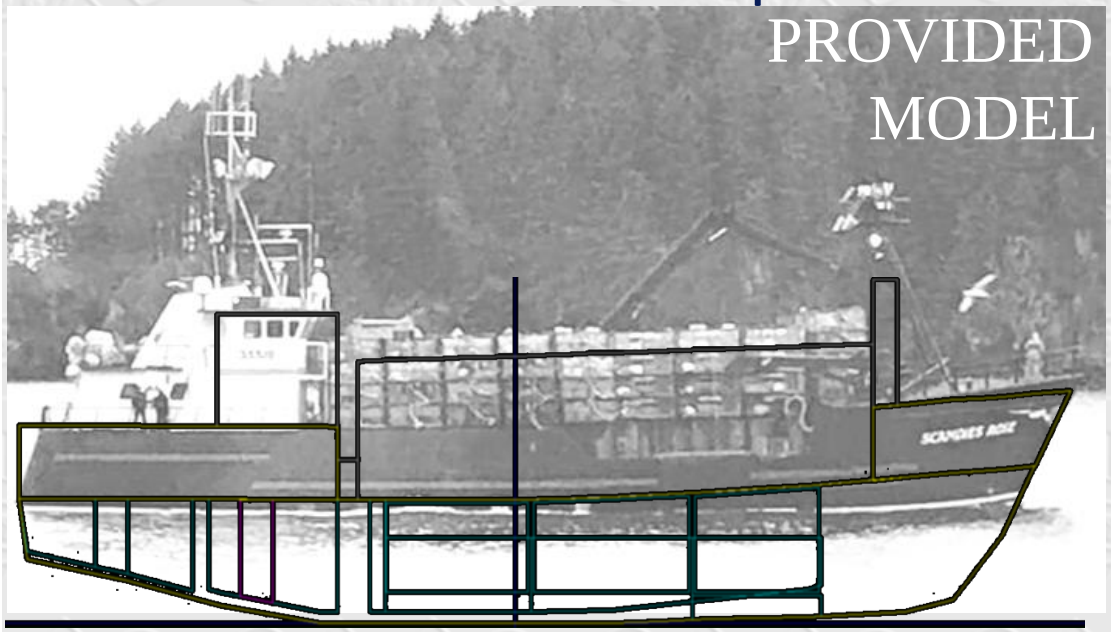
- Free Surface Effect in Tanks
- Icing Loads
- Size of Freeing Ports
- Watertight Integrity

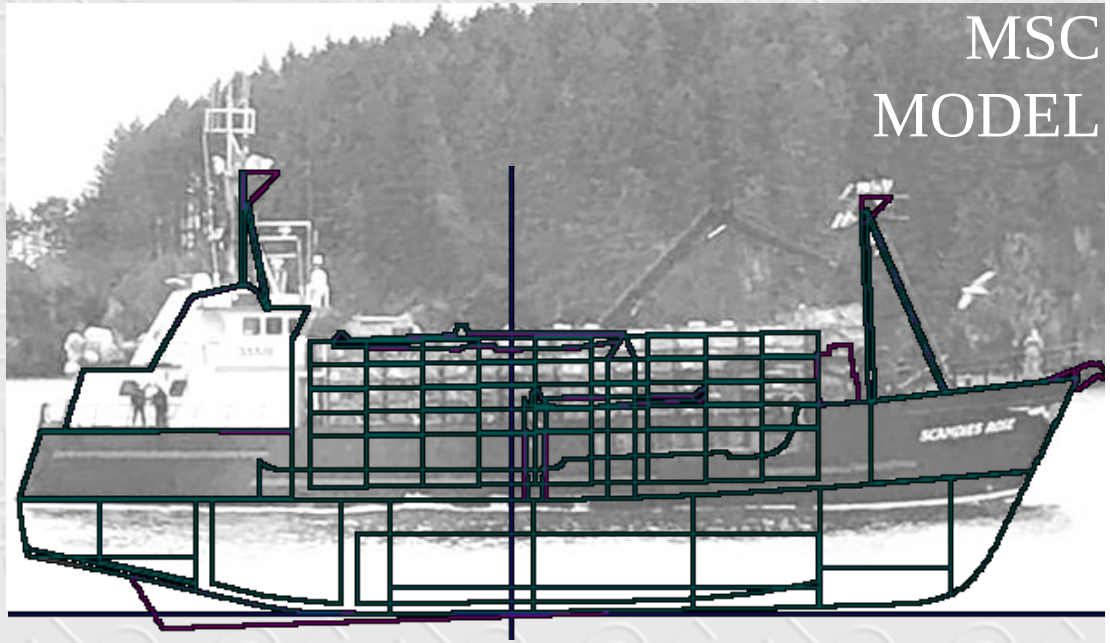
SCANDIES ROSE: Forensic Regulatory Analysis Approach

1. Created hull model from available documents and pictures
2. Used available stability test notes from 1988 and 2019 to calculate weight and center of gravity
3. Evaluated each loading/operating condition from the 1988 and 2019 stability instructions as well as two estimated casualty voyage conditions using regulatory criteria
4. Results are compared to provided documentation prepared for SCANDIES ROSE and Stability Instructions to SCANDIES ROSE's Master

SCANDIES ROSE: Modeling Comparison/Conclusions

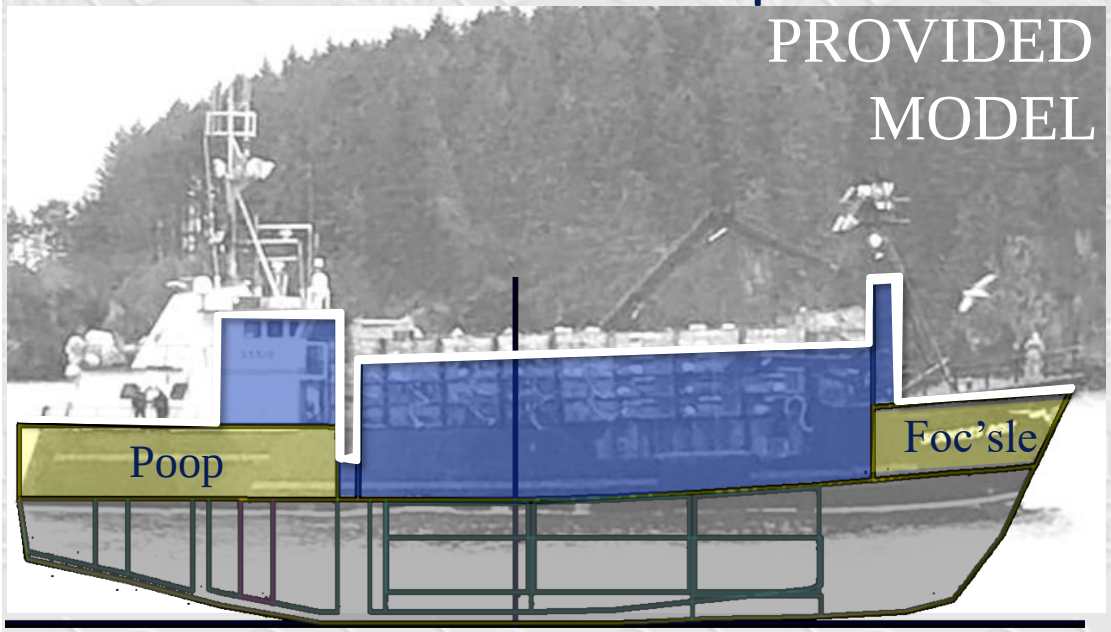
1. SCANDIES ROSE's computer model does not match created model or provided documentation:

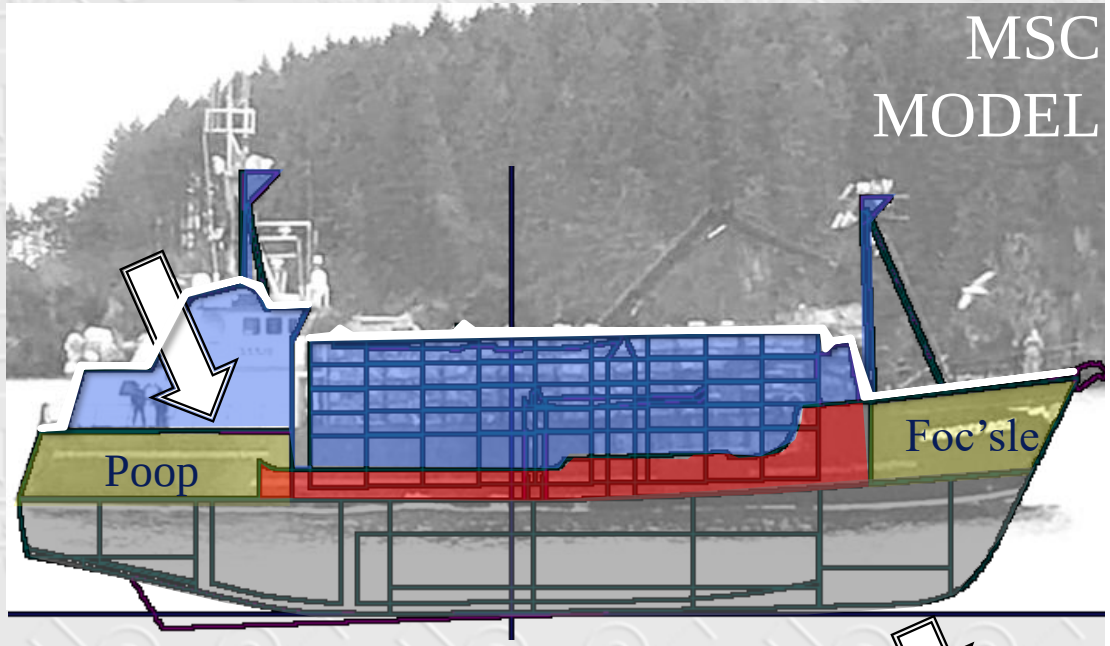




SCANDIES ROSE: Modeling Comparison/Conclusions

1. SCANDIES ROSE's computer model does not match created model or provided documentation:





a. Poop and Forecastle Volumes
b. Bulwarks not Modeled
c. Windage
d. No Downflooding Points
e. Icing Surface Area
f. Tank Capacities

SCANDIES ROSE: Stability Test Comparison/Conclusions

2. Provided stability test data and documentation do not support weight and centers of gravity used in stability analysis.

1988 Stability Test Results	1988 Culver	1988 MSC	Difference
Lightweight (Long Tons)	485.35	392.57	MSC 93 LT Lighter
Vertical Center of Gravity (Feet abv Baseline)	14.09	14.63	MSC 6 inches Higher
Longitudinal Center of Gravity (Feet Aft of Amidships)	10.74	7.41	MSC 3 ft 4 inches Fwd

2019 Stability Test Results	2019 Culver	2019 MSC	Difference
Lightweight (Long Tons)	548.32	578.33	MSC 30 LT Heavier
Vertical Center of Gravity (Feet abv Baseline)	14.69	15.26	MSC 7 inches Higher
Longitudinal Center of Gravity (Feet Aft of Amidships)	3.30	0.52	MSC 2 ft 9 inches Fwd

SCANDIES ROSE: Stability Test Comparison/Conclusions

2. Provided stability test data indicates excessive weight gain from 1988 to 2019.

1988 Stability Test Results	1988 Culver	1988 MSC
Lightweight (Long Tons)	485.35	392.57

Lightweight Difference (LT)	+62.97	+185.76
Lightweight Difference	+13%	+47%

2019 Stability Test Results	2019 Culver	2019 MSC
Lightweight (Long Tons)	548.32	578.33

SCANDIES ROSE: Stability Analysis Conclusions

3. Analysis of 1988 and 2019 Stability Instructions indicate that many provided 2019 loading conditions fail regulatory stability.

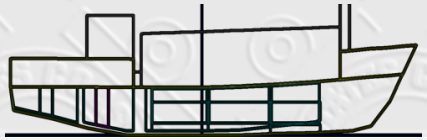
2019 Sample Loading Condition	Hydrostatics Model: / Lightship Characteristics:	Reference (a)		MSC - Small Pots		MSC - Large Pots	
		Ref (b)	MSC	Ref (b)	MSC	Ref (b)	MSC
2019 Stability Book Condition 1: Max Consumables, 208 Small Pots, Holds 2 and 3 full		Fail	Fail	Fail	Fail	Fail	Fail
2019 Stability Book Condition 2: 75% Consumables, 208 Small Pots, Holds 2 and 3 Full		Pass	Fail	Fail	Fail	Fail	Fail
2019 Stability Book Condition 3: 50% Consumables, 208 Small Pots, Holds 2 and 3 Full		Fail	Fail	Fail	Fail	Fail	Fail
2019 Stability Book Condition 4: 25% Consumables, 208 Small Pots, Holds 2 and 3 Full		Pass	Fail	Fail	Fail	Fail	Fail
2019 Stability Book Condition 5: 10% Consumables, 208 Small Pots, Holds 2 and 3 Full		Pass	Fail	Fail	Fail	Fail	Fail
2019 Stability Book Condition 6: Max Consumables, Tendering, All Holds Full		Fail	Fail	Fail	Fail	Fail	Fail
2019 Stability Book Condition 7: 75% Consumables, Tendering, All Holds Full		Pass	Fail	Fail	Fail	Fail	Fail
2019 Stability Book Condition 8: 50% Consumables, Tendering, All Holds Full		Pass	Pass	Fail	Fail	Fail	Fail
2019 Stability Book Condition 9: 25% Consumables, Tendering, All Holds Full		Pass	Pass	Pass	Fail	Pass	Fail
2019 Stability Book Condition 10: 10% Consumables, Tendering, All Holds Full		Pass	Pass	Pass	Fail	Pass	Fail
2019 Stability Book Condition 11: Crabbing, 3 Holds Full, 168 Small Pots		Fail	Fail	Fail	Fail	Fail	Fail

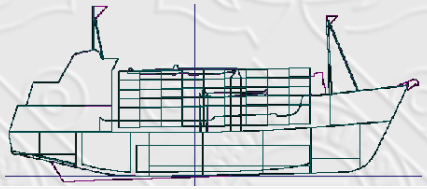
Provided Model – Provided Lightship

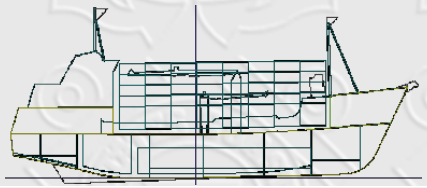
MSC Model

SCANDIES ROSE: Casualty Voyage Analysis Conclusions

4. Casualty voyage loading conditions did not comply with regulatory stability standards while nearly meeting stability instructions (number of pots, freeboard, holds flooded)







2019 Loading Condition	Hydrostatics Model: / Lightship Characteristics:	Reference (a)		MSC - Small Pots		MSC - Large Pots	
		Ref (b)	MSC	Ref (b)	MSC	Ref (b)	MSC
Investigating Officer's Condition 1: 195 Small Pots, Holds 2 and 3 Full. Fuel and Water Full, 20,000lb bait		Fail	Fail	Fail	Fail	Fail	Fail
Investigating Officer's Condition 2: 195 Small Pots, Holds 2 and 3 Full. Fuel and Water Full except #1 WTs, 20,000lb bait		Fail	Fail	Fail	Fail	Fail	Fail

SCANDIES ROSE: Icing Loads in Stability Analysis

5. Actual icing was likely asymmetric and not well represented by regulatory icing standards.

Iced crab pots on SANDRA FIVE (NTSB)

Summary of Conclusions

1. Provided hydrostatics model did not match MSC's model created from available documents and pictures
2. Provided stability test notes from 1988 and 2019 do not support lightweight used in provided analyses. MSC has low confidence in 2019 test accuracy.
3. Provided model and test results could not have accurately analyzed conditions for regulatory stability. MSC analysis indicates many failing loading conditions.
4. MSC analysis indicates that SCANDIES ROSE did not comply with stability criteria for the casualty voyage.
5. Actual icing likely differed from regulatory requirements.