

May 17, 2016

Rear Admiral Paul F. Thomas  
Assistant Commandant for Prevention Policy  
U. S. Coast Guard  
2703 Martin Luther King Jr Ave SE, Stop 7509  
Washington, DC 20593-7509

Subj: Towing Safety Advisory Committee Final Report – Task 14-01  
Review of and recommendations based on the Report of Investigation into the Grounding  
of the Mobile Offshore Drilling Unit (MODU) KULLUK

Dear Admiral Thomas,


I am writing today to forward the final report and recommendations of the Towing Safety Advisory  
Committee for Task Statement 14-01.

The enclosed report was formally approved by the Towing Safety Advisory Committee at the spring  
meeting held in New Orleans, LA on April 14, 2016. The final report complies with the requirements of  
the charge of the committee which was established to make the recommendations to the U. S. Coast  
Guard regarding the ROI into the grounding of the MODU KULLUK.

The Subcommittee Chair, Capt. Eric Johansson, Co-Chair Capt. Michael Vitt and the 22 subcommittee  
members worked very diligently to prepare a very comprehensive report and provided 24 specific  
recommendations to the Coast Guard to improve Towing Safety.

The members of the Towing Safety Advisory Committee greatly appreciate the support and cooperation  
of the U. S. Coast Guard participating and assisting the subcommittee with the Task. We are grateful for  
the chance to provide to the Coast Guard, the thoughtful advice and recommendations from the Towing  
Industry as the Coast Guard conducts its regulatory oversight. Should you have any questions regarding  
the final report or recommendations, please don't hesitate to contact me or Capt. Johansson.

Sincerely,



Steven J. Huttman  
Chairman, Towing Safety Advisory Committee

Encl: (1) Final Report – Towing Safety Advisory Committee Task 14-01

cc: Capt. Eric Johansson, Vice Chair, TSAC & Task 14-01 Chair  
Capt. Michael Vitt, Task 14-01 Subcommittee Co-Chair  
CDR Jose Perez, Designated Federal Officer (DFO) – Towing Safety Advisory Committee  
LCDR William A. Nabach, Alternate DFO – Towing Safety Advisory Committee  
William Abernathy – Alternate DFO – Towing Safety Advisory Committee



## **TOWING SAFETY ADVISORY COMMITTEE**

### **TASK 14-01**

Review of and recommendations based on the Report of  
Investigation Into the Grounding of the Mobile Offshore Drilling Unit  
(MODU) KULLUK

(Short Title: MODU KULLUK ROI)

## **Final Report and Recommendations**

**TOWING SAFETY ADVISORY COMMITTEE**

November 3, 2014

To: Towing Safety Advisory Committee

From: Capt. Eric Johansson, Chair  
Capt. Michael F. Vitt, Co-Chair

RE: Task 1401 “*Review of and recommendations based on the Report of Investigation Into the Grounding of the Mobile Offshore Drilling Unit (MODU) KULLUK*”

At the June 2014 Towing Safety Advisory Intersessional Committee meeting a subcommittee was tasked with providing Review of and recommendations based on the Report of Investigation Into the Grounding of the Mobile Offshore Drilling Unit (MODU) KULLUK

Capt. Mark Grosshans was nominated for Chairman and Capt. Mike Vitt was nominated as Co-Chair of this Subcommittee. TSAC members without dissent approved both nominations.

At the Fall TSAC meeting, September 2014, held in Washington D.C. Chairman Grosshans recused himself as Chair and member of TASK 14-01

Capt. Eric Johansson was nominated as Chairman for TASK 14-01 and approved by the committee without dissent.

Subcommittee participants include TSAC members, industry, and Government Agencies. A complete list of participants is attached as Enclosure (1) to this report.

Respectfully Submitted,



Capt. Eric Johansson

TASK 14-01 Subcommittee Chair

Enclosure: (1) TSAC Representatives & Subcommittee Participants  
(2) Task Statement 14-01  
(3) Sample Tow Procedure Guidelines  
(4) Sample Voyage Planning Guidelines  
(5) Sample Towing Gear Selection Flow Chart

## **1. PLAN OF ACTION (POA)**

- 1.1. Review the Report of Investigation along with supporting information and provide comments and recommendations to the Coast Guard and the industry based on your findings.
- 1.2. Make recommendations regarding additional considerations when towing MODU's in the arctic marine environment.
- 1.3. Evaluate the practice of logging ocean towing operations for MODU's or vessels of a similar nature. Determine the effectiveness of a log being kept detailing the history of each item of the towing equipment utilized for the MODU tow. This includes shackles, towing plates, connector links, bridge chains, surge equipment pendant wires and other towing connections.
- 1.4. Examine and prescribe technical standard and best practices for ocean tows of MODU's or vessels of a similar nature to include towing equipment, identification and logging of the use of this equipment, inspection regimes to include trip-in-tow and warranty surveys and non-destructive testing of towing equipment prior to tows. Development of technical standards should include review of existing primary source standards such as the U.S. Navy Towing Manual.
- 1.5. Examine and prescribe a process for the issuing of tracking certificates that accompany towing hardware. The process of issuing and tracking certificates that accompany towing hardware to include identifying a particular component by a standardized tracking method currently in review in TSAC Task Statement 13-06 - Towing Gear and that product to be formally incorporated and referenced into the KULLUK TSAC 14-01.
- 1.6. Provide a detailed review of towing configurations and tow escorts for MODU ocean tows and development of tow plans in most effective manner.
- 1.7. Evaluate usage and application of strain monitoring devices equipped on towing vessels to determine the recommended procedures to reduce the likelihood of towing equipment failures. Examine the correlation between catenary and the information provided by strain monitoring devices to effectively provide safety in towing operations.
- 1.8. Examine and make recommendations regarding the competencies, roles, responsibilities, authorities and conduct of the Tug Master, and the Tow Master (if separate) for ocean towing of MODU's or other vessels of a similar nature.
- 1.9. Examine and make recommendations regarding the competencies and conduct of the marine warranty surveyor for trip-in-tow or other surveys for ocean towing of MODU's or other vessels of a similar nature.
- 1.10. Make recommendations for the development of a comprehensive process for planning and executing tows, including final tow plans, in a manner compatible with the use of a safety management system (SMS) for ocean towing of MODU's or other vessels of a similar nature.
- 1.11. Provide any other recommendations to the Coast Guard that the Committee feels is appropriate for this subject matter.
- 1.12. Provide an Draft Report no later than Fall 2015

1.13. Submit Final Report not later than Spring 2016.

## **2. ACTION**

- 2.1. Subcommittee review and approved amended TASK
- 2.2. Identify preliminary public documents
- 2.3. Identify collate TASK statement items for sub groups
  - a. *Tow Plans, Voyage Plans, Towing Configurations*
  - b. *Tow Gear – Identification, selection, testing, utilization, monitoring and logging*
  - c. *Tug Master and Tow Master competencies, roles, responsibilities, authorities and conduct*
  - d. *Competencies and conduct of Marine Warranty Surveyor Work*
- 2.4. Identify sub group leaders
  - a. *Tow Procedures, Voyage Plans, Towing Configurations*
    - i. Capt. R. Glas, Sub Group Leader
  - b. *Tow Gear – Identification, selection, testing, utilization, monitoring and logging*
    - i. Bartley Eckhardt, P.E. Sub Group Leader
  - c. *Tug Master and Tow Master competencies and responsibilities*
    - i. Capt. M. Vitt, Sub Group Leader
  - d. *Competencies and conduct of Marine Warranty Surveyor Work*
    - i. Kord Spielmann, Sub Group Leader
- 2.5. Subcommittee meeting, December 2<sup>nd</sup>, 2014 New Orleans, LA
- 2.6. Member and public comments.
- 2.7. Subcommittee meeting, March 23, 2015 Hotel Galt, Louisville KY.
- 2.8. Draft Report presented March 26<sup>th</sup>, 2015, Spring TSAC Meeting
- 2.9. Member and public comments.
- 2.10. Revised Draft Report Summer 2015 Tele-Conference Meeting
- 2.11. Group B Meeting, October 9<sup>th</sup>, 2015
- 2.12. Subcommittee meeting, October 21<sup>st</sup>, 2015
- 2.13. Member and public comments
- 2.14. Interim Final Report and Recommendations to be presented for consideration by Towing Safety Advisory Committee Fall 2015
- 2.15. Member and public comments
- 2.16. Revised Draft Report to be published on U. S. Coast Guard Homeport website for comments.
- 2.17. Final Report and Recommendations Spring 2016.

### **3. DEFINITIONS** (Underline indicates a definition introduced by this Report)

**ALARP** - An abbreviation of the term “As Low As Reasonably Practical (or Practicable)” when referencing a process for assessing the amount of effort and resources that should reasonably be applied to reduce risk. Reducing a risk to a level that is ALARP involves objectively determining the balance where the effort and cost of further reduction measures become disproportionate to the additional amount of risk reduction obtained.

**AHTS** - This is an abbreviation for a towing vessel that is purpose built to tow vessels, handle anchors and act as an offshore supply vessel when not engaged in towing.

**AHT**- This is an abbreviation for a towing vessel that is purpose built to tow vessels and handle anchors but is not generally used as an offshore supply vessel. An AHT vessel may be shorter in length and have less freeboard than an AHTS vessel.

**Attachment Point** - Point of attachment between the tow and the towed vessel. The attachment point transmits the towing load from the towline to the vessel.

**Auto-Render**- The capability of the winch to automatically pay out at a pre-set maximum tension in order to prevent the tension member from exceeding the pre-set tension. See also: Render Recovery

**Automatic Gear or Automatic Tow Winch**- An arrangement on a towing winch that allows the tow cable to pay out and heave in automatically when set at certain tensions.<sup>1</sup>

**Barge** - Means a non-self propelled vessel as defined in 46 U.S.C. 102

**Barge Supervisor** - Means an officer restricted to service on MODUs whose duties involve support to the Offshore Installation Manager (OIM) in marine-related matters including, but not limited to, maintaining watertight integrity, inspecting and maintaining mooring and towing components, and maintaining emergency and other marine-related equipment. A Barge Supervisor, when assigned to a MODU, is equivalent to a mate on a conventional vessel.

**Beaufort Wind Scale** – A numerical scale for indicating wind speed with numbers (or Forces) that range from Beaufort Force 0 (Calm) to Beaufort Force 12 (Hurricane).

**Bollard Pull** - The maximum pulling power that a tug can generate under a static pull.

**Boundary Line** - Marks the dividing point between internal and offshore waters for the purposes of several U.S. statutes and, with exceptions, generally follows the trend of the seaward, high-water shorelines. *See* 46 C.F.R. Part 7.

**Bits** - Metal posts aboard vessels supported in the frames or other substantial structural members below decks to which mooring or towing lines are made fast using either horns or cavals.

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<sup>1</sup> Blank, John S. (1989) Modern Towing, Cornell Maritime Press.

**Breaking Strength (BS)** - The actual or ultimate rated load required to pull a wire, strand, or rope to destruction.

**Breasted Tug** - One or more tugs towing a unit astern with independent tow wires.

**Bridles** - A length of chain or wire extending from the bow of a tow. Usually refers to the rigging of a tow with two legs from the tow's bow to a delta plate.

**Cable** - A heavy wire of great strength. Applications include attachment to anchors and towing.

**Catenary** - The downward curve or sag of a rope, wire, or chain suspended between two points

**Chafing Gear**- Material used to prevent chafing and wear on both the hawser and the tug's structure

**Chafing Pendant (Pennant)** - A length of chain used to reduce chafing or wearing.

**Chain Bridle** - Two legs of chain joined by a delta's plate extending from the bow of a unit towed.

**Chain Pendant (Pennant)** - A single length of chain extending from the stern of a tug used as a towing connection element, usually fitted with an eye at one or both ends.

**Chain Shackle** - A U-shaped fitting with a pin used for chain connections in a towing rig

**Charterer** - Means the person or organization that contract for the majority of the carrying capacity of a ship for the transportation of cargo to a stated port for a specified period. This includes "time charterers" and "voyage charterers."

**Chock** - A heavy smooth-surfaced fitting usually located near the edge of the weather deck through which wire ropes or fiber hawsers may be led.

**Classification Requirements** - Means applicable rules and supplementary requirements of the American Bureau of Shipping, or other recognized classification society.

**Cleat** - An anvil-shaped deck fitting for securing or belaying lines (referred to as a Kevel on Western Rivers).

**Cleat Guard** - A device secured to ends of the cleat to prevent line fouling.

**Closed Spelter Socket** - A wire rope termination.

**Coast Guard** - Means the organization established and continued under section 1 of title 14.

**Coast Guard-Accepted** - Means: (1) That the Coast Guard has officially acknowledged in writing that the material or process at issue meets the applicable requirements; (2) That the Coast Guard has issued an official policy statement listing or describing the material or process as meeting the applicable requirements; or (3) That an entity acting on behalf of the Coast Guard under a

Memorandum of Agreement has determined that the material or process meets the applicable requirements. Per 46 C.F.R. Subchapter Q.

**Coastwise-** means a route that is not more than 20 nautical miles offshore on any of the following waters: (1) Any ocean; (2) The Gulf of Mexico; (3) The Caribbean Sea; (4) The Bering Sea; (5) The Gulf of Alaska; or (6) Such other similar waters as may be designated by a Coast Guard District Commander.

**Coastwise Voyage** - Is a domestic voyage and means a voyage in which a vessel proceeds:  
(1) From one port or place in the United States to another port or place in the United States;  
(2) From a port or place in a United States possession to another port or place in the same possession, and passes outside the line dividing inland waters from the high seas; or  
(3) From a port or place in the United States or its possessions and passes outside the line dividing inland waters from the high seas and navigates on the high seas, and then returns to the same port or place.

**Critical Tows (or Non-Routine Tows)** - are those ocean tows potentially using a hawser having a Risk Factor >15, according to the following:

- a. Risk Factor is defined as the product of the probability of occurrence and potential severity of consequences, each on a respectively scale of 1 to 5, 5 being highest probability and highest severity.
- b. Risk is the combination of the probability of some event occurring during a time period of interest and the consequences, (generally negative) associated with the event. In mathematical terms, Risk can be calculated by the equation:<sup>2</sup>

**Risk = Consequence x Probability**

- c. There are components, equipment, and machinery aboard a towing vessel whose failure could lead to catastrophic consequences.

**Crew** - Means all persons carried on board the vessel to provide navigation and maintenance of the vessel, its machinery, systems, and arrangements essential for propulsion and safe navigation or to provide services for other persons on board.

**Delta Plate**<sup>3</sup> - A heavy triangular steel plate with reinforced or bushed holes in each corner that can accept the pin of a towing shackle. Most commonly used as the connecting point for the two legs of a towing bridle and the towing pendant or chain. May also be used in the make up of a tandem tow utilizing an underrider. Some tow plates have an extra hole that can be used to shackle in a bridle retrieving wire for hauling up the bridle.

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<sup>2</sup> American Petroleum Institute. (2009). Risk-Based Inspection: "API Recommended Practice 580", Second Edition. Washington, D.C. API Publishing Services

<sup>3</sup> The terms Delta Plate, Fish Plate and Towing plate are used interchangeably as synonyms for Flounder Plate. Delta Plate is the preferred term.



**Designated Examiner** - Means a person who has been trained or instructed in techniques of assessment of a candidate for his/her task proficiency for towing vessel operations as listed and recorded in the candidate's TOAR.

**Drag** – Forces opposing direction of motion due to friction, profile, and other components.

**Drag Locking** – When towing in waves the resulting oscillating vertical motion of the towline may be partly restricted due to drag forces on the line.<sup>4</sup>

**Dynamic Load** - Relating to energy or physical force in motion; as opposed to static load, a force producing motion or change.

**Environmental Communications** - Broadcasts of information about the environmental conditions in which vessels operate, i.e., weather, sea conditions, time signals adequate for practical navigation, notices to mariners, and hazards to navigation.

**Evaluation** - Means processing an application, from the point of receipt to approval or denial of the application, including review of all documents and records submitted with an application as well as those obtained from public records and databases.

**Extreme Towline Tension** - The additive accumulation of the complex dynamic responses of tug, tow, and towline.

**Field** – This term refers to a geographical where oil exploration and exploitation activities occur based upon an underwater reservoir or reservoirs containing petroleum or natural gas or both.

**Fish Hooks** - Outer wires of wire rope that break and cause short ends to project from the rope; a sign of wire rope deterioration.

**Fitting** - Specially designed pieces on a ship's deck used to control or secure a line or rope (e.g., chock, bitts, padeye, etc.).

**Gauging** - The only practical way of determining the degree of deterioration is to measure the thickness of the member in question and compare it with the original thickness. Thickness measurements can be made by drilling and gauging or by ultrasonic measurement, the term gauging is meant to include both methods of measurement. There are two approaches to gauging. First, gauging is used to provide a quantitative basis for evaluating a questionable local condition. Second, Belt gauging goes beyond the investigating of a local condition. It involves taking readings around several complete transverse sections of the hull including deck, sides and bottom.

**Gob Line** - Line or chain used to secure the towline aft over the centerline of a tug.

**Hawser** - Any line used in astern towing.<sup>5</sup>

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<sup>4</sup> Recommended Practice DNV-RP-H103; Modelling and Analysis of Marine Operations (2011) 7.2.5

**In Irons** - An expression used by ship handlers to indicate limited control in maneuvering the ship. In towing, this can be caused by a tow wire that is “captured” at the stern, reducing the effect of the rudder of the tug.

**Inland Waters of the United States** - Means those waters of the United States lying inside the baseline from which the territorial sea is measured and those waters outside such baseline which are a part of the Gulf Intracoastal Waterway.

**Inter Field Move** – An inter field move is a voyage from one field to another. It can be either relatively short or a long distance that usually takes 24 hours or longer. A field move, in comparison is a short transit within one field that may take less than 24 hours.

**International Association of Drilling Contractors (IADC)** – is a trade association of drilling contractors and companies engaged in, among other activities, offshore drilling.

**International Voyage** - Means a voyage between a country to which SOLAS applies and a port outside that country. A country, as used in this definition, includes every territory for the international relations of which a contracting government to the convention is responsible or for which the United Nations is the administering authority. For the U.S., the term “territory” includes the Commonwealth of Puerto Rico, all possessions of the United States, and all lands held by the United States under a protectorate or mandate. For the purposes of this subchapter, vessels are not considered as being on an “international voyage” when solely navigating the Great Lakes and the St. Lawrence River as far east as a straight line drawn from Cap des Rosiers to West Point, Anticosti Island and, on the north side of Anticosti Island, the 63rd meridian.

**Jack Up Rig** - This refers to a type of drilling rig that has three or more legs that jack down to the bottom so that the vessel is suspended above the water. When the legs are jacked up, it becomes a vessel for the purposes of movement.

**Joint Rig Committee** - Joint Rig Committee (JRC) is a committee of the Lloyds Market Association (LMA),

**Length Of Tow** - Means, when towing with a hawser, the length in feet from the stern of the towing vessel to the stern of the last vessel in tow. When pushing ahead or towing alongside, length of tow means the tandem length in feet of the vessels in tow excluding the length of the towing vessel.

**Load Cell** - An instrument for measuring tension or torque.

**Master** - Means the officer having command of a vessel.

**Metric Tonnes** - DNV-RP-H103 utilizes principally metric units for analysis, and critical tows are frequently done by, and involve, international entities. It is recommended that any expression of force in Tonnes is understood to be Metric Tonnes (MT).

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<sup>5</sup> Blank, John S. (1989) Modern Towing Cornell Maritime Press

**MODU** – This is an abbreviation for Mobile Offshore Drilling Unit, which is a floating installation temporarily attached to the seabed of offshore locations, located for the purpose of exploring for, developing, or producing oil, natural gas or mineral resources.

**MOU** - This is an abbreviation for the term Mobile Offshore Unit, which performs construction, maintenance (including the maintenance of wells), lifting operations, pipe-laying/burying and related operations, production systems, and acts as a floating storage system, among other things.<sup>6</sup>

**Navigable Waters** - Means all navigable waters of the United States including the territorial sea of the United States, extending to 12 nautical miles from United States baselines, as described in Presidential Proclamation No. 5928 of December 27, 1988.

**Norman Pins** - Steel pins mounted along the aft bulwarks of a ship that limit the forward sweep of the tow wire.

**Ocean Towing** - Point-to-point towing outside of protected harbors

**Ocean Tugs** - Ocean-going vessels designed specifically for towing

**Offshore Supply Vessel (OSV)** - means a vessel that: (1) Is propelled by machinery other than steam; (2) Does not meet the definition of a passenger-carrying vessel in 46 U.S.C. 2101(22) or 46 U.S.C. 2101(35); (3) Is more than 15 gross tons; and (4) Regularly carries goods, supplies, individuals in addition to the crew, or equipment in support of exploration, exploitation, or production of offshore mineral or energy resources.

**On the Brake** - Towing with the tow hawser restrained by the brake system of the towing machine or winch.

**On the Dog** - Towing with the winch having a pawl engaged in the ratchet cog of the towing machine's drum. Operative/emergency use of a winch dog restricts the ability to release a tow wire unless the machine is equipped with a remote release mechanism.

**Padeye** - A metal fitting welded to a deck or bulkhead designed to accept a chain or shackle.

**Pendant (Pendant Rig or Pennant)** - A single wire or chain that leads from the apex of a towing bridle to the towline; a single wire or chain that leads from the bow of the tow to connect to the tow hawser; a length of wire used as an underrider wire in a "Christmas tree" rig.

**Pilot** - Means a Federal pilot required by 46 U.S.C. 764, a state pilot required under the authority of 46 U.S.C. 211, or a registered pilot required by 46 U.S.C. 216.

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<sup>6</sup> IMO Resolution A.1079(28), Recommendations for the Training and Certification of Personnel on Mobile Offshore Units (MOUs), Adopted on 4 December 2013, International Maritime Organization.

**Pilotage Waters** - Means the navigable waters of the United States, including all inland waters and offshore waters to a distance of three nautical miles from the baseline from which the Territorial Sea is measured.

**Poured Socket** - A wire rope termination installed by pouring molten zinc over splayed wire, often referred to as “spelter socket.”

**Recognized Classification Society** - Means the American Bureau of Shipping or other classification society recognized by the Commandant in accordance with 46 C.F.R. Part 8.

**Regulated Navigation Areas** - A regulated navigation area is a water area within a defined boundary for which regulations for vessels navigating within the area have been established under this 33 C.F.R. §165.10.

**Render Recovery** – A means of a winch to automatically maintain a pre-set tension by alternately paying-out and hauling back. Generally recovery haul back is limited to the point of initial rendering.<sup>7</sup>

**Risk** - the combination of the probability of some event occurring during a time period of interest and the consequences, (generally negative) associated with the event. In mathematical terms, Risk can be calculated by the equation: <sup>8</sup> Risk = Consequence x Probability

**Risk Factor** - the product of the probability of occurrence and potential severity of consequences, each on a respectively scale of 1 to 5, 5 being highest probability and highest severity.

**Route** - The general geographic body or bodies of water endorsed on the face of a license specifically, oceans, near-coastal, Great Lakes–inland, western rivers, or limited local area. Specifies in the vessel’s USCG Certificate of Inspection (COI).

**Safe Working Load** - The load for which a rope, fitting, or working gear is designed.

**Safety Zone** - Is a water area, shore area, or water and shore area to which, for safety or environmental purposes, access is limited to authorized persons, vehicles, or vessels. It may be stationary and described by fixed limits or it may be described as a zone around a vessel in motion.

**Seagoing Vessel** - Means a ship that operates beyond the boundary line specified in 46 C.F.R. Part 7.

**Self Propelled** - Has the same meaning as the terms “propelled by machinery” and “mechanically propelled.” This term includes vessels fitted with both sails and mechanical propulsion.

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<sup>7</sup> Research Vessel Safety Standards 10<sup>th</sup> Ed. (2015) University National Oceanographic Laboratory System (UNOLS)

<sup>8</sup> American Petroleum Institute. (2009). Risk-Based Inspection: “API Recommended Practice 580”, Second Edition. Washington, D.C. API Publishing Services

**Shark Jaws** - Mechanically Operated stopper device located just forward of the towing or anchor handling vessel's tow pins used to stopper off and hold, while under tension, towing pendants, chain and other equipment during tow connection or disconnecting process or anchor handling operations.

**Shock Line** - A length of large diameter (12 inch -15 inch) nylon line of various lengths used between a towing vessels tow wire and the tows towing bridle pendant or chain for the purpose of absorbing and dampening the shock on the tow gear by sea conditions. See also: Surge Gear.

**Single Point Failure** - A single point failure is a failure of a component or subsystem that results in failure of the entire system. For example, failure of the main towline or main shackles results in loss of control of the tow. Single point failures must be avoided if a failure of the system can produce dangerous conditions.<sup>9</sup>

**Smit Towing Bracket** - Two vertical plates similar to a pair of freestanding padeyes with an elliptical pin fitted between them.

**Steady (or static) Towline Tension** - Resistance of the ship to be towed, the tow hawser, and the vertical component of wire catenary.

**Stern Rollers** - The horizontal and vertical rollers at the stern of a tug used to lead capture and control the tow hawser.

**Strain** - To draw or take in tension; to injure or weaken by force, pressure, etc.; to stretch or force beyond the normal, customary limits; to change the form or size of, by applying external force.

**Surge Gear** - Lengths grade 2 or 3 stud link anchor chain (generally in one shot lengths) used between a towing vessels tow wire and the tows towing bridle pendant or chain for the purpose of absorbing and dampening the shock on the tow gear by sea conditions.

**Tandem Tugs**- Towing vessels that are towing in line with one unit in front of the other unit.

**Tandem Tow** - A tow of two vessels carried out by a tug having a double drum tow winch with two tow wires or by a tug with a single drum tow winch with an under-rider drum. A tug with a single drum tow winch can also tow multiple tows by utilizing intermediate hawsers between the tows.

**Terminal Gear** - means the gear used to control, protect, and connect the towline

**Texas Bar** - A tow span style mounted on the stern fitted with a sheave and used primarily with tow wires.

**TOAR** – the abbreviation for Towing Officers' Assessment Record.

**Towing Officers' Assessment Record** – (TOAR) means a written record of tasks pertaining to the navigation and operation of a towing vessel that are being assessed for a candidate's proficiency by a

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<sup>9</sup> Brauer, Roger, Safety and Health for Engineers. (1990) Van Nostrand Reinhold, New York, NY.

U.S. Coast Guard approved Designated Examiner. TOAR's are geographically different to reflect the requirements of operating a towing vessel upon Oceans/Near Coastal waters, Inland/Great Lakes waters, Western Rivers and Limited areas. There appears to be regulatory gap for ocean-going towing vessels of 300 GT or more whereby the Master and other officers need not have demonstrated proficiency of the operation of towing vessels.

**Towline** – Means the wire or fiber line that is used to tow. See also: Hawser.

**Towing** – Towing refers to the use of towing vessels to push, pull or otherwise move towed vessels that lack the means of self-propulsion typically from one location to another.

**Towing Command** - The command that performs the tow.

**Towline Fatigue** - The weakening of a towline due to cyclic application of load.

**Towing Gear** - Describes the entire system of components that make up the connection between the tug and the tow.

**Tow Master**- The on-scene manager responsible for the overall towage of the towed vessel or asset. A Tug Master may be designated as Tow Master where appropriate.

**Towing Pad** - Large padeye to which a towline may be attached.

**Towline Strength** - The nominal breaking strength of the tow hawser.

**Towline Tension** - The stress imparted to a towline during a towing operation. See also: Extreme Towline Tension.

**Tow Procedure** – The guidance documents that outline the details, steps and personnel responsibilities for the proposed operations to include information regarding picking up a tow, getting underway with a tow, towing while underway and releasing a tow. In the case of MODU's, the removal from a location, towage and emplacement at a new location.

**Tow Winch** - The tow winch is a rotating mechanical device with a horizontal shaft and spool(s)/drum(s) containing the towing vessel's tow wire, powered by electricity, hydraulics, or internal combustion engines that forms the primary connection between towing vessel and the tow. It is located on the stern of the towing vessel right aft of the deckhouse and is used to stow, pay out or take in wire as needed. See Also: Automatic Tow Winch; Automatic Gear; Auto Render and Render/Recovery.

**Towing Vessel**- means a commercial vessel engaged in or intending to engage in pulling, pushing or hauling alongside, or any combination of pulling, pushing, or hauling alongside.

**Tug Master**- The master of a towing vessel.

**Underway** - Means that a vessel is not at anchor, made fast to the shore, or aground. When referring to a mobile offshore drilling unit (MODU), underway means that the MODU is not in an on-location or laid-up status and includes that period of time when the MODU is deploying or recovering its mooring system.

**Vessel** - Means every description of watercraft or other artificial contrivance used, or capable of being used, as a means of transportation on water other than a public vessel.

**Warranty Survey** - The non-regulated inspection of a proposed rig move by a knowledgeable, experienced third party to examine and inspect all facets of the proposed move including but not limited to, the rig to be towed, the towing vessel(s), their respective command personnel and crew, the towing gear, and the voyage, route, contingency and tow planning usually but not always assigned by insurers.

**Warranty Surveyor** – This means the qualified individual that performs the warranty survey.

#### **4. TOWING VESSELS**

Towing Vessels operating in the United States of America are obligated under law to perform their duties as set forth in the Code of Regulations Title 46 Shipping and Title 33 Navigation and Navigable Waters regardless of configuration, or the type or number of units towed.

US Flagged Towing Vessels currently fall under two categories Subchapter C (Uninspected Vessels) or Subchapter I (Cargo and Miscellaneous Vessels). It is anticipated that all towing vessels will fall under Subchapter M (Towing Vessels).

- Subchapter C (Uninspected Vessels) - Towing vessels greater than 26-feet on Inland, Western Rivers, Great Lakes, and Seagoing Tugs less than 300 Gross Register Tons (GRT).
- Subchapter I (Cargo and Miscellaneous Vessels) – Seagoing Tugs greater than 300 Gross Register Tons (GRT)

##### **4.1 Types of Towing Vessels used for Oilfield Work**

It is helpful to note that towing vessels vary considerably in size, style, shape, horsepower, bollard pull and capability. Traditional oil field tugs are generally twin-screw conventional model-bow style towing vessels of moderate horsepower that have a towing winch on the stern. These tugs, for example, routinely tow and shift 300 ft. x 75 ft. and 400 ft. x 100 ft. material barges as well as construction and pipelay/bury barges and the like to, from and around oil fields. Such tugs are also utilized to handle anchors for such barges and smaller rigs as well. Typically, such boats have a bollard pull of 40 to 60 tons. More recently, larger and more powerful modern vessels are being required for such duties. Azmuthing Stern Drive (ASD) or Z-Drive tractor tugs are becoming more

common and bollard pulls of 80-100 tons are becoming the norm. Two examples are found at Signet Maritime Corporation's website.<sup>10</sup>

For larger rig moves, however, a bollard pull of 150 tons or more may be specified either by owner/operator or the warranty surveyor. Such tugs may be powerful twin or triple screw conventional tugs or tractor tugs. These boats are generally purpose built for these duties that have dynamic positioning capabilities and rated for DP2 or better. Good examples are Crowley Towing's Ocean Class tugs.<sup>11</sup>

Deep Sea Tugs of traditional style were designed for easy seakeeping while towing long distances, for emergency towing of ships, and sometimes for salvage work. More modern tugs that tow MODUs are multi-purpose, specialized vessels. A very common design feature is a large accommodation block and bridge situated far forward and a long clear stern. According to one authority, these newer style vessels don't ride or tow as well particularly in very rough weather. In addition, these vessels have compromises in design due to their specialized operations other than towing.<sup>12</sup> Two such specialized towing and other purpose vessels are described below.

An Anchor-Handling Tug (AHT) is a purpose-built towing vessel to be utilized for oil field towing, anchor handling and rig moves. Such vessels may have 10-15,000 BHP and a bollard pull of more than 150 tons. Likewise, an Anchor-Handling Tug Supply (AHTS) does similar duties but can be utilized to carry cargo. An AHTS is generally larger than an AHT. Good examples of both are shown at EMAS's website, which is one of the largest offshore support services provider in Asia.<sup>13</sup>

Edison Chouest Offshore's AIVIQ is currently described by ECO as an Icebreaking AHT.<sup>14</sup> The U.S. Coast Guard's report on the grounding of the KULLUK described the AIVIQ as an Icebreaking AHTS.<sup>15</sup> The AIVIQ reportedly is about 360' LOA, about 80' wide and draws about 34' of water. Interestingly, the USCG Report on the Grounding of the MODU KULLUK stated that the AIVIQ's loosening and tightening of the towline due to heavy weather was a causal factor of the shackle failure. Hancox notes that AHTS tugs ride poorly and can overload the breaking strength of the towing gear because of the way they are designed.<sup>16</sup>

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<sup>10</sup> See [http://www.signetmaritime.com/vessels\\_tugs.html](http://www.signetmaritime.com/vessels_tugs.html), visited October 18, 2015.

<sup>11</sup> See <http://www.crowley.com/What-We-Do/Marine-Solutions/Vessel-Specifications/Tugs/Ocean-Class>, visited October 18, 2015.

<sup>12</sup> Michael Hancox, *Towing*, Clarkson Research Services, Ltd. (2011) at pp. 4-5 and 196-200.

<sup>13</sup> See <http://www.emas.com/index.php/our-expertise/emas-marine/our-fleet-2/anchor-handling-tug-supply-vessels/>, visited October 18, 2015.

<sup>14</sup> See <http://www.chouest.com/vessels.html>, visited October 18, 2015.

<sup>15</sup> Report of Investigation of the Grounding of MODU KULLUK, at p. 10, Footnote 11.

<sup>16</sup> *Supra*, note 12.



## 5. CRITICAL TOWS

While best management practices include a Safety Management System (SMS) that pertains to a contemplated project or proposed tow, the use of other risk evaluations are recommended. For purposes of this Report, it is suggested that under this sample risk assessment method, Critical Tows are those ocean tows having a Risk Factor >15, according to the following criteria:

- a. Risk is defined as the product of the probability of occurrence and potential severity of consequences, each on a respectively scale of 1 to 5, 5 being highest probability and highest severity.
- b. Risk is the combination of the probability of some event occurring during a time period of interest and the consequences, (generally negative) associated with the event. In mathematical terms, Risk can be calculated by the equation:

$$\text{Risk} = \text{Consequence} \times \text{Probability}^{17}$$

- c. There are components, equipment, and machinery aboard a towing vessel whose failure could lead to catastrophic consequences.
- d. Where the towage of MOU's is contemplated, "2" shall be added to the Probability of Failure (POF) and Risk recalculated.

### Highest Risk

In terms of Consequence severity, those failures that can result in allisions, collisions, or loss of tug and/or tow have the highest ranking, where those failures (non-critical systems, for example) that are not likely to result in injury or catastrophic loss, carry the lowest ranking. The highest consequences are sub-graded such that failures that could endanger other vessels, or people and property ashore, are considered the most severe. Generally, these are failures that result in loss of control, loss of tug and/or and loss of tow.

Critical tows, would, by definition, carry a "4" or "5" Consequence Rating.

### Determining Consequence of Failure (COF)

In order to determine Risk, it is necessary to determine a Consequence of Failure (COF). Traditionally, this is a 5-point numerical scale where 1 represents negligible consequence and 5 represents a potentially catastrophic impact.<sup>18</sup>

### **Consequence Rating Used to Calculate Risk.**

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<sup>17</sup> American Petroleum Institute. (2009). Risk-Based Inspection: "API Recommended Practice 580", Second Edition. Washington, D.C. API Publishing Services

<sup>18</sup> U.S. Coast Guard, Human Element and Ship Design Division: *Marine Operations Risk Guide, A Guide to Improving Marine Operations by Addressing Risk.* (2004) <http://www.uscg.mil/hq/cg5/cg5211/docs/morg.pdf>. Excerpted and Modified

5	Collision/Allision/Loss of Tug/Loss of Tow resulting in fire or explosion, and/or toxic chemical release, injury to personnel or loss of life and/or damage to critical infrastructure.
4	Fire, explosion, sinking affecting the vessel itself and pollution limited to that caused by the vessel itself with the potential of personnel injuries.
3	Collision/Allision/Loss of Tug/Loss of Tow resulting in fire and/or environmental release not immediately harmful to people and/or damage to non-critical infrastructure.
2	Mechanical, thermal or chemical energy release affecting one or more of the vessel's crew and without harm to the environment.
1	Failure of non-critical system affecting part of the vessel itself without harm to the crew or the environment.

**Table 1**

Determining Probability of Failure (POF)

In order to determine Risk, it is necessary to determine Probability of Failure (POF). Traditionally this is a 5-point numerical scale where 1 represents a remote possibility and 5 represents a frequent possibility.

A critical point is that single point failures are more likely to yield a high consequence failure than an equivalent failure in a redundant system. Certain criticalities may require that more than one towing vessel of equal brake horsepower and bollard pull be used to reduce risk.

The probability of any failure is greatly reduced when the system being evaluated for failure is 100 percent redundant, provided the system itself is reasonably safe and suited for its intended purpose.

**Probability of Failure Rating Used to Calculate Risk**

5	Single point Failure in Beaufort $\geq 9$
4	Redundant Failure in Beaufort $\geq 9$
3	Single Point Failure in Beaufort 7 & 8
2	Redundant Failure in Beaufort 7 & 8
1	Benign Weather Beaufort $\leq 6$

**Table 2**

Where the use of wire bridles or previously utilized Terminal Gear is contemplated, "1" shall be added to the Probability of Failure (POF) and Risk recalculated. See section 7.7 and 7.11

Critical tows would, by definition, carry a "4" or "5" Probability of Failure Rating.

Examples\*

<p>Container barge running offshore</p> <p><b>-Non-hurricane season (Beaufort 7-8)</b></p> <p>COF = 4 POF= 3</p> <p>Risk =12      <u>Not Critical</u></p>
<p>Oil / Chemical Barge running offshore</p> <p><b>-Non-hurricane Season (Beaufort 7-8)</b></p> <p>COF=5 POF=3</p> <p>Risk =15      <u>Not Critical</u></p> <p><b>-Hurricane Season (Beaufort ≥ 9)</b></p> <p>COF=5 POF=5</p> <p>Risk =25      <u>Critical</u></p>
<p>MODU running offshore</p> <p><b>Beaufort ≤ 6</b></p> <p>COF = 5 POF = 2</p> <p>Risk = 10      <u>Not Critical</u></p> <p><b>Beaufort &gt; 6</b></p> <p>COF = 5 POF ≥ 4</p> <p>Risk = 20      <u>Critical</u></p>

\*Note: any failure of the main towline or terminal connections constitutes by definition, a single point failure.

## **6. VOYAGE PLANS, TOW PROCEDURES, TOWING CONFIGURATIONS**

Discussion:

Voyage planning is required by regulation in the Code of Federal Regulations (C.F.R.) for all towing vessels navigating in the navigable waters of the U.S. regardless of area of operation with limited exceptions as follows:

### **6.1 Voyage Plans**

Voyage Plans are required by 33 C.F.R Part 164.80 for all Towing vessels except as follows:

- (i) Used solely for any of the following services or any combination of these services—
  - (A) Within a limited geographic area, such as a fleeting-area for barges or a commercial facility, and used for restricted service, such as making up or breaking up larger tows;
  - (B) For harbor-assist;
  - (C) For assistance towing as defined by 46 C.F.R. 10.103;
  - (D) For response to emergency or pollution;
- (ii) A public vessel that is both owned, or demise chartered, and operated by the United States Government or by a government of a foreign country; and that is not engaged in commercial service;
- (iii) A foreign vessel engaged in innocent passage; or
- (iv) Exempted by the Captain of the Port (COTP).<sup>19</sup>

Proposed 46 C.F.R. Subchapter M Subpart F, Navigation watch assessments, applies to all towing vessels unless otherwise specified. Certain vessels remain subject to the navigation safety regulations as stated in 33 C.F.R. Part 164.80 (c). Vessels not subject to Voyage Plans as enumerated in 33 C.F.R. Part 164.80 (c) must complete a Navigation watch assessment as per proposed 46 C.F.R. Subchapter M, Subpart F.

33 C.F.R. Subchapter P Part 164 (70-82), incorporated by reference, is specific to Towing Vessels and therefore are compulsory for all Towing Vessels unless otherwise identified.<sup>20</sup>

Compulsory Voyage Plans required by regulation must take precedent above any voluntary plans including Tow procedures. Regulatory required Voyage Plans are effective when developed and/or approved by the Tug Master addressing navigation issues. As a minimum standard, when done properly, Voyage Plans provide a solid foundation and may be expanded to encompass additional information or augmented with additional procedures.

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<sup>19</sup> 33 C.F.R. Subchapter P Part 164 Section 80 (c)

<sup>20</sup> 33 C.F.R. Chapter I, Subchapter P, Part 164, Section 01

If any part of a towing vessel's intended voyage is seaward of the baseline (i.e., the shoreward boundary) of the territorial sea of the U.S., consideration for Voyage Plan policy should include but not limited to items listed below (i) – (ix) as well as other mandatory rules/regulations (33 C.F.R. Chapter 1, Subchapter P, 46 C.F.R. Vessel Class Subchapter C, I, and proposed M) while taken into consideration guidelines and recommendations from Industry Organizations and Class Societies. At a minimum, Voyage Plans must consider the enumerated detailed requirements as outlined in 33 C.F.R., Chapter 1, Subchapter P, Part 164, Section 80 (c) iii and are not intended to be confused with “Tow Procedures”.

“The voyage plan must follow company policy and its Safety Management System (SMS) and consider the following (related requirements noted in parentheses):

- (i) Applicable information from nautical charts and publications (also see paragraph (b) of section 164.72), including Coast Pilot, Coast Guard Light List, Marine Safety Information Bulletins (MISB’s) and Coast Guard Local Notice to Mariners for the port of departure, all ports of call, and the destination;
- (ii) Current and forecast weather, including visibility, wind, and sea state for the port of departure, all ports of call, and the destination (also see paragraphs (a)(7) of section 164.78 and (b) of section 164.82);
- (iii) Data on tides and currents for the port of departure, all ports of call, and the destination, and the river stages and forecast, if appropriate;
- (iv) Forward and after drafts of the barge or barges and under-keel and vertical clearances (air-gaps) for all bridges, ports, and berthing areas;
- (v) Pre-departure checklists;
- (vi) Calculated speed and estimated time of arrival at proposed waypoints;
- (vii) Communication contacts at any Vessel Traffic Services, bridges, and facilities, and any port-specific requirements for VHF radio;
- (viii) Any master's or operator's standing orders detailing closest points of approach, special conditions, and critical maneuvers; and
- (ix) Whether the towing vessel has sufficient power to control the tow under all foreseeable circumstances.<sup>21</sup>

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<sup>21</sup> 33 C.F.R. Chapter I, Subchapter P, Part 164, Section 80 (c) 3

Voyage plan considerations include, but are not limited to:

33 C.F.R. Navigation and Navigable Waters, Chapter I, Subchapter P (PORTS AND WATERWAY SAFETY) Subchapter I (ANCHORAGES), Subchapter J (BRIDGES)

33 C.F.R. Subchapter I	• Anchorage
33 C.F.R. Subchapter J	• Bridges
33 C.F.R. Subchapter P Part 160	• Ports and Waterway Safety
33 C.F.R. Subchapter P Part 161	• Vessel Traffic Management
33 C.F.R. Subchapter P Part 162	• Inland Waterways Navigation Regulations
33 C.F.R. Subchapter P Part 163	• Towing of Barges
33 C.F.R. Subchapter P Part 164	• Navigation Safety Regulations
33 C.F.R. Subchapter P Part 165	• Regulated Navigation Areas and Limited Access Areas
33 C.F.R. Subchapter P Part 166	• Shipping Safety Fairways
33 C.F.R. Subchapter P Part 167	• Offshore Traffic Separation Schemes

It is recommended that Company Voyage Planning Policies contain Voyage Planning flow charts. Sample Voyage Planning Guidelines can be found in Appendix 4.

Proposed Subchapter M

Subchapter M Part F	• Vessel Operational Safety <sup>22</sup>
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IMO Guidelines

In the IMO Guidelines for Safe Ocean Towing it states that all aspects of towage should be planned in advance including as follows:

1. Maximum anticipated environmental conditions

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<sup>22</sup> Proposed Title 46 subchapter.

2. Tides/Currents
3. Water Depths
4. Tow (size, windage, displacement, cargo storage, and draft)
5. Weather routing advice with careful consideration bollard pull of the towing vessel
6. Towing arrangements and procedures (with routing planned so that under all normal circumstances the water depth is at least half the length of the paid out tow line).
7. Contingency Plan for Points of Refuge (a copy should also be carried aboard the barge or towed vessel if manned)
8. Manuals for routine towing operations
9. Manuals for special towage requirements<sup>23</sup>

The IMO Guidelines for Safe Ocean Towing is largely consistent with already existing United States Voyage Planning requirements.

## **6.2 Tow Procedures**

Voluntary Tow Procedures are intended to reduce risk to a level ALARP. Tow procedures should be prepared for tows considered to be a Critical Tow. Such procedures may include the use of more than one towing vessel to reduce the risk to ALARP in cases of technically demanding towed assets, for example, the KULLUK. Multiple towing vessels might be used when towing in restricted or harsh environments and/or where sea room and response time for rescue and salvage assets are limited. When such tugs are deployed, additional towing vessels should be of equivalent bollard pull as the lead towing vessel and be equipped with the same terminal gear.

Tow procedures when utilized should include information not already required/identified within the Vessel's Voyage Plan and act as a stand-alone document. Along with Voyage Plans, Tow Procedures must have the full support/approval of the Tug Master. Tow Procedures are not a substitute for Voyage Plans.

Tow procedures may include (or reference), but not be limited to, the following subjects:

1. General
  - a. Go/No Go departure criteria and associated decision-making process.
  - b. Contact details and responsibilities.
  - c. Reporting requirements: who to, how often and content.
  - d. Arrival details, contacts, field plan (scaled chart of the oil field clearly displaying the location of all surface and subsea assets), etc.

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<sup>23</sup> IMO Guidelines for Safe Ocean Towing, Rev. 7, Pg. 3-4

- e. Contingency planning
  - f. Communications Schedules
2. Description of the towed asset, vessel or object.
- a. Any limiting criteria and motions (roll, pitch and period, etc.) for the transport or tow, weather forecasting arrangements (2 independent sources).
  - b. Motions and strength - detailed supporting calculations for the motions and accelerations, longitudinal strength and strength of the seafastening and cribbing/grillage.
  - c. Drawings to include, where applicable, cargo, general arrangement (GA) and other key drawings of vessel and cargo, stowage plan, towing arrangement, cribbing /grillage arrangement, load-out /discharge plan, seafastening arrangement, guidepost details etc.
3. Description of the towing vessel(s)
- a. Reference documents, including applicable standard operating procedures of each operator.
  - b. Towing vessel bollard pull calculation (if applicable).
  - c. Towing vessel specification, including but not limited to, stability documentation.
  - d. Tow configurations and drawings.
  - e. Fuel system efficacy

### **6.3 Towing Configurations**

Differing towing situations and vessel configurations are unique to towing vessels requiring proper planning beforehand. Compliance with mandatory rules/regulations and best management practices utilizing guidelines and recommendations from recognized Industry Organizations and Class Societies is an essential element of risk management. Towage of any kind in all latitudes requires due care and consideration for both the forecast and potential operational environment. It must be noted that the towage of the KULLUK was not in Arctic waters and therefore was NOT an Arctic tow. A separate tasking for towage of all kinds, and in particular the towage of rigs and MODUs in the harsh and remote environment of Arctic waters is recommended as it was outside the tasking of this Subcommittee and beyond the scope of this Report.



## **7. Tow Gear– Identification, selection, testing, utilization, monitoring and logging**

### **7.1 Proper Technical Analysis**

A proper technical analysis of the forces to which a Critical Tow may be subjected is complex. Traditional rules of thumb may not apply. Historically, the required Bollard Pull (BP) of the towing vessel is estimated based on the size, weight, shape and hydrodynamic resistance of the tow. The traditional tow typically has a well-recognized hull form and is generally longer than it is wide.

However, Critical Tows may involve massive, unusually shaped tows and/or are contemplated to occur in moderate to extreme weather conditions. In these circumstances, extreme towline tension can be very high and can cause the BP of the towing vessel, determined by traditional methods, to be exceeded.

It is typical, and not unreasonable, for the tow gear to be sized as a function of BP. Therefore, if conditions (of any tow, especially a Critical Tow) cause BP to be exceeded, not only is the towing vessel undersized, but the tow gear is as well, potentially leading to catastrophic consequences.

A proper technical analysis should be undertaken of the proposed Critical Tow, to determine (as a minimum) the following:

- Extreme Towline Tension for given sea states, and speeds
- Limits of the tow (i.e. Go - No Go criteria)
- Required BP of the towing vessel
- Set points for the Automatic Winch as a function of sea state
- Requirements for the synthetic emergency towline and its methods of deployment and connection.
- Recommended catenary length(s)

It is likely that the technical analysis is an iterative process, whereby the limits of the tow will be dictated by practical limits of the type, size and strength of the main tow wire, and hence BP of the towing vessel and size and nature of the towing winch (assuming the three are properly matched for a given towing vessel).

The following primary source documents (at a minimum) are recommended for consideration in performing a proper technical analysis of the proposed Critical Tow:

1. Recommended Practice DNV-RP-H013 Modelling and Analysis of Marine Operations
2. Hancox, Michael; Towing- Oilfield Seamanship Series Volume Four; Clarkson Research Services, Ltd., 2011

3. U.S. Navy Towing Manual 1 July 2002
4. U.S. Navy Salvor's Handbook 1 January 2004
5. Principles of Naval Architecture
6. Bart J. Eckhardt, Peter D. Squicciarini (2013) *Towing Vessel Safety: Risk-based Maintenance and Inspection of Towing Vessel Machinery and Systems*.

***It is important to note that no single primary source document or standard described above contains the requisite information to conduct a proper technical analysis of the proposed Critical Tow.***

It is recommended that the owner(s) of the towing vessel(s) and the towed vessel respectively utilize (a) qualified engineering professional(s) to perform a proper (six-degree freedom of motion) technical analysis of the proposed Critical Tow.

The respective analysis will establish modelling, verification and validation of the proposed Critical Tow. It is preferred that each respective analysis be performed by a Professional Engineer, licensed in any single state that could be affected in the event of a mishap. Each respective analysis shall, in determining the output of the analysis previously described, verify (at a minimum) the following:

- The characteristics of all vessel(s) potentially involved in the Critical Tow, including, but not necessarily limited to:

- Dead Weight Tonnage
- Length, Breadth, Draft
- Stability in the contemplated sea states
- Size/configuration/strength/suitable location of attachment points for intended and emergency use
- Fuel system efficacy for its intended purpose during the Tow

Technical considerations in performing a proper technical analysis of the proposed critical Tow (including in an emergency) include, but are not necessarily limited to:

- Hydrodynamic properties of towing vessel(s) and tow
- Sea state, including influences of wind, current, wave height and wave period
- Speed
- Fatigue Load
- Impact Loads
- Energy absorption by the towline catenary
- Towline Stiffness

- Drag Lock
- Six Degree motion of towing vessel and tow

**7.2 General Guidance**

The following general guidance is provided:

**7.2.1. Force Units** - It is recommended that any expression of force in tons (tonnes) is understood to be Metric Tonnes. See Table 3 for convenient conversion factors:

Multiply This	By This	To Obtain This
ton (short)	2000 907.185 0.8929 0.9072	lb kg ton (long) tonne (metric)
ton (long)	2240 1016.047 1.12 1.0160	lb kg ton (short) tonne (metric)
tonne (metric)	1000 2204.62 0.9842 1.1023	kg lb ton (long) ton (short)

**Table 3**

**7.2.2. Shock Lines** – It is recommended that shock lines when used in lieu of surge gear (chain) be new or certified, properly protected in storage, and used within the limits defined by the rope’s manufacturer. Where the use of Shock Lines is contemplated, “1” shall be added to the Probability of Failure (POF) and Risk recalculated. See section 7.7

The impact of sea, swell, variable currents and the intermittent forces of weather cause tension loading in the fore and aft axis of the tow string. This tension loading “surge” is typically detrimental to the tow string’s overall integrity and can cause catastrophic damage. Generally a tow that is properly set up with appropriate tug/tow separation will be protected from surge forces by weight of the tow wire catenary. The insertion of additional chain in the tow string provides surge protection, but this method simply enhances the benefit of catenary for the purposes of surge protection. For shallow water towing or towing in special circumstances where the catenary or length of the wire will cause impediment of safe towing operations, “shock lines”, “stretchers” or other manufactured instruments have been employed for the purpose of protection against surge in the tow string. These devices are designed, manufactured and ultimately certificated for use as surge protection and as such must be maintained in

good condition as the operator would maintain any other element of the tow string. At every use, these devices must be analyzed for suitability given the characteristics of the surge forces extant or expected during the coming voyage. The level of analysis will vary with the complexity of the tow, but the process of analysis prior to use must be implemented regardless of tow complexity. Certificates of manufacture and inspection must be maintained, along with a log documenting every use and inspection as part of an operator's management system.

**7.2.3. Wear Surface** – The use of replaceable wear sleeves for running surfaces requires further study outside the scope of this task. It is recommended that running surfaces be polished stainless steel of a grade suited for the application.

**7.2.4. Working Load Limit** – Expression of limits for load, such as breaking strength (BS), ultimate strength (US), yield strength (YS) and proof load (PL) are primarily engineering terms of art that are poorly understood and of little practical importance to those outside the engineering community.

It is recommended that any expression of allowable loads and load limits is understood to be Working Load Limit (WLL), i.e. the acceptable load limit after proper factors of safety have been applied. Historically, this acceptable load limit was Safe Working Load in U.S. Engineering parlance. The U.S. Navy identifies a critical caveat; shackles marked with WLL are applying an WLL for lifting and not towing. Determination of validation and verification of Working Load Limit (WLL) and/or Safe Working Load (SWL) should be part of the Proper Technical Analysis described in 7.1 above and the Sample Towing Gear Selection Flow Charts.

**7.2.5. Intentional Weak Link** – The use of an intentional weak mechanical link in the tow system is not recommended.

**7.2.6. Flowchart** – A flowchart that describes the major steps in a proper technical analysis is presented in Appendix I.

**7.2.7. Certified Bollard Pull** – The static bollard pull of the towing vessel should be determined by a static bollard pull test certified by the American Bureau of Shipping or equivalent organization.

**7.2.8. Prohibition of Hot Work and Contamination** – Towing gear should not be subjected to any hot work or chemicals that could alter its material properties. Towing gear should not be subjected to contaminants, including especially abrasive blasting grit (including overspray). Towing gear should not be dragged along any surface other than smooth, clean steel plate.

**7.2.9 Towing Vessel Capability** – Towing vessel(s) for Critical Tows twin-screw, of adequate brake horsepower, bollard pull and capability as defined by the proper technical analysis. All potential single points of failure in the propulsion should be considered and eliminated to the best extent practical. Examples include, but are not limited to, potential for crippling forces and explosions and contamination of the fuel oil service system.

### **7.3 Automatic Towing Winch**

The automatic towing winch shall be

- Of robust construction and proven for the intended conditions of service
- Compliant with the requirements of ISO 7365:2012 Shipbuilding and Marine Structures- Deck Machinery-Towing winches for deep sea use.
- Capable of recording key data including load, strain and setpoints for render/retrieve
- Matched appropriately to the towing vessel

DNV-RP-H103 and the U.S. Navy Towing Manual contemplate the use of automatic render/recover towing winches. It is recommended that only automatic render/retrieve towing winches be utilized for critical tows. However, when assessing Risk, the worst case conditions associated with lock up (i.e. a failure of, or the inability to utilize, auto render/recovery feature) be considered. Suitable redundancy in a lock-up condition may only be realizable with multiple towing vessels.

### **7.4 Main Towline**

Existing regulation 33 C.F.R. Subchapter P clearly identifies monitoring and logging of towlines and terminal gear as follows:

- (a) Towline. The owner, master, or operator of each vessel towing astern shall ensure that the strength of each towline is adequate for its intended service, considering at least the following factors:
  - (1) The size and material of each towline must be—
    - (i) Appropriate for the horsepower or bollard pull of the vessel;
    - (ii) Appropriate for the static loads and dynamic loads expected during the intended service;
    - (iii) Appropriate for the sea conditions expected during the intended service;
    - (iv) Appropriate for exposure to the marine environment and to any chemicals used or carried on board the vessel;
    - (v) Appropriate for the temperatures of normal stowage and service on board the vessel;
    - (vi) Compatible with associated navigational-safety equipment; and
    - (vii) Appropriate for the likelihood of mechanical damage.

- (2) Each towline as rigged must be—
- (i) Free of knots;
  - (ii) Spliced with a thimble, or have a poured socket at its end; and
  - (iii) Free of wire clips except for temporary repair, for which the towline must have a thimble and either five wire clips or as many wire clips as the manufacturer specifies for the nominal diameter and construction of the towline, whichever is more.<sup>24</sup>

### Specifications

Tow wires should have independent wire rope cores (IWRC).

Tow wires should be of improved plow steel or extra improved plow steel.

Tow wires should be heavy lubricated or galvanized at the time of manufacture.

Tow wires should be 6 x 19 or larger (more flexible).

The breaking strength (BS) of the wire rope or towing hawser should be certified by the manufacturer by pull-testing to destruction a portion of wire from the mill run from which it originated.

### Terminations

The towing end of the tow wire should terminate in a spelter socket, or a spliced eye with thimble, and should be sized to exceed the breaking strength of the tow wire.<sup>25</sup>

It is recommended:

Multiply Extreme Towline Tension by 1 to obtain WLL of the Main Towline  
Multiply WLL of the Main Towline by 4 to obtain minimum required breaking strength (BS).<sup>26</sup>

Minimum required BS of the Main Towline shall be at least two (2) times BP.<sup>27</sup>

NOTE: Multiply wire size having appropriate WLL by appropriate bending factor to determine final towline wire diameter.

NOTE: Towing provides useful direction in the maintenance and inspection of wire rope, pages 302 – 310.<sup>28</sup>

## **7.5 Monitoring and Logging**

<sup>24</sup> 33 C.F.R. Chapter 1, Subchapter P, Part 164, Section 74

<sup>25</sup> The American Waterways Operators Responsible Carrier Program 2006. Page IV-7

<sup>26</sup> U.S. Navy Towing Manual, SL740-AA-MAN-010, 1 July 2002

<sup>27</sup> Hancox, Michael, Towing, Oilfield Seamanship Vol. 4, Clarkson Research Services 2011. And: The American Waterways Operators Responsible Carrier Program 2006. Page IV-7

<sup>28</sup> Hancox, Michael, Towing, Oilfield Seamanship Vol. 4, Clarkson Research Services 2011.

Existing regulation clearly identifies monitoring and logging of towlines and terminal gear as follows:

The condition of each towline must be monitored through the following:

- (i) Keeping on board the towing vessel or in company files of a record of the towline's initial minimum breaking strength as determined by the manufacturer, by a classification ("class") society authorized in §157.04 of this chapter, or by a tensile test that meets API Specification 9A, Specification for Wire Rope, Section 3; ASTM D 4268 (incorporated by reference, see §164.03), Standard Test Method for Testing Fiber Ropes; or Cordage Institute CIA 3, Standard Test Methods for Fiber Rope Including Standard Terminations;
- (ii) If the towline is purchased from another owner, master, or operator of a vessel with the intent to use it as a towline or if it is retested for any reason, keeping on board the towing vessel or in company files of a record of each retest of the towline's minimum breaking strength as determined by a class society authorized in §157.04 of this chapter or by a tensile test that meets API Specification 9A, Section 3; ASTM D 4268 (incorporated by reference, see §164.03) or Cordage Institute CIA 3, Standard Test Methods;
- (iii) Conducting visual inspections of the towline in accordance with the manufacturer's recommendations, or at least monthly, and whenever the serviceability of the towline is in doubt (the inspections being conducted by the owner, master, or operator, or by a person on whom the owner, master, or operator confers the responsibility to take corrective measures appropriate for the use of the towline);
- (iv) Evaluating the serviceability of the whole towline or any part of the towline, and removing the whole or part from service either as recommended by the manufacturer or a class society authorized in §157.04 of this chapter or in accordance with a replacement schedule developed by the owner, master, or operator that accounts for at least the—
  - (A) Nautical miles on, or time in service of, the towline;
  - (B) Operating conditions experienced by the towline;
  - (C) History of loading of the towline;
  - (D) Surface condition, including corrosion and discoloration, of the towline;
  - (E) Amount of visible damage to the towline;
  - (F) Amount of material deterioration indicated by measurements of diameter and, if applicable, measurements of lay extension of the towline; and
  - (G) Point at which a tensile test proves the minimum breaking strength of the towline inadequate by the standards of paragraph (a)(1) of this section, if necessary; and
- (v) Keeping on board the towing vessel or in company files of a record of the material condition of the towline when inspected under paragraphs (a)(3)(iii) and (iv) of this section. Once this record lapses for three months or more, except when a vessel is laid up or out of service or

has not deployed its towline, the owner, master, or operator shall retest the towline or remove it from service.

- (b) Terminal gear. The owner, master, or operator of each vessel towing astern shall ensure that the gear used to control, protect, and connect each towline meets the following criteria:
  - (1) The material and size of the terminal gear are appropriate for the strength and anticipated loading of the towline and for the environment;
  - (2) Each connection is secured by at least one nut with at least one cotter pin or other means of preventing its failure;
  - (3) The lead of the towline is appropriate to prevent sharp bends in the towline from fairlead blocks, chocks, or tackle;
  - (4) There is provided a method, whether mechanical or non-mechanical, that does not endanger operating personnel but that easily releases the towline;
  - (5) The towline is protected from abrasion or chafing by chafing gear, lagging, or other means;
  - (6) Except on board a vessel towing in ice on Western Rivers or one using a towline of synthetic or natural fiber, there is fitted a winch that evenly spools and tightly winds the towline; and
  - (7) If a winch is fitted, there is attached to the main drum a brake that has holding power appropriate for the horsepower or bollard pull of the vessel and can be operated without power to the winch.<sup>29</sup>

## **7.6 Emergency Towline**

It is anticipated that the emergency towline will be of synthetic construction. Only new line, certified as to its rating by the manufacturer, shall be utilized. If utilized, it shall be destroyed following its use, provided it is not, or would not be, the subject of an investigation.

### **7.6.1 Emergency Towing Gear**

Each towing vessel shall be equipped with a emergency towing gear, including a properly rated Emergency Towline, and Emergency Towplan and a predetermined means to deploy and retrieve the Emergency Towline.

It is recommended:

Multiply Extreme Towline Tension by 1 to obtain WLL of the Emergency Towline.  
Multiply WLL by 10 to obtain minimum required breaking strength of the Emergency Towline.<sup>30</sup>

## **7.7 Bridles, Pendant and Surge Gear**

<sup>29</sup> 33 C.F.R. Chapter 1, Subchapter P, Part 164, Section 74

<sup>30</sup> U.S. Navy Salvor's Handbook, S0300-A7-HBK-010, 1 January 2004.



Bridles for ocean towing

Bridles should be Grade 2 or higher welded or forged integral stud link chain.

Where the use of a chain bridle is not practical, wire bridles shall be of a size and type equivalent or superior to the Main Towline.

If wire bridles are utilized, “1” shall be added to the calculated Probability of Failure (POF) and the Risk recalculated.

Surge gear

Surge chains should be Grade 2 or higher welded or forged integral stud link chain.

Surge chains should be of the same grade and type and at least as large as that in the towing bridle.

Each end of the chain may have an end link or one studless link.<sup>31</sup>

It is recommended:

For Chain

Multiply Extreme Towline Tension by 1 to obtain WLL of the Bridle, Pendant and Surge Gear.

Multiple WLL by 4 to obtain minimum required proof load (PL) of the chain utilized.<sup>32</sup>  
Chain is never to be welded on.

For Shock Lines

Multiply Extreme Towline Tension by 1 to obtain WLL of the Spring (Surge) Line.

Multiply WLL by 12 to obtain minimum required braking strength of the Shock Line.

Inspect the chain prior to use in the Critical Tow as follows:

**3-4.5 Chain Inspection.**

Inspect chain for elongated or cracked links prior to, during and after use.

Elongated link check:

- A stretched link will exceed the manufacturer’s specified length.

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<sup>31</sup> The American Waterways Operators Responsible Carrier Program 2006. Page IV-7

<sup>32</sup> U.S. Navy Towing Manual, SL740-AA-MAN-010, 1 July 2002.

- **Consider any six links (five links for commercial chain) exceeding the manufacturer's specifications to be stretched.**

Crack link check :

- Ring each link under strain with a hammer.
- Good links will have a clear, ringing tone.
- Bad links will have a dull, flat tone.<sup>33</sup>

Their use shall be documented in accordance with logging requirements of the main towline.

## 7.8 Shackles

Special attention is to be given to the main shackle, as it is a specific point of vulnerability.

Towing shackles are to be double nutted, safety pinned with bolts double nutted and the bolt ends peened over .

Shackles can be considered a potential weak link in the tow configuration due to constant movement of the tow, shock load, side loading, and the number of moving parts that make up each shackle. Every reasonable precaution should be taken to ensure the longevity and performance ability of shackles used in a critical ocean tow configuration. It is recommended that the following additional requirements for all shackles used in critical ocean tows:

- a. All shackles must be Alloy/Grade B steel.
- b. All shackles must be bolt type.
- c. All bolt type shackles must be double nut (2 jam nuts) secured with locking bolts.
- d. Cotter key peened at end of bolt (optional)
- e. At no time are materials other than locking bolts and cotter keys to be used in securing bolt type shackles, (scrap metal pieces, welding rods, etc.)
- f. Shackles shall never be welded on.

Shackles shall be selected so as to minimize any tendency to rotate or for joining members to jam, as well as to minimize bending loads to which the shackle could be subjected.

It is recommended:

multiply Extreme Towline Tension by 1 to obtain WLL of the main shackle.  
multiply WLL by 3 to obtain minimum required proof load (PL) of the main shackle.<sup>34</sup>

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<sup>33</sup> U.S. Navy Salvor's Handbook, S0300-A7-HBK-010, 1 January 2004.

<sup>34</sup> U.S. Navy Towing Manual, SL740-AA-MAN-010, 1 July 2002. Page 3-8

### **7.9 Delta Plates (Fish Plate)**

Delta plates shall be

- of robust construction
- manufactured by an experienced and proven manufacturer
- certified for their WLL rating by the manufacturer
- subject to non-destructive examination including x-ray prior to use
- subject to, when of welded construction, weld procedures to recognized standards such as ASME and performed by a welder duly certified
- reverted to non-critical service following its use, and subject to visual inspection provided it is not, or would not be, the subject of an investigation
- subject to the same logging requirements as the main towline

It is recommended:

Multiply Extreme Towline Tension by 1 to obtain WLL of the delta plate.

Multiply WLL by 3 to obtain minimum required breaking strength (BS) of the delta plate.

### **7.10 Attachment Points, Padeyes and Smit Brackets**

Attachment points, padeyes and Smit Brackets shall be subject to visual and Dye Penetrant (DP) or Magnetic Particle Inspection (MPI) prior to use in a Critical Tow. Attachment points, padeyes and Smit Brackets shall be verified to be fully and appropriately carried through to the vessel's structure.

It is recommended :

Multiply Extreme Towline Tension by 1 to obtain WLL of the attachment point.

In normal use: Multiply WLL by 3 to obtain minimum required Yield Strength (YS) of Component Assembly.<sup>35</sup>

In emergency use: Multiply WLL by 7 to obtain minimum required Yield Strength (YS) of Component Assembly<sup>36</sup>

### **7.11 Terminal Gear**

It is recommended that, for critical tows, only be utilized. Furthermore, it is recommended that all Terminal Gear be provided with certifications and traceability back to the original mill, and certifications that appropriate destructive type tests and non-destructive examinations (including, but not limited to x-ray) have been carried out.

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<sup>35</sup> Navy Towing Manual

<sup>36</sup> U.S. Navy Towing Manual pg. 3-8

Where the use of previously utilized Terminal Gear is contemplated, “1” shall be added to the Probability of Failure (POF) and Risk recalculated.

### **7.12 External Strain Monitoring**

The use of external strain monitoring requires further study outside the scope of this task. Typically, automatic render/recover towing winches utilize integrated strain monitoring.

## **8. TUG MASTER AND TOW MASTER COMPETENCIES AND RESPONSIBILITIES**

The International Safety Management Code specifically requires that every Company should develop, implement and maintain a safety management system to include: “defined levels of authority and lines of communication between, and amongst, shore and shipboard personnel.”<sup>37</sup> It also provides that: “The Company should establish in the safety management system that the master has the overriding authority and the responsibility to make decisions with respect to safety and pollution prevention and to request the Company’s assistance as may be necessary.”<sup>38</sup>

The Code of Federal Regulations further places upon the owner, Master or operator of every towing vessel the burden that shall ensure that each person directing and controlling the movement of the vessel understands the arrangement of the tow and the effects of maneuvering on the vessel towing and on the vessel, barge, or object being towed.<sup>39</sup>

The ISM Code requires that the Company define the level of authority of the Master, however, the IMO also recognizes two types of Master for Towing Operations. The commercial realities of the ocean towing of MODU’s, SPAR’s, large production structures and similar vessels engaged in the exploration and exploitation of oil and gas resources have caused a system of the Tug Master and the Tow Master having both separate and concurrent authorities and responsibilities that is unique to rig moves. The adage that: “No one can serve two masters” is trite but carries a good deal of truth. Nonetheless, the economics, the great potential for disaster with exposure to liabilities and the difficulties of distance, geographical location, rig design as well as the vagaries of wind, wave and weather have caused the insurers of, and the owners and operators of, such vessels to leave little to chance.

That being said, the required voyage and tow planning typically delineates the duties of both the Tug Master and the Tow Master. An additional consideration is whether the person in charge of the towed rig, the Offshore Installation Manager (“OIM”) is the same individual as the Tow Master. For pipelay/bury barges or jack-up rigs, for example, the Barge Engineer may be the OIM. Many semi-

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<sup>37</sup> ISM Code 1.4.1

<sup>38</sup> ISM Code 5.2

<sup>39</sup> 33 C.F.R. § 164.78(a)(1)

submersibles and self-propelled drill ships to be towed require a licensed master on board and act as OIM during a transit if the vessel is manned.

The OIM is a position, not a person and multiple individuals can fill that role. Whatever the title of the person acting as OIM, if this individual overseeing the move has little towing experience, a licensed and suitably experienced marine advisor may be required by a warranty surveyor, company procedures or common sense. Moreover, the OIM may be required to position the rig at its destination using very accurate position survey systems. This may require multiple towing vessels to assist in placement as directed by the OIM.

There is little doubt that once the towing vessel has connected its terminal gear and is underway, the master of the towing vessel is legally responsible for the conduct of the tow. In fact, where multiple tugs are engaged to tow a rig, one tug is nominated as the lead tug and the rest are subordinate to the lead tug. However, nothing limits the responsibility of the Tug Master for the safety of their own vessel during such operations. The locomotive power provided for the rig move whether from a single towing vessel or multiple tugs is just one factor of the safe and successful transit whether in field or going a distance. It takes a group of people with specialized skills, knowledge and experience to control any move—the Tug Master is just one part of the whole.

Thus, the persons overseeing the rig move, the Marine Superintendent, the OIM and/or Tow Master supervising the move and directing the tow operations all are in line of the command authority for the move. Breaking down the lines of responsibility for a rig move results in an explanation of the typical division of duties.

The OIM who may or may not be the Tow Master for a rig move bears the direct responsibility for the placement, movement on or off location and bears the ultimate responsibility for the rig's safety, commercially successful positioning and use and production of effort. The OIM is responsible for the rig at all times. Compounding the difficulty of identifying the person in charge is the fact that multiple persons may be in charge during different phases as, for example, when a jack-up rig is underway versus raising/lowering its legs. The OIM is usually the ultimate authority for the towed rig while on board and responsible for the riding crew and overall operations, including marine operations.

The Tow Master, however, directs the towing vessels operations especially for moves that have a spread of multiple towing vessels pulling in several directions. The Tow Master should be an experienced vessel master holding an appropriate, valid license and STCW endorsements and have documented experience engaged in the type of unit being mobilized. Proficiency with plans, procedures and particular guidelines is considered necessary as applicable to the unit being towed.

Water tight integrity, ballasting and de-ballasting procedures are crucial points of knowledge for the Tow Master.

Finally, the Tug Master at various points of the voyage may be considered subordinate to the OIM/Tow Master and the reverse may also be true depending upon the specific situation. While the Tug Master cannot be relieved of the solemn and ultimate authority and accountable for their vessel and the tow while underway that is vested in them by virtue of long custom, maritime law and common sense, the successful rig move is not overall controlled by the Tug Master. The comprehensive sight picture is typically retained by the Tow Master and/or OIM.

Of course, it would be inadvisable for the Tow Master to ignore the advice and observations of the involved Tug Master(s) during a rig move if it bears upon safe operations, forecast and un-forecast weather that could cause delays or other known or unknown difficulties while en route. Consideration should be given to local knowledge, preferable routing and other strategic and tactical information to safely and efficiently prosecute the voyage. Moreover, communication and pre-planning are key. The Tug Master and when employed, Tow Master should understand their respective roles, agree upon clear lines of authority at any given phase of the intended move and satisfy each other that they together have the requisite knowledge, experience and resources to carry out the mission safely. In summary, the division of authority and concurrent responsibilities for a successful rig move may appear convoluted to an outsider but this system distilled from thousands of rig moves appears to be the practical and sensible approach.

The M/V AIVIQ was a Subchapter I Certificated vessel and was manned per the Certificate of Inspection with properly credentialed mariners. As the voyage was not in Arctic waters, the Subcommittee has found that no additional training or qualifications requirements are necessary for the personnel manning towing vessels operating in Near Coastal or Oceans routes.

## **9. MARINE WARRANTY SURVEYORS**

### **Introduction**

In the planning of a rig tow, a Marine Warranty Surveyor's purpose is to use their education, experience and training to provide advice in a risk management role. Normally, a Marine Warranty Surveyor ("MWS") is hired by insurers of one or more parties to the planned towage with the goal to protect the insurers.

The MWS makes recommendations concerning best practices and specific actions that will mitigate the risk of the tow. The authority of the MWS is restricted to the principals who appointed the MWS. Although those principals may have significant influence over the operation by virtue of financial risk, the MWS does not typically have any managerial or command authority over the tug or tow. Nonetheless, sufficient autonomy must be had to provide a professional and unbiased view.

At the conclusion of a successful marine warranty survey, the MWS will typically write a report of findings and recommendations as well as issuing a Warranty Certificate of Approval.

The MWS should have experience in multiple rig moves or tows, be familiar with the proposed routing and destination, have sufficient recency in similar projects, and ideally hold a current, valid license as a Master endorsed for the routes contemplated and a towing endorsement or have held command on semisubmersibles, drill ships, MODUs and towing vessels.

One area that remains to be fully developed is a consistent method of identify, training, testing and certification of Marine Warranty Surveyors worldwide. Many companies that provide marine warranty surveyors have an internal training and vetting program. The International Institute of Marine Surveyors and Lloyds Maritime Academy among others offer coursework in marine warranty surveying. In April of 2013, the International Association of Marine Warranty Surveyors (“IAMWS”) was founded. The stated goal of the IAMWS to provide acceptable knowledge, experience and performance standards, a code of ethics and certification of individuals as a Certified Marine Warranty Surveyor.

### **9.1 Marine Warranty Surveyor Responsibilities**

The fundamental objective of the MWS is to mitigate risks of the tow in accordance with best industry practices. To do this, the MWS’ responsibilities normally include the following:

1. The MWS shall attend in a timely fashion and provide full information and, when appropriate, issue clear recommendations in writing to all parties of the tow designated by the principals.
2. The MWS shall identify and gather information from all responsible parties of the tow, towing vessel, towing equipment manufacturers, agents, insurance underwriters, naval architects, professional engineers, and other professionals to obtain clear data regarding the entire towing operation.
3. The MWS will identify the decision making person(s) regarding the compliance of all recommendations prior to the commencement of the voyage.
4. The MWS shall be satisfied, so far as possible, that the operations are to be conducted in accordance with:
  - Recognized codes of practice for design, operations and type of insured unit.
  - Best industry practice appropriate for the insured unit, equipment and vessels to conduct the operation.
  - Towed unit’s operating manual.
  - Acceptable levels of manning with appropriate skill sets, experience and licenses and certifications.
5. The MWS shall review the relevant documentation including, but not limited to:
  - a. Hull Surveys
  - b. Hull and Structural Drawings
  - c. Certification from Classification Societies
  - d. Routing Plans
  - e. Forecast, Historical and/or Expected Ocean & Weather Conditions

- f. Towing Equipment Certifications and Records
  - g. Towing Equipment Loads Related to the Expected Tow
  - h. Crew Capabilities
  - i. Written Towing Procedures
  - j. Information about prior moves
6. The MWS shall ensure that a voyage risk assessment is performed and necessary risk mitigation measures have been put in place. In any event, the MWS shall ensure that the latest version of the International Maritime Organization (IMO) guidelines for Safe Ocean Towing is followed.
  7. The MWS shall carry out suitability surveys of towed unit, its equipment and towing vessels and its towing equipment.
  8. Review weather and sea conditions and, where appropriate, incorporate requirements as to the conditions in the recommendations.
  9. Agree the data acquisition, test and analysis plans of all component equipment meets the needed best management practices.
  10. Observe and record the preparations for the proposed operations.
  11. Attend and witness critical function tests or relevant assurance tests.
  12. The MWS shall verify and report that all recommendations in the Warranty Survey are followed by the decision-making parties or the MWS will otherwise report deviations through the MWS' principals.

## **9.2 Warranty Surveying in Detail**

The next step in the evolution of determining whether or not a specific tow should go to sea, involves a few steps to provide the certification. Each one will be separately reviewed: Communication Protocol, Towed Vessel Review, Towing Vessel Review, Navigation Route, Towing Equipment, Underway & Arrival Protocol, Contingency Plans, and Drill Review

### **9.2.1 Towed Vessel Review**

The MWS must understand the limitations and capability of the towed unit to ensure that they can withstand the rigors of the proposed voyage with steps to include the following:

1. An inspection of the towed vessel, rig or unit should at a minimum encompass the actual structural condition of the vessel, including an internal examination of all accessible tanks and voids, to determine if wastage or prior damage impairs the integrity of the vessel for the proposed voyage; the number, type, and capacities of all deck hardware that will be or may be utilized during the tow; emergency pumping capabilities; examining navigation lights and signals; reviewing emergency



procedures including those for disembarkation of the crew; communication equipment and protocols; and preparations for the voyage to maintain watertight integrity and the securing of all loose equipment on board.

2. If appropriate, the analyses and recommendations of naval architects or marine engineering consultants will be reviewed.
3. A determination of the capability of the towed vessel to be pulled through the water given the anticipated sea and wind conditions, including recommendations made by any cognizant naval architecture or engineering consultants, and to specifically address towing gear and attachments, stability condition(s) of the vessel, recommended tank liquid and ballast levels, and drafts.
4. A review of plans for and an inspection of emergency towing equipment and arrangements should the main towing gear becomes unusable.
5. For unmanned vessels being towed on extended voyages, a means to remotely indicate flooding or an excessive accumulation of bilge water should be provided, which may include alarms or conspicuously painted marks at the departure draft's waterline

### **9.2.2 Towing Vessel(s) Review**

The MWS must understand the limitations and capability of the towing vessel(s) to ensure that they can provide the appropriate bollard pull in all weather conditions during the proposed voyage with inspection and evaluation to include the following:

1. An inspection of each towing vessel should include an assessment of the mechanical condition of the vessel, including propulsion machinery, steering systems, towing machinery and associated equipment such as tensioners, tension load alarm systems and bollard pull measuring devices; towing gear and fittings, emergency and lifesaving equipment; navigation lights and signals, bridge electronics including AIS, GMDSS, fathometers, VHF and HF radio equipment, radars and ECDIS; the means of obtaining weather information; proposed ballasting, the capacities and current states of fuel, lubricating oil, gear oil and hydraulic fluid, potable water, and other consumables; and the availability of tools, spares and filters/filtration systems.
2. If appropriate, the analyses and recommendations of naval architects or marine engineering consultants will be reviewed.
3. Towing vessel officers and crews are sufficient in number and appropriately qualified and certificated for the proposed voyage.
4. At the time of inspection, all relevant records should be reviewed and valid certificates sighted including but not limited to:

- a. Certificate of Registry or Documentation
- b. Certificate of Classification with appropriate Notations
- c. Certificate of International Load Line (if appropriate)
- d. International Tonnage Certificate
- e. Bollard Pull Certificate
- f. Source documentation and records of all towing vessel equipment, including certificates and test results on wires, shackles, winches, and other towing gear
- g. Documentation and records of vessel main engines and power generation engines with proof of horsepower and load capabilities
- h. Maintenance schedules of critical equipment

### **9.2.3 Navigational Considerations and Proposed Route Planning**

1. Navigation considerations and Route/Voyage Planning which involves the MWS should take into account all evolutions from the position at departure to the final destination, including any harbor or field moves, floatovers, special obstacles requiring ballasting or de-ballasting among other arrangements, canal or lock transits, river passages, ocean voyage(s), and final mooring site or disposition upon arrival.
2. A recommended weather envelope is to be generated with acceptable weather, wind speeds, sea conditions including swell and wave height considerations for roll, yaw, pitch and heave of the towing vessels and towed unit using an estimated time en route based on conservative speed estimates, Planning of specific and alternative routing includes the departure, transit and arrival routes. Special considerations should include depths for adequate bottom clearances of the towed vessel at the intended draft and the towing vessel(s) tow line catenary using expected sea states, overhead/air draft clearances, distances for search and rescue response and adequate sea-room to maintain distance off of known hazards.
3. Routing planning should include calculation of time en route with impacts on reserves of fuel, lube and other oils, potable water and other consumables with an adequate reserve of not less than 15% to 20% of the anticipated totals.
4. Where applicable, ports of refuge shall be identified along the route.

### **9.2.4 Recommendations for Towing Equipment Both on Towing and Towed Vessels**

1. All towing gear for all tows determined to be as having significant risk should be recommended to be in “as new” condition, as verified by the WMS.
2. Towing wires, cables, lines, fasteners, delta plates, sockets, and shackles shall be appropriate to the proposed tow and verified by the WMS. If necessary, consultations with marine engineering consultants and manufacturers should be performed as needed.

3. Sizing the capacities of towing gear and the determination of tow line length shall be completed based upon recommendations of the naval architecture or engineering consultants, or alternatively shall be determined in accordance with best management practices.
4. Specific details and calculations should be provided for the emergency towline and components, including plans for the stowage, breakout and deployment procedures as well as the types and sizing of emergency towing lines, wires, cables and connections.

#### **9.2.5 Communications Protocols**

1. Protocols for routine reports from the towed vessels and towing vessel(s), including distribution of reports to interested parties, are to be developed to provide the following information:
  - a. Current position, course, and speed
  - b. Wind (Direction & Force)
  - c. Seas (Direction and Height)
  - d. Distance made good
  - e. Distance to destination or next port
  - f. Fuel burned during the last 24 hours, and amount of fuel remaining
  - g. ETA at destination or next port
  - h. Apparent condition of the tow if unmanned
  - i. And if manned, condition of riding crew
  - j. Any other pertinent or desired information

#### **9.2.6 Emergency Planning and Contingency Plans**

1. Ports of refuge or identified sheltered areas for heavy weather avoidance
  2. Emergency Planning
    - a. Points of Contacts for emergencies
      - i. Federal and State authorities with search and rescue response
        1. Air Assets
          - a. Arcs of maximum reachability with adequate loitering time
        2. Marine Assets
      - ii. Assets identified and preplanned use for emergency resupplies or needed parts, spares, equipment
3. Written contingency plans at a minimum should include the following scenarios:
  - a. Tow line parting and emergency tow line deployment
  - b. Towing vessel incapacity
  - c. Towed vessel hull breach
  - d. Crew evacuation from towed vessel, if appropriate
  - e. Weather contingencies beyond predicted or expected conditions

- f. Any other emergent conditions that could reasonably be anticipated

## **10. SUMMARY**

Many owners of vessels for towing as well as MODU's have asked when you start to plan for such a move. The answer lies in the amount of data that is needed or already known concerning the specific move and the vessel being towed. Each voyage is different and requires understanding of all of the above information. Keeping records of the plans made and lessons learned during any voyage whether successful or with incident will provide the opportunity to prevent incidents during future voyages. Given that there are many entities that could become part of these moves results in the determination of when to start. If this is the first voyage for a given MODU the gathering of the information above could take months before the intended voyage. Lessons that we have learned that have led to this review indicate that each voyage is different and will require sufficient time to guarantee proper Operational Risk Management leading to the best Safety Management System.

## **RECOMMENDATIONS**

1. It is recommended that Company Policy and Procedures for Voyage Plans as outlined in 33 C.F.R. Chapter I, Subchapter P, Part 164, Section 80 (c) (3) be modified for Critical Tows as follows:
  - a. "The voyage plan must follow company policy to include but not limited to (i) – (ix)"
  - b. (x) Fuel quantity with sufficient reserve
2. It is recommended that Company Voyage Planning Policies contain Voyage Planning flow charts. Sample Voyage Planning Guidelines can be found in Appendix 4.
3. It is recommended that voyages be risk assessed during the voyage planning process, whether that be by using the process documented in this Report, or using a process delineated in the company's SMS or otherwise.
4. It is recommended that in addition to Voyage Plans, Tow Procedures must be generated for the towage of Critical Tows. Sample Tow Procedures Guidelines are provided in Appendix 3 of this Report.
5. It is recommended that the following terms be adopted:
  - a. **Tow Master** - Appointed by the Owner or Operator as Subject Matter Expert for all aspects of the Rig Move.
  - b. **Tug Master** - The master of a towing vessel
6. It is recommended that when a Tow Master is employed that:
  - a. He/she must hold appropriate licenses and certifications to command the Tug Master
  - b. He/she must have appropriate Towing Experience
  - c. Tow Master Authority and Responsibility must be identified within company Safety Management System and Chain of Command.
7. It is recommended that the Marine Warranty Surveyor Industry

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- a. develop competencies and certification for consistency in conduct of the marine warranty survey;
  - b. develop and manage common core survey elements, and;
  - a. consider adopting all or part of the Joint Rig Committee Marine Warranty Surveyors Code of Practice and Generic Scope of Work and in particular, the Rig Move Warranty Survey Code of Practice/Scopes of Work.
8. It is recommended the following Definitions be utilized to avoid miscommunication or confusion of differing standards:
- a. Metric Tonnes- DNV-RP-H103 utilizes principally metric units for analysis, and critical tows are frequently done by, and involve, international entities. It is recommended that any expression of force in Tonnes is understood to be Metric Tonnes (MT).
  - b. Safe Working Load (SWL) - The U.S. Navy Towing Manual defines SWL as follows: The load for which a rope, fitting, or working gear is designed.
    - i. It is recommended that any expression of allowable loads and load limits is understood to be Working Load Limit (WLL), i.e. the acceptable load limit after proper factors of safety have been applied. Historically, this acceptable load limit was Safe Working Load in U.S. Engineering parlance. The U.S. Navy identifies a critical caveat; shackles marked with WLL are applying an WLL for lifting and not towing. Determination of validation and verification of Working Load Limit (WLL) and/or Safe Working Load (SWL) should be part of the Proper Technical Analysis described in 7.1 above and the Sample Towing Gear Selection Flow Charts.
9. The following primary source documents (at a minimum) are recommended for consideration in performing a proper technical analysis of the proposed Critical Tow:
1. Recommended Practice DNV-RP-H013 Modelling and Analysis of Marine Operations
  2. Hancox, Michael; Towing- Oilfield Seamship Series Volume Four; Clarkson Research Services, Ltd., 2011
  3. U.S. Navy Towing Manual 1 July 2002
  4. U.S. Navy Salvor's Handbook 1 January 2004
  5. Principles of Naval Architecture
  6. Bart J. Eckhardt, Peter D. Squicciarini (2013) *Towing Vessel Safety: Risk-based Maintenance and Inspection of Towing Vessel Machinery and Systems.*

***It is important to note that no single primary source document or standard described above contains the requisite information to conduct a proper technical analysis of the proposed Critical Tow.***

10. It is recommended that the owner(s) of the towing vessel(s) and the towed vessel respectively utilize (a) qualified engineering professional(s) to perform a proper (six-degree freedom of motion) technical analysis of the proposed Critical Tow.
11. It is recommended that for critical tows towing shackles are to be double nuted, safety pinned with bolts double nuted and the bolt ends peened over.
12. It is recommended that any expression of force in tons (tonnes) is understood to be Metric Tonnes. See Table 3 in Section 7.2.1, Force Units for convenient conversion factors.
13. It is recommended that shock lines when used in lieu of surge chain be new or certified to manufacturers specification properly protected in storage, and used within the limits defined by the rope's manufacturer. Where the use of Shock Lines is contemplated, "1" shall be added to the Probability of Failure (POF) and Risk recalculated. See section 7.7
14. It is recommended that for critical tows running surfaces be polished stainless steel of a grade suited for the application.
15. It is recommended that any expression of allowable loads and load limits is understood to be Working Load Limit (WLL), i.e. the acceptable load limit after proper factors of safety have been applied (see recommendation 8.b). Historically, this acceptable load limit was Safe Working Load in U.S. Engineering parlance. The U.S. Navy identifies a critical caveat; shackles marked with WLL are applying an WLL for lifting and not towing. Determination of validation and verification of Working Load Limit (WLL) and/or Safe Working Load (SWL) should be part of the Proper Technical Analysis described in 7.1 above and the Sample Towing Gear Selection Flow Charts.
16. It is recommended that, critical tows:  
  
Multiply Extreme Towline Tension by 1, to obtain WLL of the Main Towline  
  
Multiply WLL of the Main Towline by 4 to obtain minimum required breaking strength (BS).<sup>40</sup>
17. It is recommended that, critical tows:  
  
Multiply Extreme Towline Tension by 1 to obtain WLL of the Emergency Towline.

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<sup>40</sup> U.S. Navy Towing Manual, SL740-AA-MAN-010, 1 July 2002

Multiply WLL by 10 to obtain minimum required breaking strength of the Emergency Towline.<sup>41</sup>

18. It is recommended that, critical tows:

Multiply Extreme Towline Tension by 1 to obtain WLL of the Bridle, Pennant and Surge Gear.

Multiply WLL by 4 to obtain minimum required proof load (PL) of the chain utilized.<sup>42</sup>

Chain is never to be welded on.

19. It is recommended that, critical tows shackles be double nutted and peened.

20. It is recommended that, critical tows:

Multiply Extreme Towline Tension by 1 to obtain WLL of the main shackle.

Multiply WLL by 3 to obtain minimum required proof load (PL) of the main shackle.<sup>43</sup>

21. It is recommended that, critical tows:

Multiply Extreme Towline Tension by 1 to obtain WLL of the delta plate.

Multiply WLL by 3 to obtain minimum required breaking strength (BS) of the delta plate.

22. It is recommended that, critical tows:

Multiply Extreme Towline Tension by 1 to obtain WLL of the attachment point

23. It is recommended that, if a critical tows is planned, all Terminal Gear be provided with certifications and traceability back to the original mill, and certifications that appropriate destructive type tests and non-destructive examinations (including, but not limited to x-ray) have been implemented/documented as per company guidelines (including but not limited to recognized standards) and during pre-tow preparations.

24. It is recommended that only automatic render/retrieve towing winches be utilized for critical tows. However, when assessing Risk, the worse case conditions associated with lock up (i.e. a failure of, or the inability to utilize, auto render/recovery feature) be considered. Suitable redundancy in a lock-up condition may only be realizable with multiple towing vessels.

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<sup>41</sup> U.S. Navy Salvor's Handbook, S0300-A7-HBK-010, 1 January 2004.

<sup>42</sup> U.S. Navy Towing Manual, SL740-AA-MAN-010, 1 July 2002.

<sup>43</sup> See id. pp. 3-8

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2. 46 C.F.R. SUBCHAPTER C – UNINSPECTED VESSELS
3. 46 C.F.R. SUBCHAPTER I – CARGO AND MISCELLANEOUS VESSELS
4. 46 C.F.R. SUBCHAPTER M (Proposed)

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**Enclosure (2) TSAC Task 14-01**

**TOWING SAFETY ADVISORY COMMITTEE (TSAC)**

**TASK STATEMENT TASK #14-01**

I. TASK TITLE:

Review of and recommendations based on the Report of Investigation Into the Grounding of the Mobile Offshore Drilling Unit (MODU) KULLUK (Short Title: MODU KULLUK ROI)

II. BACKGROUND:

The conically shaped Mobile Offshore Drilling Unit (MODU) KULLUK (O.N. 802785) was being towed by a single towing vessel in heavy seas off of Southwestern Alaska when the towing equipment failed. The Kulluk was manned by eighteen persons and following a near shore route from Dutch Harbor, Alaska to the Seattle, Washington area. Following the towing equipment failure, the single towing vessel experienced significant mechanical difficulties and additional response vessels were dispatched to assist the towing vessel and the Kulluk. The extreme winter weather which is typical for this geographic area and encountered during this operation compounded the challenging response efforts. The personnel were evacuated from the Kulluk due to the severity of the situation. Towing operations were reestablished at various times during the response phase of this operation and each attempt failed for a variety of reasons. The MODU Kulluk grounded off of Oceans Bay, Alaska on Monday, December 31, 2012.

III. DISCUSSION:

Within the Report of Investigation into the incident and in the interests of reducing the possibility of the occurrence of similar events, the investigators recommended that the Coast Guard partner with the Towing Safety Advisory Council (TSAC) to address the towing related issues raised by this marine casualty and the towage of MODU's in the arctic marine environment, in general.

IV. TASKS:

1. Review the Report of Investigation along with supporting information and provide comments and recommendations to the Coast Guard and the industry based on your findings.
2. Make recommendations regarding additional considerations when towing MODU's in the arctic marine environment.
3. Evaluate the practice of logging ocean towing operations for MODU's or vessels of a similar nature. Determine the effectiveness of a log being kept detailing the history of each item of the towing equipment utilized for the MODU tow. This includes shackles,

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towing plates, connector links, bridge chains, surge equipment pendant wires and othertowing connections.

4. Examine and prescribe technical standard and best practices for ocean tows of MODU's or vessels of a similar nature to include towing equipment, identification and logging of the use of this equipment, inspection regimes to include trip-in-tow and warranty surveys and non-destructive testing of towing equipment prior to tows. Development of technical standards should include review of existing primary source standards such as the U.S. Navy Towing Manual.
5. Examine and prescribe a process for the issuing of tracking certificates that accompany towing hardware. The process of issuing and tracking certificates that accompany towing hardware to include identifying a particular component by a standardized tracking method currently in review in TSAC Task Statement 13-06 - Towing Gear and that product to be formally incorporated and referenced into the KULLUK TSAC 14-01.
6. Provide a detailed review of towing configurations and tow escorts for MODU ocean tows and development of tow plans in most effective manner.
7. Evaluate usage and application of strain monitoring devices equipped on towing vessels to determine the recommended procedures to reduce the likelihood of towing equipment failures. Examine the correlation between catenary and the information provided by strain monitoring devices to effectively provide safety in towing operations.
8. Examine and make recommendations regarding the competencies and conduct of the Tug Master, and the Tow Master (if separate) for ocean towing of MODU's or other vessels of a similar nature.
9. Examine and make recommendations regarding the competencies and conduct of the marine warranty surveyor for trip-in-tow or other surveys for ocean towing of MODU's or other vessels of a similar nature.
10. Make recommendations for the development of a comprehensive process for planning and executing tows, including final tow plans, in a manner compatible with the use of a safety management system (SMS) for ocean towing of MODU's or other vessels of a similar nature.
11. Provide any other recommendations to the Coast Guard that the Committee feels is appropriate for this subject matter.

V. DUE DATE:

Provide all recommendations to the Coast Guard no later than Fall 2015.

VI. TSAC REPRESENTATIVE:

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**Enclosure (3) - TSAC Task 1-401 Sample Tow Procedure Guidelines**

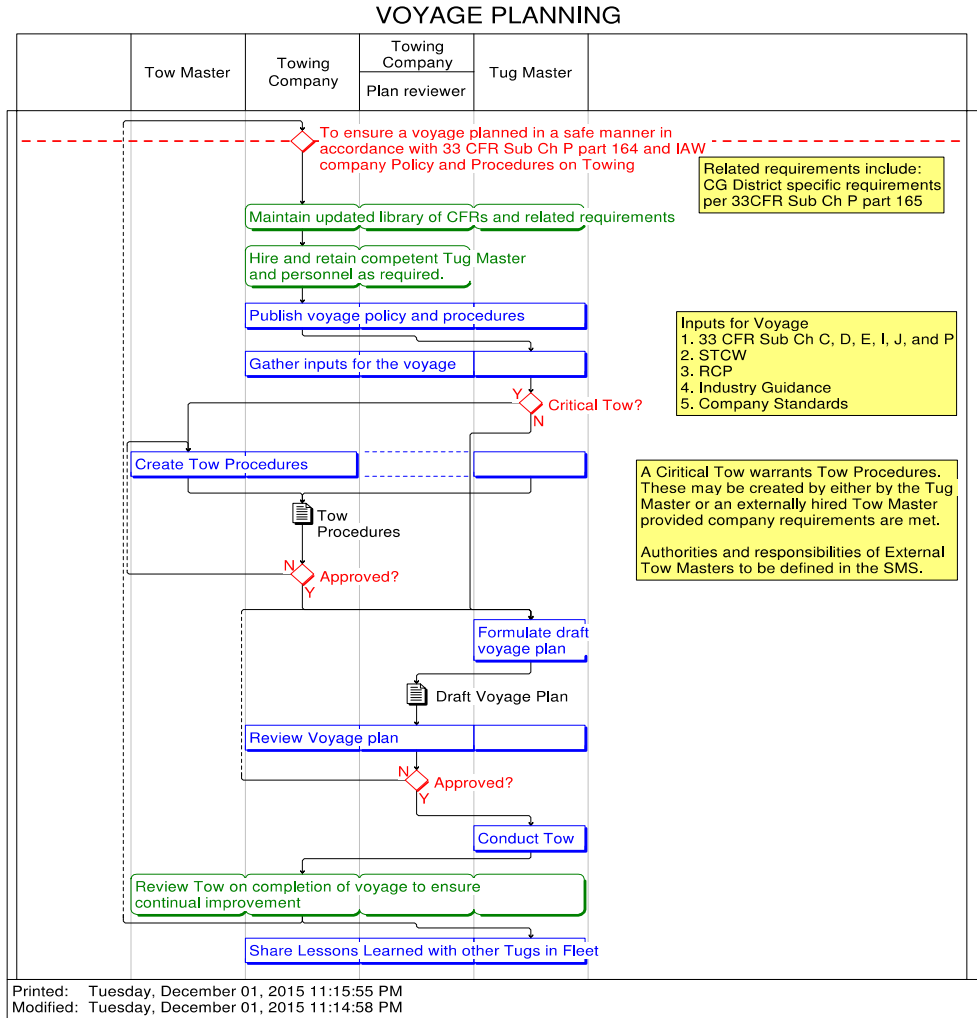
- INTRODUCTION
  - General- Executive Summary of operation contemplated
  - Requirements- List of documents and process' to be detailed later in document
  - Present Location –Details and Hazards
  - New Location - Details and Hazards
  - New Location Site Survey Information- Side Scan, Bathymetry, Soil Analysis, Debris removal, etc.
  
- RESPONSIBILITIES
  - Narrative
  - Offshore Installation Manager (OIM)
  - Rig Mover
  - Marine Section Leader (Operator's Marine Representative)
  - Appointed Marine Warranty Surveyor (MWS)
  - Vessel Masters
  - Rig Positioning Surveyor
  - Contact Numbers
  
- PRE-MOVE PREPARATIONS - Sometimes referred to as Three Phase Planning
  
- ENVIRONMENTAL CONDITIONS - Weather Working Limits at each critical point of operation and Historical data for the area. Currents included depending on the area.
  
- NAVIGATION PACKAGE – COMMUNICATIONS - Internal and External communications methods and brief explanation of Nav Package to be installed and capabilities and redundancies.
  
- DEPARTURE FROM PRESENT LOCATION - Go/No Go criteria and step by step process if warranted.
  
- TOW, ASSIST , and ESCORT VESSELS - Will detail vessels and their roles/positions during the operation
  
- UNDER TOW - Detail of route with any observations on hazards/obstructions.
  
- MOVE INTO FINAL POSITION - Go/No Go criteria and step by step process if warranted.
  
- PRELOADING - For Jackups, Go/No Go criteria and step by step process if warranted.
  
- PIRACY - Contingencies and procedures
  
- ANNEX 1: TOW ROUTE INCLUDING APPROACH DIAGRAMS AND PLATFORM LAYOUT

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- ANNEX 2: PRE-RIG MOVE MEETING MINUTES (None Recorded)
- ANNEX 3: LOCATION APPROVAL
- ANNEX 4: ENVIRONMENTAL CONDITIONS EXERPTS FROM MOM
- ANNEX 5 BOLLARD PULL
- ANNEX 6: TUG SPECIFICATIONS/ INSPECTION SHEET REVISION HISTORY



Enclosure (4) – TSAC Task 14-01 Sample Voyage Planning Guidelines



Enclosure (5) Sample Towing Gear Selection Flow Chart

