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# DNV Towing Recommendations

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**Rolf Hilmar Hansen**, Det Norske Veritas, Norway

*SYNOPSIS:* This is a review of some important towing related requirements and recommendations given in Det Norske Veritas (DNV) Rules for Planning and Execution of Marine Operations, ref. /1/, hereafter referred to as "VMO Rules" (VMO = Veritas Marine Operations). The VMO Rules was issued in 1996, based on the "DNV Standard for Insurance Warranty Surveys in Marine Operations" of 1985. Latest update of the VMO Rules was in 2000. Our experience with these Rules is discussed in the paper, and some possible future changes are indicated as well. DNV is planning to issue new, completely revised VMO Rules in 2005.

## 1 INTRODUCTION

### 1.1 Application of VMO Rules

The VMO Rules is a free-standing document within the DNV hierarchy of Rules, Standards and Certification Notes, and cannot be directly used in connection with the classification of vessels.

As the full title of the VMO Rules indicates, it covers planning and performance of marine operations, including towing operations.

The Rules contains the following parts and chapters:

- Part 1- Planning, stability, design loads, structural design.
- Part 2, Chapter 1 – Load Transfer Operations
- Part 2, Chapter 2 – Towing
- Part 2, Chapter 3 – Special Sea Transports
- Part 2, Chapter 4 – Offshore Installation
- Part 2, Chapter 5 – Lifting
- Part 2, Chapter 6 – Sub Sea Operations
- Part 2, Chapter 7 – Transit and Positioning of Mobile Offshore Units

The overall objective of the Rules is to ensure that marine operations are performed within defined and recognised safety levels.

When DNV is acting as Marine Warranty Surveyor (MWS) of a marine operation, review of documents and survey during preparations and execution of the operation is performed according to the VMO Rules. When the required documentation of an operation has been received, reviewed and approved, the prevailing conditions have been found acceptable, and all surveys completed to the DNV Marine Surveyor's satisfaction, a Marine Operation Declaration may be issued:

- For towing of a barge or a ship, DNV "Towing Declaration", will normally be used.
- For all other operations, DNV "Marine Operation Declaration" will be used.

Also, the VMO Rules is often a contractual document for development of offshore oil/gas fields, which contractors have

to deal with and warranty surveyors have to inspect in accordance with, regardless of the name of the actual MWS-company.

### 1.2 Salvage operations

Salvage operations are not particularly covered in the VMO Rules. It is realised that during salvage of a vessel (in particular with crew and passengers onboard) one often has to use the equipment and resources available on site, regardless of rules and regulations. However, the recommendations to capacity and strength of tugs and equipment given in the VMO Rules may still be useful during salvage operations.

### 1.3 References

- /1/ DNV Rules for Planning and Execution of Marine Operations, 1996/2000.
- /2/ DNV Rules for Classification of Ships.
- /3/ IMO Circular MSC/Circ.884 – Guidelines for Safe Ocean Towing, 1998.
- /4/ ITS 2002 – Paper "Bollard Pull" by Hannu Jukola and Anders Skogman, Steerprop Ltd.

## 2 OPERATIONS

### 2.1 General

Regardless of the technical condition of towing vessel, equipment and towed object as addressed in the following chapters, the success of the towing operation is highly depending on the standard and experience of the crew, and in particular the master. This issue is not discussed further in this paper; it is assumed that the crew holds the relevant certificates and that proper seamanship will be exercised.

### 2.2 Weather routing

Towing operations may be categorised as;

- unrestricted or
- weather routed.

Marine operations with an operation reference period,

exceeding 72 hours are normally defined as unrestricted operations. Environmental criteria for these operations shall be based on extreme value statistics. However, the design criteria for determination of *minimum towing force* for open sea towing (i.e. unrestricted towing) is fixed (see sect. 3.2) and not based on actual statistics for the towing route and season.

A towing operation may be weather routed (i.e. weather restricted) due to limitations on the towed object. Weather routed tows shall seek shelter if weather situations exceeding the operation criteria are forecasted or experienced. Ports of refuge and/or area of shelter shall be defined in the towing procedures. Entrance, geography and size of shelter shall be considered. Weather routing criteria will normally be given as recommendation on the towing certificate/declaration issued by the MWS.

Regardless of category (unrestricted/weather routed) of the towing operation, a tow out criteria of Beaufort Force 5 or better for the coming 24 hours is normally applicable. The intention with the tow out criteria is to allow time for familiarisation with the tow, and to ensure adequate distance to shore in case of adverse weather conditions.

*DNV experience: There have been weather routed towing operations where the forecast for the route seems not being conscientiously assessed onboard the tug, and bad weather encountered resulting in towline breakage and/or damage to the towed object. In principle, such action of the tug master (or lack of action!) may be classified as "breach of warranty" and may render the insurance of the towed object invalid.*

### 2.3 Voyage reporting

Daily voyage reporting to owners of tug and towed object is normally required, and should at least contain position, sea condition, speed, ETA and status of tug and towed object. The reports should be copied to the MWS.

*DNV experience: Even if voyage reporting is given as a recommendation on the DNV Towing Declaration, the report is often not copied to DNV. This is unfortunate in case of incidents occurring during the tow, and may cause embarrassment towards the insurance.*

### 2.4 Towing manual

A towing manual shall be prepared and distributed to key personnel.

The manual shall normally contain information regarding;

- tow out criteria,
- criteria for seeking shelter,
- towing route,
- ports/areas of shelter,
- estimated towing time (ETD, ETA),
- environmental limitations w.r.t. structural capacity of object, seafastening, etc.,
- contingency actions,
- description of the ballast condition,
- reporting routines for progress of the tow, ETA, status, etc.,
- contact persons and telephone numbers,
- expected environmental conditions for the intended towing route for the relevant season, and

- procedures for departure and arrival as well as calls at intermediate ports.

The tow master (usually the tug master) shall familiarise himself with the towing manual.

## 3 TUG

### 3.1 Type, size and classification of tug

The towing vessel can be a tug, an anchor handler, or a type that combines these functions with several others, and have the Class Notation "Tug". The main requirement is that the vessel must be equipped with a remote operated towing winch. The background for the towing winch requirement is at all times to have the flexibility to adjust the length of the towing line according to environmental conditions, water depth, other traffic, and width of the navigated area. Formally there is no minimum size/length of a tug, but vessels for open sea towage shall not have any service restrictions. Note that the VMO Rules penalise tugs of less than 45m length with respect to towing efficiency, see 3.2 below.

DNV is considering redundancy requirements on critical systems (propulsion, steering, winch, etc.) for tugs performing towing of "high value" objects in the next revision of the VMO Rules.

The tug must, of course, hold valid statutory certificates and trading permit and will be inspected by the MWS prior to commencement of the towing operation. Class is formally not required; a certificate from the national maritime authority is also acceptable.

Tugs with a towing hook only (i.e. no towing winch) are not accepted by DNV for ocean towing, but may be permitted for towing in harbours or towing jobs of short duration/length in sheltered waters.

*DNV experience: There have been a few cases where tugs have been turned down at the time of inspection by the DNV marine surveyor due to gross overdue validity of certificates or a general unsatisfactory condition of the tug (e.g. fuel oil spill/leaks in the engine room).*

### 3.2 Minimum bollard pull of tug

According to the VMO Rules towing force for open sea towing shall be sufficient to maintain zero speed under the following conditions:

- sustained wind velocity  $V_w = 20$  (m/s),
- head current velocity  $V_c = 1$  (m/s), and
- significant wave height  $H_s = 5$  (m).

Towing force for coastal towing and towing in narrow or shallow waters representing a danger for grounding, shall be sufficient to maintain a speed over ground, in safe direction, of minimum 2 knots under defined environmental design conditions. Note that for an area with strong current this may lead to higher towing force than required for ocean tow. Also, passage through narrows may require additional tug(s) connected to the stern of the towed object.

Required tug bollard pull (BP) shall be estimated based on calculated required towing force and tug efficiency in waves.

*DNV experience: The DNV BP criteria seems to be*

established and accepted by the industry, even though the current criteria is 1.0 m/s, compared with 0.5 m/s given in the IMO Guidelines ref. /3/. Usually the current resistance is the least part of the calculated total towing resistance (contributions from wind, waves and current).

### 3.3 Tug efficiency

Unless more accurate calculations or model tests of towing efficiency of the tug in waves are made, the continuous static bollard pull stated in the bollard pull certificate shall be multiplied with an efficiency factor:

$$\gamma_{TE} = 0.75(1 - \gamma_L)$$

where

$\gamma_{TE}$  : tug efficiency factor

$\gamma_L$  : tug length factor,  $\gamma_L = (1 - L/45)^2$

L : tug length (m), not to be taken more than 45 m

For tugs performing weather routed towing or towing in protected areas/harbours, a tug efficiency factor below may be used instead:

$$\gamma_{TE} = (0.875 - \gamma_W/8)(1 - \gamma_L * \gamma_W)$$

where

L : length of tug (m), not to be taken more than 45 m

$\gamma_L$  : tug length factor,  $\gamma_L = (1 - L/45)^2$

$\gamma_W$  : wave factor,  $\gamma_W = H_s/5$

H<sub>s</sub>: limiting significant wave height (m) for the weather routed towing operation, or the probable significant wave height in the protected area/harbour. H<sub>s</sub> is not to be taken less than 1 meter and not more than 5 meter in this equation.

The resulting tug efficiencies from the formulas above are given in Table 1. It is clear from the formulas and the table that for a tug of more than 45 m length its efficiency for ocean towing (i.e. unrestricted towing) is found to be,  $\gamma_{TE} = 0.75$  and for weather routed towing maximum  $\gamma_{TE} = 0.85$ .

### 3.4 Bollard pull certificate

All towing vessels should have a bollard pull (BP) certificate. Such certificate is also required in the VMO Rules. Usually

the BP certificate is issued by the classification society of the vessel, after a BP test. Several of the classification societies (including DNV) have procedure for such tests which is more or less in line with the bollard pull test procedure given in Appendix A of the IMO Guidelines ref. /3/.

The adequacy or precision of the various BP test procedures may of course be discussed, see e.g. ITS 2002 paper from Steerprop Ltd., ref. /4/. The DNV BP test procedure is therein considered to be one of the better ones. We do however agree with Steerprop Ltd. that a more detailed commonly accepted test procedure would be advantageous for the towing industry and their clients.

Note that according to the VMO Rules the bollard pull certificate (and the test!) shall not be older than 10 years. Also, if the vessel has undergone significant structural or machinery changes a new bollard pull test may be required and could also be advantageous with respect to the BP figure.

*DNV experience: There are tugs with dubious BP certificates, either far too old or issued by unknown bodies/consultants. We have also experienced certificates based on theoretical calculations, which is of course unacceptable as a BP certificate.*

*When acting as MWS, DNV will in such cases either reject the tug or determine the BP to be used as follows:*

– Tug with propeller nozzle: BP = BHP/90

– Tug without nozzle: BP = BHP/110

(BHP = brake horse power of the propulsion machinery)

### 3.5 Equipment of tugs

- For ocean towing the towing vessel shall be equipped with a certified towing winch of capacity matching the bollard pull, remote operated from the wheelhouse and with towline load monitoring.
- One spare towline of minimum length and strength as required for the main towing line shall be onboard the towing vessel, preferably on a separate drum on the towing winch or on a storage drum.
- At least one suitable workboat with propulsion should be

**Table 1 Tug efficiency,  $\gamma_{TE}$**

Tug length (m)	Unrestricted towing	Weather routed towing/harbour Sign. wave height HS (m)				
		1.0	2.0	3.0	4.0	5.0
10	0.30	0.75	0.63	0.51	0.40	0.30
20	0.52	0.80	0.72	0.65	0.58	0.52
30	0.67	0.83	0.79	0.75	0.71	0.67
40	0.74	0.85	0.82	0.79	0.77	0.74
50	0.75	0.85	0.83	0.80	0.78	0.75
60	0.75	0.85	0.83	0.80	0.78	0.75
70	0.75	0.85	0.83	0.80	0.78	0.75
80	0.75	0.85	0.83	0.80	0.78	0.75
90	0.75	0.85	0.83	0.80	0.78	0.75
100	0.75	0.85	0.83	0.80	0.78	0.75

carried onboard for transferring personnel and equipment from the tug to the towed object.

*DNV experience: In the next revision of the VMO Rules it will probably be required that ocean-going tugs shall have the spare towline on a separate drum on the winch.*

## 4 TOWING LINE

### 4.1 Minimum length and strength of towing line

For unrestricted towing VMO Rules require that the main towing line shall have a length of not less than 2000BP/MBL. The certified minimum breaking load (MBL), in tonnes, of the main and spare towing lines (steel wire ropes) shall be taken as:

- 3.0 BP                      BP ≤ 40
- (3.64 – 0.8 BP/50)      BP 40 < BP < 90
- 2.2 BP                      BP ≥ 90

where

BP : continuous static bollard pull of the vessel in tonnes.

These recommendations to towline strength are equal to the requirements for the additional Class Notation “Tug” in DNV Rules for Classification of Ships, ref. /2/.

The resulting towline length and MBL is shown in Table 2.

*DNV experience: The towline MBL requirement is now found to be reasonable after being reduced for smaller tugs in the 2000-revision of the VMO Rules. Most tugs seem to comply with the minimum requirements, even if the 2.2 factor for tugs of more than 90 t BP is higher than the 2.0 factor recommended in the IMO Guidelines ref. /3/.*

### 4.2 Fibre rope pennant

Synthetic fibre rope pennant (“stretcher”) should normally not be used where there is adequate depth and sea room to

allow for sufficient shock absorbing in the tow line catenary. If fibre rope pennants are used the pennants shall be in as new condition.

Minimum breaking load of any fibre rope pennants shall not be less than;

- 2.3 times the tow line MBL for tugs with bollard pull less than 50 tonnes,
- 1.5 times the tow line MBL for tugs with bollard pull greater than 100 tonnes, and
- linearly interpolated between 1.5 and 2.3 times the tow line MBL for tugs with bollard pull between 50 and 100 tonnes.

The resulting fibre rope MBL is included in Table 2.

*DNV experience: DNV is in principle reluctant to the use of fibre rope pennant/spring during ocean towing. Our experience is that these pennants are often “used up” before new ones are purchased. However, we are at present looking into the 1.5 – 2.3 additional safety factor on fibre rope pennants required by the VMO Rules and may reduce this factor in the next revision. It will then be even more important that such pennants are in “as new” condition, as recommended in the VMO Rules.*

### 4.3 Condition of towing lines

Before departure an inspection of the towing wire ropes shall be performed by the DNV marine surveyor. At least the first 50 metres of the towing wire should be streamed for inspection.

According to the VMO Rules the towing line shall not be used if the reduction of towline strength due to wear, corrosion and broken wires exceeds 10 per cent and there is severe kinking, crushing, or other damages resulting in distortion of the rope structure. Also, the tow line should be subject for special evaluations if number of broken wires over a length of 7 times the tow line diameter exceeds 6 per

**Table 2 Minimum towline length and MBL of steel wire rope and fibre rope pennant**

Tug bollard pull (tonnes)	Towline length (m)	Steel wire towline MBL (tonnes)	Fibre rope pennant MBL (tonnes)
20	667	60	138
30	667	90	207
40	667	120	276
50	704	142	327
60	746	161	344
70	794	176	349
80	847	189	344
90	909	198	329
100	909	220	330
120	909	264	396
140	909	308	462
160	909	352	528
180	909	396	594
200	909	440	660
250	909	550	825
300	909	660	990

cent of total number of wires in the rope, if significant wear of outer layer of wires are found or if the tow line is found significantly corroded.

Wire rope end sockets or other end connections should not be older than two years, depending on the extent of use (wear and tear). Soft eye is not accepted, and neither is the use of wire rope clips to make an end eye on the towing line.

A log for the towing lines shall be kept onboard, giving the following information on each rope;

- date taken in use,
- records of inspection,
- date of renewal of end sockets or other end connections and
- report on damage to the rope.

*DNV experience: There have been several cases where the towing wire rope has failed inside the spelter socket probably due to improper casting with resin compound. It requires special training to perform proper “socketing” of a new spelter socket to the tow wire. Bad “socketing” may not be visual afterwards.*

## 5 TOWED OBJECT

### 5.1 Towing bridle and brackets

A bridle should preferably be used for connection of the tow line to the towed object. Chains should be used in the way of chafing areas such as fairleads.

Each single leg, components and connections (shackles, rings etc.) in the bridle shall have a MBL not less than the MBL of the main tow line. Reductions of equipment MBL due to bending in way of fairleads, end connections etc. shall be considered. Fairleads shall have a shape preventing excessive bending stress in the chain links/wire.

Shackles, rings etc. are normally acceptable if stated safe working load (SWL) is minimum 1/3 of the main towline MBL.

A towing bridle should normally be attached to towing brackets. Towline brackets/attachments (including emergency towline attachment) shall be designed to resist towline pull from any likely direction (usually  $\pm 90^\circ$ ), with the use of fairleads if necessary. The ultimate capacity of any towline attachment (bracket, bollard and their foundations) shall not be less than 1.3 times the MBL of the towline.

*DNV experience: There have been cases where the tug has an oversized towline (MBL more than 4 times the BP of the tug) leading to an unusual high requirement to towing bracket capacity. In the next revision of the VMO Rules it will probably be introduced alternative recommendations (technical or operational) covering such cases.*

*The towing bracket capacity may also be insufficient if the actual tug is significantly more powerful than needed or planned. This problem is usually overcome by giving the master of the tug a recommendation on maximum towline pull to be exercised during the tow.*

### 5.2 Emergency towing line

An emergency towing wire rope of minimum length equal to the length of the towed object shall be connected to a bridle or single leg connection, and lashed to the barge side for easy release. A recovery trailing line with a pick-up buoy shall be fitted to the emergency towing wire rope. The trailing line shall be of floating material and shall have a minimum breaking load not less than 30 tonnes. The distance from the aft extremity of the towed object to the buoy shall not be less than 50 metres. In addition to the trailing line, a messenger line of length 100 metres may be considered necessary between the buoy and the trailing line.

*DNV experience: It is crucial that the emergency towing line arrangement has sufficient length and strength to facilitate pick-up and connection to the towing vessel and continuation of the towing operation .*

### 5.3 Behaviour of towed object

The steering quality and the rolling of the towed object may depend on several factors; shape of underwater body, trim, draught, stability, rudder/skeg, bridle or single leg, towing speed, etc. The VMO Rules recommend minimum 0.5% (of object length) trim by stern to help the steering characteristics.

*DNV experience: There have been cases where the towed object yawed violently even with towing in a bridle, and call at the nearest port for corrective actions became necessary. Rudder or skeg will always be advantageous, and change in ballast condition may also help.*

### 5.4 Other requirements

- The towed object (barge, ship or any other self-floating structure) shall have sufficient stability and water- and weathertight integrity for the towing operation. The stability shall be documented to be in compliance with relevant criteria.
- If bilge pumps are not fitted on the towed object, bilge suction may be arranged by portable pumps placed on board, powered from the tug.
- There shall normally be an anchor with cable onboard for emergency use, rigged for easy release.
- For unmanned towed objects, means for entering from the tug shall be arranged on both sides.
- Navigation lights and signals to be installed on the towed object.
- Towing of ships; securing of propeller shaft axial and against rotation if shaft is disconnected from engine/gearbox, securing of rudder if disconnected from steering gear.

*DNV experience: Watertightness of the towed object is an obvious important element. There have been cases where a partly completed hull has been towed to a new shipyard for completion. Propeller and shaft have been installed before departure, but not gearbox/engine. Due to insufficient securing of the propeller shaft it came loose (slipped backwards) and caused leakage through tailshaft sealing which flooded the engine room and nearly sunk the vessel.*

## DISCUSSION – DAY ONE, PAPER No. 7

**Joop Timmermans**, International Transport Contractors Management BV

I have two questions. The IMO guidelines for safe ocean towage feature quite prominently in your paper. My understanding is that they have never been adopted. Is that correct? And why do they then feature so prominently?

**Rolf Hilmar Hansen**

You mean that the IMO guideline is not adopted?

**Joop Timmermans**

No

**Rolf Hilmar Hansen**

OK

**Joop Timmermans**

I am asking that question of you.

**Rolf Hilmar Hansen**

I don't know, but you can find it in the IMO Official.....

**Joop Timmermans**

As far as I know, they have never been adopted. Secondly, has DNV ever rejected a towing vessel based on the experience of the tug's crew? Of the lack of experience of the tug's crew?

**Rolf Hilmar Hansen**

Yes, once.

**Joop Timmermans**

Only once. I feel there is quite a debate about bollard pull certification, but there is never a debate about the experience of a tug's crew. Surveyors never put criteria on what the experience is of a master of a tug – have you done so many ocean crossings; have you done this or that? That is never put on paper.

**Rolf Hilmar Hansen**

I'm not quite sure, in fact.

**Joop Timmermans**

We towed some of the 'ghost ship' fleet from the United States to the UK, and one of the recommendations of the surveyor was that the master had to have experience with at least three double-tows across the Atlantic. The chief mate had to have experience with at least one double-tow across the Atlantic, and the bosun had to have at least three double-tows across the Atlantic, as well. I thought that is something which not many companies can do. Fortunately, we could do it, but I think those are the recommendations we are looking at.

**Rolf Hilmar Hansen**

You mean this was a requirement from DNV? In our view, if

you have all the papers, the certificates and so on, for the personnel, it's very rare that the marine warranty surveyor has any additional requirements in this regard.

**Joop Timmermans**

The surveyor puts these additional recommendations to the tug's crew. I think you could do more in that respect at DNV.

**Rolf Hilmar Hansen**

OK. What we should like to see is to get something written on this, because we could then be able to include that in our next revision of the rules, and I guess your comments now will be included.

**Johan de Jong**, MARIN

I would like to ask you a question about a table you presented on the tug efficiency; this is also on page 3, and it shows the relation between tug lengths and sea state and the resulting tug efficiency. Could you explain to me a little bit what the underlying data are for that formula? Is it based upon experience from DNV with executed or performed tows, or is it based on any research data. So, I'm referring to Table 1, Page 3, which I think you also showed on one of the slides.

**Rolf Hilmar Hansen**

The table there is based on some stats on some papers we had on tug efficiency, but then we just developed some curves, which approximately go through those points. It also takes into account that this 45m length of a tug, which some 30 years ago, defined in DNV internal guidelines for towing, the tug should preferably be more at 45m in length. And then we just developed some curves off that, and we ended up with these factors here. For ocean-going tows, you will rarely have a tug with less than 30m in length, I guess. So the part of the table for the really small tugs is not so relevant for ocean-going tugs.

But back to your question, it's not based on any special towing test or anything from this. It's just a couple of figures that we had from some old papers.

**Robert Underhill**, Jayco Mooring & Rigging

A rope salesman's question – has any consideration been given to looking at the use of HMP ropes, Spectra Dyneema-type ropes in place of wire?

**Rolf Hilmar Hansen**

Yes, we are in fact looking into it. So it may happen in the next revision of the rules. But I guess this is very interesting for the tug owners; I don't know whether any tug owners had taken Dyneema or similar ropes in use as the main towline yet. I don't think so, but it is very interesting, so we may in fact try to include something as I said, in the next revision if it's not too early. We'll look into it.