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CRUDE OIL TANKER CARGO PLAN PROPERTIES

Assoc. Prof. Dobrin Milev, PhD

Department of Operation and Management of Maritime Transport

“Nikola Vaptsarov” Naval Academy

Phone: 0895 742374

E-mail: d.milev@nvna.eu

***Abstract:** All cargo operations on board crude oil tankers have to be carefully planned and documented well in advance of their execution. The details of the cargo plan must be discussed with all the crew involved in the operations, both on the vessel and at the oil terminal. The operational plan sometimes requires modification after following consultation with the terminal's loading master and following changing circumstances on the ship and ashore. Any changes must be duly recorded and brought to the attention of all parties concerned.*

The loading plan of a crude oil tanker and especially of a double hull tanker must take into account the ship's stability instructions, available on board in the trim and stability booklet and need to avoid excessive free surface moments with the consequent loss of stability. Depending on the design, type and number of the ship's tanks, the free surface effect could result in the transverse metacentric height being significantly reduced. The situation will be most severe in case of wide cargo tanks with no centreline bulkhead and ballast tanks with the shape of letter "U".

The most critical stages of any cargo operation are during filling the double bottom ballast tanks when discharging of cargo, and emptying the tanks during loading of cargo. It is the responsibility of the cargo officer to prepare reliable cargo plan having in mind all the ship's operational and constructional properties. All of them must be considered and presented to the crew involved in the operation.

Keywords: Crude Oil tanker, Cargo Plan, Loading, Discharging, Stability

INTRODUCTION

The loading plan of an Oil Tanker and especially of a Double hull Tanker must take into account the ship's stability instructions (Trim and Stability booklet) and the need to avoid excessive free surface with the consequent loss of stability.

Depending upon the design, type and number of these tanks, the free surface effect could result in the transverse metacentric height being significantly reduced. The situation will be most severe in cases of wide cargo tanks with no centreline bulkhead and the so-called "U ballast tanks, which have no centreline bulkhead. (ISGOTT, 6th Edition, OCIMF)

The most critical stages of any operation will be whilst filling the double bottom ballast tanks during discharge of cargo, and emptying the tanks during loading of cargo. If sufficient cargo tanks and double bottom tanks are slack simultaneously, the overall free surface effect could well be sufficient to reduce the transverse metacentric height to a point at which the transverse stability of the ship may be threatened. This could result in the ship suddenly developing a severe list. Large free surface area is especially likely to threaten stability at greater soundings with associated high vertical centre of gravity. It is imperative that tanker and terminal personnel involved in cargo and ballast operations are aware of this potential problem, and that all cargo and ballast operations are conducted strictly in accordance with the ship's loading manual. Where they are fitted interlock devices to prevent too many cargo and ballast tanks from being operated simultaneously, thereby causing an excessive free surface effect should always be maintained in full operational order and should never be over-ridden. (International Convention for the Control and Management of Ship's Ballast Water and Sediments)

EXPOSITION

1. Cargo Plan

1.1. Roles and Responsibilities

The Chief Officer is responsible to create a cargo plan for the intended cargo operation.

Master's verification and approval has to be obtained. The plan must be communicated to all Deck OOWs and Chief Engineer and ensure their understanding and ask them to countersign it.

Cargo plan details discussion has to be conducted, as well as any changes thereafter with terminal representatives. In case of changes to the cargo plan, the Master must reapprove it and Deck OOWs countersign it. A copy of the cargo plan must be send to the shipping company for review.

1.2. Preparation for Cargo Plan

For the preparation of the cargo plan, the Chief Officer shall consider:

- Cargoes to be handled quantity and characteristics, i.e. density, temperature, etc.;
- Cargo segregation requirements and intended loading and discharging sequence;
- Changes in Load Line zones along the intended route;
- Differences in sea water density between loading and discharging ports and along the intended route;
- Draft limitations in loading and discharging ports and throughout the intended route, including air draft where applicable;
- Limitations at manifold height from waterline during cargo operations;
- Condition of vessel's cargo tanks and systems;
- Crude oil washing requirements;
- Avoidance of slack tanks;
- Reid vapour pressure;
- Hull stress, trim and stability at all stages of cargo operation and voyage.
- Cargo's thermal expansion when sailing to a warmer climate, even in case of an unplanned change in voyage orders, or when heating-up cargo (Load Lines Convention 1966, IMO);
- Safeguards against contamination.
- Consumption of bunkers and fresh water and intended bunkering operations;
- Keep the vessel always afloat;
- Never load any cargo or slop tank to a level exceeding 98% capacity;
- Ensure that moulded draft amidships is never less than the formula:

$$2.0 \text{ meters} + 0.02 * \text{LOA (Length overall)} \quad (1)$$

- Check on board cargo and ballast quantity and comply with terminal's requirements, for example, some terminals require that vessel's deadweight is never less than 30% of her summer deadweight (DW) by the formula:

$$\text{Ship's DW} = 30\% * \text{DW summer} \quad (2)$$

1.3. Cargo Handling Plan

The following information must be specified in the cargo plan, which is common for the loading and discharging plan (<https://www.marineinsight.com/>):

- ✓ Quantity and grade of each parcel;
- ✓ Cargo tanks to be used and ullages at different stages of operation;
- ✓ Density, temperature and other relevant properties;
- ✓ A plan of the distribution, lines and pumps to be used;
- ✓ Transfer rates and maximum allowable pressures;

- ✓ Line up of manifold, crossover, drop, block, bulkhead, vent and IG valves;
- ✓ Critical stages of the operation;
- ✓ Notice of rate change;
- ✓ Venting requirements;
- ✓ Details of deck watch procedures (e.g., tending moorings/ gangways);
- ✓ Stability and stress information;
- ✓ Drafts, trim and list;
- ✓ Ballast operations;
- ✓ Emergency stop procedures;
- ✓ Emergency spill procedures and spill containment;
- ✓ Health hazards in case of oil spill;
- ✓ Hazards of the particular cargoes, e.g. content of toxic gas, and necessary safety procedures;
- ✓ Personal Protective equipment needed for crew and visitors;
- ✓ Charterer's special instructions related to cargo and port operations.

Other relevant details of operation, as applicable could be the precautions against static generation, initial start-up rates, control of cargo heating systems, line clearing, under keel clearance limitations and bunkering.



Figure 1. Loading and discharging software

Chief officer has to be familiar with the on board loading instrument for the preparation of the cargo plan. A separate computer is dedicated for the installation of cargo loading and discharging software presented on Figure 1.

For the loading cargo plan as particular operation the specific procedures are (<https://knowledgeofsea.com/>):

- ❖ Sequence of loading;
- ❖ Topping off method and sequence;

- ❖ Identification of "crash" tanks;
- ❖ Minimum number of valves to remain open.

For the discharging cargo plan the difference is in the following operations:

- ❖ Sequence of discharge;
- ❖ Draining sequence;
- ❖ Crude oil washing procedures
(<https://www.imo.org/en/OurWork/Environment/Pages/Crude-Oil-Washing.aspx>);
- ❖ COP (Cargo Oil Pump), RPM (Revolutions per minute)/pressure restrictions;
- ❖ Inert gas operations.

The cargo and ballast history should be recorded in the "Cargo & Ballast History Log" and in the "Ballast Water Record Log", (MARPOL, Consolidated Edition).

2. Stress and stability

2.1. Stress Calculation

The Chief Officer must ensure:

- Builder's recommended limits are not exceeded at any stage of voyage, cargo or ballast operations.
- Distribution of cargo, ballast, fuel and fresh water meets requirements for stress, trim and draft, including all anticipated conditions of partial loading and partial discharge.
- Planned sequence of cargo, ballasting and bunkering operation meets requirements of stress, trim and draft.
- Recording of stress calculations every hour.

All records of stress calculations must be retained on board for a period of 2 years, in case of further claims on the operations performed shown on Figure 2.

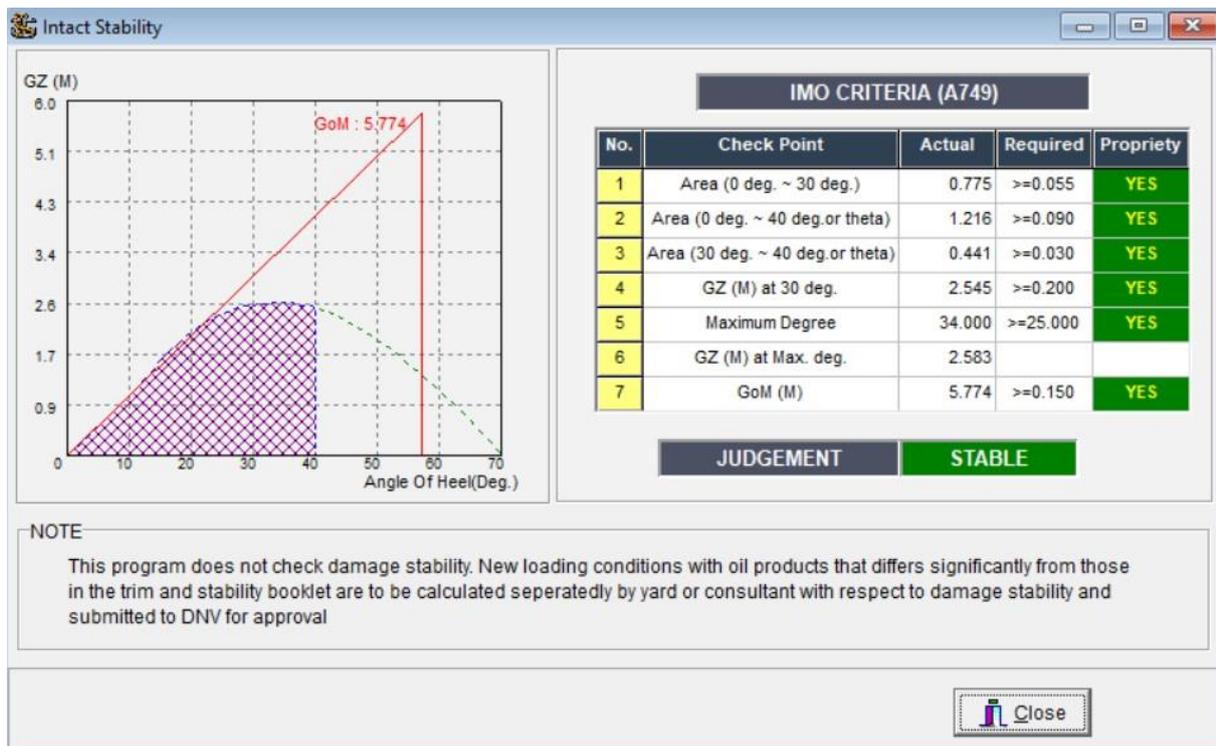


Figure 2. Ship's loading instrument calculation for stability

2.2. Stability Considerations and Free Surface Effect

Large number of slack tanks will result in reduction of Transverse Metacentric Height (GM) due to free surface effect. The most critical stages of any operation are:

- ✓ Filling the double bottom ballast tanks during discharge of cargo;
- ✓ Emptying the ballast tanks during loading of cargo;
- ✓ Partial loading/discharge of cargo.

The Chief Officer must:

- ✓ Plan cargo and ballast operations in line with ship's stability booklet.
- ✓ Keep partially filled tanks to a minimum.
- ✓ Ensure that Deck OOWs are familiar with free surface effects and any vessel's inherent stability issues.
- ✓ Constantly monitor the shear forces and bending moments on the ship's loading instrument on Figure 3.

2.3. Loss of Stability

In case of loss of stability, the Chief Officer shall apply the following principles (EPA - Environmental Protection Agency, VGP Vessel's General Permit) :

- ✓ Notify terminal.
- ✓ Cease all cargo, ballast and bunker operations and prepare a plan for restoring positive stability.
- ✓ Increase the GM by lowering the vertical centre of gravity.
- ✓ Consider the moorings; never attempt to control a list by adjusting mooring rope tension.

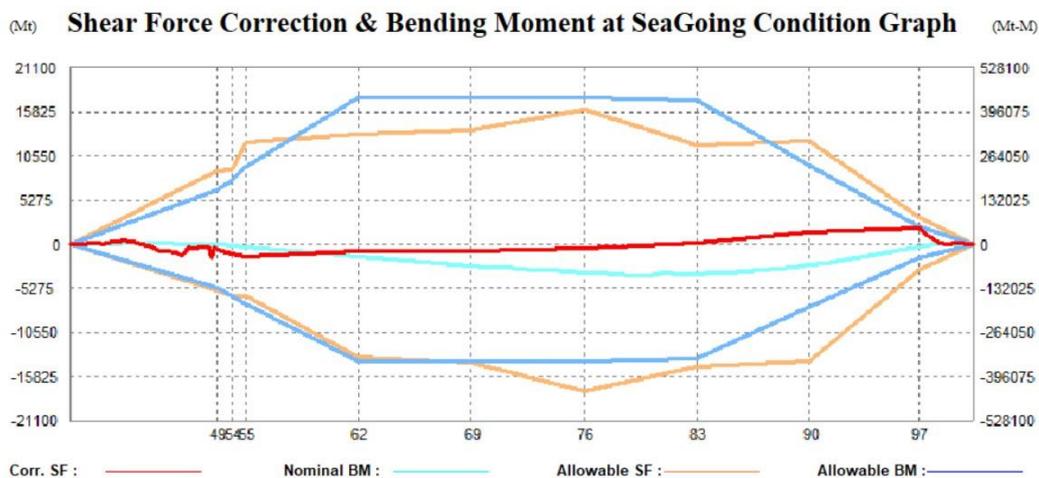


Figure 3. Ship's loading instrument calculations for bending moments and shear forces

Double bottom ballast tanks have to be filled slack, starting with those on the low side, followed by the high side ones. Filling compartments on the high side, will likely result in a violent change of list to the opposite side.

The empty double bottom ballast tanks must be filled in case the pressing up of slack double bottom tanks is insufficient to regain stability. This will initially result in a further loss of stability caused by the additional free surface effect but the added mass below the vessel's original centre of gravity will soon restore stability.

If a loss of stability becomes evident during loading or discharging all cargo, ballast and bunker operations must cease and a plan is prepared for restoring positive stability.

In general the following principles will apply:

- The vertical centre of gravity must be lowered in the most effective way.
- Where slack double bottom ballast tanks exist, these should be filled, starting with those on the low side, followed by those on the high side.
- If the pressing up of slack double bottom tanks is insufficient to regain stability, it may be necessary to consider filling empty double bottom ballast tanks. It must be recognized that this will initially result in a further loss of stability caused by the additional free surface effect; this, however, will soon be corrected by the effect of the added mass below the vessel's original centre of gravity.
- No attempt should be made to correct a list by filling compartment on the high side. As this is likely to result in a violent change of list to the opposite side.
- The restraint provided by moorings should be considered. To attempt to control a list by adjusting mooring rope tension could be dangerous and is therefore not recommended. In completion of loading, the number of lashing holds should be at a minimum and in any event of more than specified in the stability information book.

CONCLUSION

Crude oil tanker cargo plan is an essential element of the vessel's operation. It's a combination of knowledge and good sea practice on the account of the chief officer responsible for the cargo operation. Based on the loading instrument and all the international maritime regulations, it must be prepared to assure the ship's stability and operational requirements. It has a lot of properties to be observed gained from the experience and experimental research of the ship's operators.

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