Chapter 5

Final Stage of the Discharging Operation

§ Procedure for implementing the final stage of the discharging operation

Discharging operation at the final stage should be implemented according to the procedure given below.

1. Measures when the oil level decreases (P5-2 to P5-3)

[Click here to view video – 041.mp4]

Appropriate measures should be adopted when the oil level decreases. These measures include selection of pump and line, isolating or changing over the suction line and so on. (Refer to Chapter 3.)

2. Changing over the grade of oil (P5-4 to P5-6)

When multiple grades of oil is loaded (if 5 or 6 grades of oil are added to the commingling tank, the result may be 8 to 9 grades of oil), it need to change over the grade of oil may arise at the end of the discharging of each grade of oil at the discharging port.

This work will not arise if only one grade of oil is loaded.

3. Stopping the cargo pump (P5-7 to P5-8)

To stop the cargo pump, reduce the pump rpm to the minimum rpm, fully close the delivery valve, notify the Engine Department and then stop the pump.

4. Stripping work (P5-9 to P5-21)

Stripping work should be implemented by an efficient operating method so that all the advantages of the equipment mentioned below are utilized to the maximum and the best performance of the said equipment is extracted.

1) Eductor (Jet Pump)
2) JSS (Jet Stripping System)
3) AUS (Automatic Unloading System)
4) PRIMAVAC System
5) Stripping pump

5. Discharging the stripped oil (P5-22 to P5-27)

Before finishing the discharging operation, discharge the stripped oil including oil remaining in the gathering tank (slop tank) according to the procedure given below.

1) At terminals where fresh oil is required, discharge the stripped oil before discharge the fresh oil.
2) At terminals where fresh oil is not required, discharge the stripped oil in each grade.
1. **Measures when the oil level decreases**

When the oil level decreases according to the progress of the discharging work, changes occur in the discharge pressure and suction pressure of the cargo pump, and in the steam chest pressure, and the discharging rate decreases. Even if the pump rpm is raised, the discharging rate cannot be maintained. Appropriate measures should be adopted to cope with this substantially reduced discharging rate and to prevent cavitations.

(Refer to "1.6 Cavitation" on P3-11 of the "Discharging Section.")

*About substantially reduced discharging rate*

When the level in the suction tank decreases, the discharge flow rate is adjusted while increasing the pump rpm so as to maintain the planned flow rate. However, a condition is reached when the discharge flow rate cannot be maintained by adjusting pump rpm because of the relationship between suction pressure and pump rpm. The substantially reduced discharging rate occurs in this condition.

### 1.1 Changeover of suction line (from shared line to independent line)

#### 1.1.1 Period of changeover

Although the timing for changeover of the suction line cannot be judged unconditionally since the number of discharging tanks and the kinds of discharging circumstances are many, an approximate timing can be identified at as described below.

1) When discharging starts, the segregating valve of the tank bottom line and the common line valve of the pump room are opened to make the suction line a common line. The discharge and suction pressures of the each pump cannot be made uniform merely by adjusting the pump rpm or by adjusting the delivery valve so that an unbalance occurs due to the differences in tank level or in the piping resistance. This is the time to change over from common suction line to independent suction line.

2) The height of the bottom line of the tank is about 2 to 3 m. Close the segregating valve in the line from the tank bottom to a level of about 3 m in case of general crude oil other than cargo oil of high vapor pressure. Close the common line valve while observing the pump operating condition, the oil remaining in each piping system and the balance, and completely isolate each line. At this stage, the appropriateness of the number of pumps in operation should be judged, and if necessary, this number should be reduced.

#### 1.1.2 Concrete example of changeover

<table>
<thead>
<tr>
<th>Discharging tank:</th>
<th>1C sounding 2m / 3C sounding 3 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>5C sounding 4 m</td>
<td>SP ullage 12 m</td>
</tr>
<tr>
<td>Pumps used:</td>
<td>No. 1, 2 and 3 cargo pumps in operation</td>
</tr>
<tr>
<td>1 tank cleaning</td>
<td>(Stripping of 1C, slop to slop)</td>
</tr>
<tr>
<td>Pump in operation:</td>
<td>No. 1 pump for tank 1C</td>
</tr>
<tr>
<td></td>
<td>No. 2 pump for tank 5C</td>
</tr>
<tr>
<td></td>
<td>No. 3 pump for tank 3C</td>
</tr>
<tr>
<td>All line segregating valves are fully closed.</td>
<td></td>
</tr>
</tbody>
</table>

If a common line is being shared, the No. 1 pump derives its suction from 5C also, which has an adequate level, through the common line. If the common valve is fully closed while maintaining the pump rpm and the delivery valve to completely isolate the line, the phenomena mentioned below will occur.

1) The suction pressure of the No. 1 pump reduces and it becomes difficult to maintain pump operation.
2) Conversely, the suction pressure of the No. 2 pump increases slightly and pump can be run more easily.
3) No appreciable change can be observed in the No. 3 pump.

Measures should be adopted in anticipation of the phenomena mentioned above. Firstly, the pump rpm should be reduced to approximately the minimum rpm, the discharge valve should be throttled to about 10% opening, the valve V.274 of the port side slop tank should be opened to about 30% and measures should be adopted to prevent abrupt change of the suction pressure in the No. 1 pump to negative pressure. These measures should be adopted for isolating the common line.
1.2 Delivery valve adjustments

When the suction pressure becomes negative even when the pump rpm is reduced and there is a risk of cavitations or a risk of exceeding the operating range of the pump, the stage for throttling the delivery valve has been reached. At this stage, throttle the fully open delivery valve to open it by 50%. Then gradually adjust it so that the required delivery pressure is obtained. When the delivery valve is throttled to 50% or less, the pump operational adjustments can be performed quickly.

*31 What is triple shutting?

Triple shutting is the method of closing a line at locations where measures to prevent oil leaks are necessary. The method consists of closing 3 valves or a combination of closing 2 valves and inserting a blank plate in the line. It is generally used in a line that connects the sea and cargo lines. In the Takasago Maru, it is installed at the "V.191 +blank plate +V.192" connection of the sea and common lines.

1.3 Precautions

1.3.1 Precautions when changing over from shared line to independent line

1) Before closing the line segregating valve, confirm that the suction head in the line leading to each pump is appropriate.

2) If the pump rpm and delivery valve have been adjusted when closing the line segregating valve or the common line is being shared, no appreciable change is observed on the pump side even if this segregating valve is closed. However, it should be borne in mind that the pump suction pressure may drop abruptly depending on the number of suction tanks used. Thus, preparations should be made beforehand to adjust the pump rpm and delivery valve in anticipation of the abrupt drop in pressure. The general practice is to reduce the pump rpm to the minimum rpm and then change over from shared line to independent line. Subsequently, the pump pressure should be raised gradually while monitoring the suction pressure, rpm and delivery pressure. At this stage, each pump should be adjusted so that the maximum flow rate is obtained.

1.3.2 Precautions when changing over the common line from shared to independent line

1) Before isolating the common line, confirm that the suction head in the line leading to each pump is appropriate.

2) The changeover of the common line from a shared line to an independent line will bring about abrupt fluctuations in pump load depending on the number of suction tanks, tank levels, pump rpm and pump discharge and suction pressures. Therefore, measures such as isolating one pump first after considering the number of suction tanks and levels in each tank, and running the other two pumps in parallel, should be considered.

If necessary, measures to prevent extreme unbalance of the pumps should be adopted, such as reducing the pump rpm to the minimum rpm and throttling the delivery valve to about 10%.
2. Changing over the grade of oil

2.1 Pump operation when changing over the grade of oil

1) Number of cargo pumps in operation
   The discharging operation should be implemented at the maximum discharging capacity of the ship. Generally, three cargo pumps are operated, but sometimes the number of pumps in operation has to be reduced according to the number of discharging tanks on the ship, restrictions on flow rate at the receiving terminal and restrictions on the manifold pressure.

2) Timing to stop the cargo pump
   The discharging plan does not generally consider the stoppage of three cargo pumps simultaneously when they are being used to discharge cargo oil from multiple cargo tanks. It is recommended that the pumps be stopped one after another at intervals of 15 minutes or more. Thus, one cargo pump is in operation at the time of changeover of the grade of oil. During discharging the part quantity of the grade of cargo oil, the discharging will be stopped with high level in the tank, and the pump is generally stopped at the terminal’s order. In this case, instructions will be given on reducing the discharging rate and the method of stopping the pump at the meeting before the discharging operation. These instructions should be followed.
   The timing for reducing the discharging rate is often indicated when some oil is yet to be received. The quantity of oil yet to be received is notified from time to time by the terminal. The pump rpm and the discharging rate should be reduced in accordance with these notifications.

3) Time to spend for changing over the shore reception tank
   Two cases may be considered: the same company is to receive the cargo oil in the ship, or two or more companies are to receive the cargo oil in the ship. If different companies are to receive the oil at the same berth, slightly more time is required for changing over the grade of oil. All pumps have to be stopped and some waiting time is incurred. Also, when different companies are to receive the cargo oil, sometimes complete stripping of the tank may be demanded. This point should be clarified and confirmed during the meeting before the discharging operation.

4) No-load operation of pump
   The period of the no-load operation of the pump cannot be set unconditionally since it depends on the grade of oil, oil temperature and other seasonal factors. However, a period of 10 to 15 minutes may be taken as a guideline. Whether no-load operation of the pump is to be implemented or whether the pump is to be stopped depends on the time required for the changeover of the grade of oil. (Refer to "2.1 Pump no-load operation" on P3-21 of the "Discharging Section.")

2.2 Method of changing over the grade of oil

In principle, the method of operation should be as described in "Chapter 2 Start of Discharging Work." The two conditions related to the tank main line given below, may be considered.

1) When gas is included in the tank main line.
2) When the tank main line is filled with oil.

2.2.1 Case 1 (stopping the cargo pump when changing over the grade of oil)
   With the cargo pump in the stopped condition, perform the following:

1) Request the Engine Department to make preparations for starting the pump.
2) Make preparations for starting the pump according to the method given in "Chapter 2 Starting the Discharging Work" in the "Discharging Section."

3) If the riser and deck line of the pump contain oil, deliver the oil to be discharged to the suction line and prime the pump.
4) Adopt measures to prevent the water hammer phenomenon.
5) Open the segregation line valve and common line valve in the main line of the tank to be used so that the line is shared. Then deliver oil from one of the discharging tanks nearer to the bow of the ship. A pressure difference may sometimes arise between the segregating line and the common line. Therefore, care is necessary to carefully open and close the valve by very small amounts repeatedly.
6) Crack open the tank main valve and deliver oil slowly.
If the riser and the deck line are filled with oil, and if the discharge valve is slightly opened for bleeding air, the non-return valve may be struck by the back pressure of oil, therefore there is no need to open the discharge valve.

7) When the suction pressure in the cargo pump starts rising gradually, open the tank main valve from the crack open condition to about 10%. In this condition, carefully deliver oil until the pump suction pressure reaches the head pressure of the tank. When the head pressure of the tank is reached and the suction pressure stabilizes, gradually open the tank main valve until it is fully open.

8) Request the Engine Department to start the pump.
9) Fully close the delivery valve, start the cargo pump and when the minimum rpm is reached, confirm that the governor is working effectively.

10) Open the gate valve after discussion with the terminal.
11) Monitor the pump and suction pressures for 1-2 minutes considering that gas may exist in the suction line. Confirm that there is no abnormality in the pointer swing and the indication.
12) If there is no abnormality, open the delivery valve gradually and re-start the discharging operation.

13) Make preparations so that the second and third cargo pumps can be started at 5-minute intervals and then start them at these intervals. The turbine should be in the warmed-up condition and capable of being started in about 10 minutes.

14) The IGS atmospheric discharge valve is open and is controlled according to the predetermined tank pressure, therefore the IGS need not be operated during the oil changeover. The concentration of oxygen in the supplied inert gases may sometimes rise when the pump is stopped due to the temporary load fluctuations of the boiler, but this concentration drops below 5% by volume when the pump is started.

2.2.2 Case 2 (changing over the grade of oil during the no-load operation of the cargo pump)
The method of changing over the grade of oil when the main tank line is filled with oil, is described below. It is customary to run only one cargo pump and have two other cargo pumps in the stopped condition before changing over the grade of oil. This is the prerequisite for the implementation of this method. Also, if the previous cargo is to be fully discharged, the tank main valve should be kept open. This method is adopted when the changeover of the receiving tank is to be performed within a short period of time.

1) Fully close the delivery valve of the cargo pump in operation.
2) After fully closing the delivery valve, set the pump rpm to the minimum rpm.
3) Gradually close the main valve of the tank while monitoring the suction pressure. The suction pressure does not become negative even when the pump discharge valve is fully closed and the tank main valve is closed. This condition should be confirmed.
4) When the pump stops (including no-load operation of pump), the gate valve should be closed. This is the basic step. When the terminal entrusts the judgment to the ship, the valve should be closed by the ship considering irregular conditions. In such cases, the terminal should be notified. Before opening the valve also, the terminal should be contacted and permission for opening the valve should be obtained.

Since the gate valve is the "branching point of responsibility" of the ship and the terminal, discussions should be held with the person in charge of the terminal each time the gate valve is opened or closed. The valve should be not opened or closed under the ship's judgment except in special circumstances.

When the pump is operating at the minimum rpm, the conditions that permit the tank main valve (suction line) to be fully closed are as given below.
(1) The delivery valve should be fully closed.
(2) There should be no leaks when the delivery valve is fully closed.

Only when these conditions are satisfied, the opening of the tank main valve can be permitted. The principle in case of centrifugal pumps is that the pressure in the suction line should be appropriate and when the tank main valve is closed for such changeover work, the work should be completed within a short time.
5) The segregating line and the common line should be shared. A pressure difference may sometimes arise between the segregating line and the common line. Therefore, care is necessary to carefully open and close the valve by very small amounts repeatedly.

6) When the tank main valve is fully closed, hold discussions with the terminal, take care to guard against negative suction pressure, and crack open the main valve of the tank (one tank only) to be discharged.

7) When the pump suction pressure starts rising, open the tank main valve to about 10% and deliver oil until the tank head pressure is reached. When the head pressure is reached and the pressure stabilizes, open the valve fully.

8) Start the pumps stopped earlier at 5-minute intervals and re-start the discharging operation.

During changeover to discharging of oil in the part cargo discharging method with the grade of oil at a high level, both the suction and discharge lines are adequately filled with oil. Therefore, negative pressure generally does not occur in the line and in the pump suction. Take particular care to guard against cargo contamination and confirm that the valve in the tank with the grade of oil to be discharged first is properly closed. Then operate the tank valve and change over the grade of oil.
3 Stopping the cargo pump

3.1 Rough stripping with the cargo pump

There is the case that the tank such as slop tank or 5C tank which can supply driving oil for stripping eductor, is not available for stripping the cargo at the discharging stage depending on the discharging sequence when multiple cargo stowage. If AUS has not been provided on the ship, the tank should be roughly stripped using the cargo pump only.

1) Isolate the segregating line and the common line, then perform the stripping operation.
2) If one pump is used for stripping two or more tanks, the method of stripping first from the tank at the forward side and then shifting to the stripping of the tanks at the aft side may be adopted. The difference in level of oil in the forward and aft tanks should preferably be more than 2m.
   a) The tank main valve of the forward tank should be fully opened while the tank main valve of the aft tank should be opened by 50%. When the level from the bottom of the forward tank becomes 1m approximately, the degree of opening of the suction valve should be changed.
   b) While adjusting the suction valve of the forward tank which is to be dried first, open the valve to about 30% to 50%. Then fully open the suction valve of the aftward tank with a slight big head.
   The valves in both tanks should be adjusted while observing the change in ullage such that the change in the forward tank is larger than that of the aft tank, although there may be differences depending on the grade of oil.
3) If the rpm of the cargo pump at this stage is excessively low, oil may be drawn from the aftward tank, while no oil is drawn and discharged from the forward tank. Therefore, fine adjustments of the pump rpm and the pump delivery valve (650 to 750 rpm: 10% to 15%) should be made and extreme precautions should be taken during the operation.

3.2 Stopping the pump

1) When the float in the forward tank touches the base point, close the tank main valve and fully open the main valve of the aftward tank.
2) Even if the pump draws in gas during the discharging of the final tank, adequate precautions should be taken since there is no tank that can do the "priming" of the pump.
3) Reduce the pump rpm to approximately the minimum rpm (650 to 750), and open the delivery valve to about 10% or less so that no gas is drawn in. Under these conditions, very fine adjustments, should be made little by little, to the pump rpm and the delivery valve. Although it is not preferable to use the pump this way, the stripping time taken by the cargo pump is short, and no problem in particular occurs.
4) If the pump is operated carefully, the tank can be stripped until the float touch level.
5) A little while after the float in the final tank touches the base point, gas starts being drawn in. Immediately close the delivery valve fully and reduce the pump rpm to the minimum rpm. The quantity of oil remaining in the tank is almost negligible.
6) When changing over the grade of oil each time, if the time for changing over the shore reception tank is prolonged, stop the pump. If the changeover can be performed within a short time, initiate no-load operation of the pump and change over to a different grade of oil to be discharged.
4. Stripping work

4.1 Estimation of time for stripping work

The estimated time required for stripping is generally about 3 hours. The breakdown is as given below.

<table>
<thead>
<tr>
<th>Activity Description</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time required for checking dryness of tank:</td>
<td>30 minutes to 1 hour</td>
</tr>
<tr>
<td>Stripping of line, pump, small diameter piping, etc.:</td>
<td>1 hour</td>
</tr>
<tr>
<td>Discharging of stripped oil from slop tank:</td>
<td>1 hour</td>
</tr>
<tr>
<td>Stripping of line, pump, etc., using the stripping pump:</td>
<td>30 minutes</td>
</tr>
<tr>
<td><strong>Total stripping time:</strong> About 3 to 3.5 hours</td>
<td></td>
</tr>
</tbody>
</table>

4.2. Stripping system

The types of stripping system are given below. Each system has its own features. The advantages of each system should be utilized to the maximum and an efficient operation such that the operation with the maximum performance of the equipment should be considered.

4.2.1 Eductor (Refer to Eductor (Jet Pump) in Fig. D-5-1)

1) Usage and application

The eductor is used for recovering and stripping the washing oil during COW in addition to the stripping of tanks, lines and pumps. Drive oil is delivered by the TCP or COP and the eductor is operated. In tankers not equipped with AUS, two eductors each with a capacity of about 1,100 m³/h are installed. A drive oil delivery tank is required for the eductor. For this, the slop tank port and starboard and the 5C tank are available. If drive oil has to be taken from suction lines unavoidably, then a head pressure equal to the cargo pump suction pressure plus 0.1 mPa (about 1 kg/cm²) is necessary. Generally, the slop tank is used as the delivery tank because of tank capacity considerations.

2) Operating principles

If liquid pressurized to a high level by the pump is spout through a nozzle, the suction side of the eductor is at low pressure and draws the liquid. Furthermore, the liquid has high velocity and low pressure at the throat, as a result of which the suction action is further enhanced. In the diffuser, the velocity gradually decreases, the pressure increases and extraction takes place. The eductor consists of a structure with a flared shape assembled with a nozzle through which the liquid is injected.

If a liquid is used as the driving medium, the appliance is called an eductor; if steam or air is used, it is called an ejector.

3) Advantages of the eductor

   a) Since the eductor has no moving parts, it is basically maintenance free.
   b) The system is very simple. No preparations are necessary before using it, and no clearing up work is necessary after using it.
   c) Its performance is best demonstrated during the stripping of crude oil of high vapor pressure. Its ability to strip crude oil in the presence of AUS and PRIMAVAC systems may sometimes be limited.

4) Disadvantages of the eductor

   a) The eductor cannot be used sometimes during the discharge of multiple grades of oil since the slop tank and 5C cannot be used. In such cases, only rough stripping can be carried out using the cargo pump or the TCP.
   b) The quantity of sedimented sludge in the slop tank increases.
   c) Large noise and vibrations sometimes occur, and problems such as damage to gauges and pipes for gauges near the eductor and separation of couplings occur.

4.2.2 JSS (Jet Stripping System; see Fig. D-5-2)

The basic functions are similar to those of the eductor. As an ancillary system, its role is to maintain the level of the drive oil tank (slop tank) through automatic controls. Since it is interlocked with the pump's discharge valve, the specified level is maintained and there is no danger of overflow. However, precautions are required when using the JSS because abrupt changes occur when the discharge valve is opened, therefore some terminals do not permit it to be used.
4.2.3 AUS (Automatic Unloading System)

1) Operating principles
This system enables the cargo pump to perform stripping. A separator tank is installed in the tank side of the pump suction. A vacuum pump is provided in the separator tank that forcibly creates a vacuum in the tank. A level switch is provided in the separator tank that automatically controls the liquid level, the vacuum pump and the discharge valve. Generally, a vacuum pump is provided in each cargo pump.

2) Advantages of the AUS
a) Tanks can be stripped and dried using the cargo pump. The stripping time when an eductor or a stripping pump is used, can be drastically cut down if AUS is used because the quantity of oil remaining is very small even though the tank main valve is used.
b) Tanks can be automatically and easily stripped.
c) The system's ability to strip conventional crude oil tanks is extremely high.
d) Since a oil remain in the line can be stripped by the main pump, the time for stripping out some of the lines can be curtailed.

3) Disadvantages of the AUS
a) The ability of the AUS to strip tanks containing crude oil of high vapor pressure is limited, and stripping may not be possible sometimes. This means that an eductor has to be used for the stripping operation and the conventional pump has to be used for rough stripping without depending on the vacuum pump in order to eliminate this shortcoming of the AUS.
b) If the AUS is used for a long period for stripping high vapour pressure cargo, a large amount of oil accumulates in the drain tank and this oil has to be disposed of during the discharging operation. Accordingly, personnel have to be stationed in the pump room from the start to the end of the AUS operation.
c) Maintenance of vacuum pump and ancillary equipment has to be carried out.
d) Additional tasks such as cleaning of drain tank and sight glass and inspection of seal water to prevent backflow from the cargo tank have to be performed.
e) The system by itself is rather complicated and many precautions have to be taken during its operation.

4.2.4 PRIMA VAC System (refer to Fig. D-5-3)
The PRIMA VAC system enables automatic priming of the pump when it is integrated with the main pump. It is also advantageous since it prevents damage to the pump that could occur when the pump is racing or overheated, or when the mechanical seal is damaged or the pump is operating with the suction and discharge valves closed. Similar to AUS, tanks can be stripped by the cargo pump when the PRIMA VAC unit is installed. The PRIMA VAC unit creates negative pressure (which is created by the vacuum pump in AUS system) through the recirculation tank and the bleed line.

1) Advantages of the PRIMA VAC system
a) Very effective stripping using a comparatively simple mechanism Stripping becomes more efficient if the header tank (slop tank) is used.
b) Stripping is enabled automatically.

2) Disadvantages of the PRIMA VAC system
a) Its use is limited in case of crude oil of high vapor pressure. For such oil, ultimately the eductor has to be used.
b) About 30 seconds are required for one priming cycle and noise also occurs during the operation.
c) Head spring has to be inspected and cleaned after the discharging operation.
d) During stripping, the gas drawn in is discharged together with the crude oil through the cargo line. This is not preferred by the receiving side.
4.2.5 Stripping pump (refer to Fig. D-5-4 and Fig. D-5-5)

1) This is a reciprocating pump (piston pump) that adequately copes with small gas inclusions. It is the most popular pump used for stripping tanks and also for stripping the final line.
2) The capacity of the pump is about 200 m³/h to 300 m³/h. The capacity of the COW nozzle of the slop tank is the most important factor in determining the pump capacity.
3) It is used for final discharging of oil using small-diameter pipelines to manifold.
4) It is used for stripping tanks when the ship is underway, but when a large amount of gas is included in the suction line, recovery oil is necessary to restore the original condition.
Fig. D-5-2 General view of the JSS system
Fig. D-5-3 General view of the PRIMAVAC system
<table>
<thead>
<tr>
<th>PART NO.</th>
<th>NAME OF PART</th>
<th>RED NO FOR 1 PUMP</th>
<th>PART NO.</th>
<th>NAME OF PART</th>
<th>RED NO FOR 1 PUMP</th>
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<tr>
<td>1</td>
<td>STEAM CYLINDER</td>
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<td>STEAM PISTON ROD GLAND PACKING</td>
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<td>VALVE ROD TOP GLAND</td>
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<td>VALVE ROD BOTTOM GLAND</td>
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<td>VALVE STEM</td>
<td>8</td>
</tr>
<tr>
<td>47</td>
<td>CROSSHEAD</td>
<td>2</td>
<td>208</td>
<td>SVC VALVE SETSCREW</td>
<td>8</td>
</tr>
<tr>
<td>48</td>
<td>CROSSHEAD PIN</td>
<td>2</td>
<td>210</td>
<td>JACK BOLT</td>
<td>8</td>
</tr>
<tr>
<td>70</td>
<td>LIQUID PISTON</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>73</td>
<td>LIQUID PISTON RING</td>
<td>4</td>
<td>241</td>
<td>ESCAPE VALVE BOX</td>
<td>1</td>
</tr>
<tr>
<td>74</td>
<td>VALVE ROD BOTTOM GLAND PACKING</td>
<td>2SETS</td>
<td>243</td>
<td>VALVE</td>
<td>1</td>
</tr>
<tr>
<td>75</td>
<td>VALVE ROD TOP GLAND PACKING</td>
<td>2SETS</td>
<td>256</td>
<td>SPRING</td>
<td>1</td>
</tr>
</tbody>
</table>

Fig. D-5-4 Cross section of reciprocating pump used as the stripping pump
Fig. D-5.5 Characteristic curves of the stripping pump
4.3. Stripping method

4.3.1 Stripping with eductor using TCP

1) Gathering tank
   The slop tank or 5C may be used as the gathering tank.
2) Eductor driving pressure
   There is no effect for discharging cargo work so that the TCP can be operated with isolated piping connection from other cargo piping related discharging cargo. The eductor driving pressure should be increased to 0.8 mPa (about 8 kg/cm$^2$) so as to enhance the stripping effect.
3) Eductor start timing
   Tank stripping is made through the tank stripping valve of each tank.
   In tankers not equipped with AUS, start the eductor at an early stage to avoid gas from tank being drawn into the cargo pump. Adjust so that the quantity of oil remaining in the tanks is not excessively unbalanced and sequentially strip the tanks.
   A tank may be stripped even if the cargo pump is discharging cargo oil from the same tank.
4) Particulars of cargo pump operation during stripping
   The level in the gathering tank increases during eductor stripping operation because some oil remains in the cargo tank. The key point here is to use the gathering tank also as a header tank with the aim of preventing overflow and ensuring suction pressure of the cargo pump, by opening the main valve of the gathering tank by about 30%, and continuing the stripping of the tank while discharging oil from the gathering tank.
   In this way, the cargo pump that obtains suction from the header tank can strip the tank independently and with comparative ease until the float touches the base point.
   The cargo pump can also be combined with other pumps, although not unconditionally. The conditions are:
   a) Cargo pump rpm between 650 to 750
   b) Delivery valve opened by 10% to 15%
   c) Tank main valve opened by 30% to 50%, but should not be throttled above 30%.
   d) The main valve of the slop tank opened by 30%.
   The pump rpm, and the opening of the delivery valve and main valve of the gathering tank should be adjusted while carefully monitoring the balance of the tanks to be stripped by observing the float gauge.
5) Frequency of tank stripping
   Tank stripping should generally be carried out for about 5 times after the tank is dry.
6) Ship’s attitude for effective stripping
   In addition to the eductor driving pressure, trim and heel of the ship are important factors that influence effective stripping.
   a) The trim should be between 4 m to 6 or 7 m. The maximum trim should be limited to about 6m so as to prevent overflow in case there are full tanks that have not yet been discharged.
   b) Ballast or cargo should be used to heel the ship in the direction of the bell mouth.

4.3.2 Stripping with AUS (Automatic Unloading System)

1) Stripping
   The tank can be stripped almost completely by the cargo pump so that only a small quantity of oil remains, which is to be stripped by the eductor.
2) Isolation of line
   When the oil level is about 3 m from the bottom, close the line segregating valve in the tank and isolate each line. Also isolate the common line.
3) AUS control signal
   The AUS can be operated in the "Fully Automatic," "Semi Automatic" or "Manual" mode. Since a pneumatic signal (control air) is used for the signal from the CCR, there is a slight delay between the input signal and the response. This point should be borne in mind during the AUS operation.
4) Start preparations
   The AUS is started before commencing the stripping operation. The general method is to start substantial preparations for starting the AUS when the ullage reaches about 20 m and to keep the system ready for use. This level has been decided considering that even if the vacuum pump starts
operating by mistake, no oil will spray out.

5) Separator tank level and vacuum pump
The separator tank pressure detectors are at two locations: on the high pressure side and the low pressure side. The separator tank level is detected from the difference in the two pressure detectors, this level is converted to pneumatic signal and transmitted to the CCR.

The vacuum pump is designed to start/stop depending on the level in the separator tank.

6) Vacuum pump start level
If the tank level is adequate (separator tank level greater than 70%), even if the AUS preparations have been completed, the vacuum pump does not start automatically.

When the oil level in the tank decreases and the separator tank level drops below 50%, the vacuum pump activates, causes negative pressure in the separator tank and forces oil to be drawn into the tank. When the level in the tank is restored to 70%, the gas extraction valve closes and ten seconds later, the vacuum pump stops automatically.

7) Pump rpm during stripping
The cargo pump rpm when AUS is used varies depending on the ship. When the level from the tank bottom reaches 1 m approximately, the cargo pump rpm should be 700 to 800 rpm (60% to 70% of the pump rpm). When crude oil of high vapor pressure is used, the rpm mentioned above should be reduced slightly. Efficient stripping cannot be obtained if the pump rpm is too high or too low. Therefore, the correct rpm for the ship should be determined based on the guidelines mentioned above. It should be noted however, that the pump usage method mentioned above applies to the stripping condition when the level in the tank has decreased. It does not apply to a tank level at which the AUS does not operate. In the latter case, the pump rpm has to be raised above that of the former case in order to perform cargo handling.

8) AUS status during stripping
When the level in the tank decreases, the vacuum pump start/stop frequently and repeatedly. When the level in the separator tank drops below 5%, the red lamp indicating low level lights up and shows that the stripping stage has commenced. Continuous operation of the vacuum pump starts, and even if the discharge valve is closed, negative pressure cannot be created in the separator tank. At this stage, the stripping operation by AUS ends.

* Negative pressure cannot be created: Tank is empty (bell mouth protrudes above the oil surface)

Even if the oil remaining in the tank is so small as to be negligible, it has to be stripped finally using the eductor. However, if a bell mouth for stripping exists in the suction of the main line, the

a) "Fully automatic" operation refers to automatic control of the vacuum pump and the AUS discharge control valve. When the separator tank level is low and the vacuum pump is continuously operating, the discharge valve is automatically kept closed until the level in the separator tank is restored.

b) "Semi automatic" operation refers to automatic operation of the vacuum pump and manual operation of the discharge valve of the cargo pump. This method is used when prompt response is necessary because the response to input in operations using the pneumatic signal is slightly delayed. Operators experienced in the AUS operation often prefer to use this method and find it more convenient.

c) "Manual" operation refers to manual operation of both vacuum pump and discharge valve of the cargo pump. This mode of operation is not used generally because of the complexity involved as a large number of gauges have to be monitored manually, and is used only when automatic operation is not possible.

In the PRIMA VAC system too, an rpm in the range of 60% to 70% is used. However, when the slop tank was used as the header tank and opened by about 30%, an rpm of about 900 to 950 was found to be the optimum range of operation.
tank can be dried up completely. If oil is observed to remain after some time, then it should be finally stripped using the eductor.

4.3.3 Precautions when using AUS

1) AUS should be used so as to prevent accidents such as the spray out of oil that caused by overflow oil through gas extract valve, seal water tank and drain tank could occur when the liquid level in the tank during discharging is lower than the position of the gas extract valve. (An ullage of 15 m or more may be taken as the yardstick for using AUS.)
   The ship's attitude should also be considered at this stage. (If the trim is large, the ullage of the tank and the position of the gas extract valve cannot be compared easily.)

2) The stripping pump should be kept ready for use before starting AUS.
   The AUS drain tank should be checked to confirm that it is empty.

3) When AUS is in operation during the cargo handling of crude oil of high vapor pressure, one crew member should always stand watch in the pump room for reading and reporting the AUS drain tank level.

4) In case of crude oil of high vapor pressure, the drain tank becomes full of crude oil that has abruptly liquefied from oil mist. If the stripping pump or eductor is not used to recover the oil in the slop tank, the oil overflows.
   In some ships, a small drain tank with an air pump is installed near the seal water tank. Before the oil drops into the drain tank at the bottom of the pump room, it can be returned to the slop tank using this air pump.

5) The pump room watch has to monitor the level in the seal water tank of the vacuum pump, check for heat generated in the gland of vacuum pump and recover oil using the air pump mentioned above.

6) A U-shaped seal tube (at least 2.5 m; 24.5 kPa=2,500 mmAq = cargo tank test pressure) is used to prevent back pressure from the slop tank. Fresh water is used as the seal water. The seal should always be checked to confirm that it is satisfactory before the ship enters the discharging port.
   When the level in the seal water tank is normal, water should be fed such that it overflows to the drain line. The overflowed water ensures that the U-shaped seal is satisfactory.
   If the U-shaped seal is broken, the gas in the tank spews out from the drain coaming of the vacuum pump through the drain tank and into the pump room due to the tank pressure, causing an extremely dangerous situation. To avoid such human errors, some ships do not have openings (drain pan of the vacuum pump) in the pump room for the AUS system itself. The drain coaming of the vacuum pump is connected to the drain tank. The oil accumulated in the drain tank should be returned to the slop tank using the stripping pump.

7) The instruction manual should be referred to as it states in detail the preparations, operation and maintenance of the AUS. The important points are: checking the level of water in the seal water tank (ensuring the integrity of the U-shaped seal), cleaning the seal water tank and the sight glass, disposing of oil remaining in the drain tank, leakage of control air, and replenishing grease in the vacuum pump bearing. The integrity of the U-shaped seal can be ensured by replenishing fresh water in the seal water tank so that it overflows to the drain tank.

8) During the stripping operation with AUS, the separator tank level changes with the start/stop of the vacuum pump and the open/close of the AUS discharge control valve. As a result, the AUS discharge control valve may be repeatedly opened fully or closed fully. Accordingly, the discharging flow rate changes excessively and if a non-return valve has been provided in the terminal line, this valve may be struck repeatedly, resulting in claims. This problem can be resolved by setting the upper limit of opening of the AUS discharge control valve manually and by inhibiting large changes in the level of the separator tank.
   The AUS discharge control valve generally does not have a valve seat ring. Therefore, valve operations should be performed always bearing in mind that metal to metal contact may occur. That is, the line cannot be completely closed by the AUS discharge control valve alone. Thus, when discharging is suspended, the line should always be completely closed by closing the pump delivery valve.
4.4 Method of stripping the pump/line

(Refer to "Fig. D-5-1 Line Diagram" on P2-27, "Fig. D-5-2 Line Diagram" on P2-28, "Fig. D-5-3 Line Diagram" on P2-29 and "Fig. D-5-4 Line Diagram" on P2-30 of the "Documents Section.")

The method of line stripping using the eductor except finally the remaining discharging pump or line is explained below.

For stripping with the eductor, there is no sequence in particular to be adhered to. A method that does not incur additional work even if an error in valve operation occurs, is described here. This method may be simply described as "stripping oil sequentially from a high location to a low location." The time required for stripping is about 1 hour whatever be the method used. If the performance of the stripping pump drops because of gas inclusion in the final discharging stage, then the oil in the riser with head is to be retained as priming oil until the end and then discharged. Thus, it should be noted that the oil at the high location has to be allowed to remain until the end.

1) Eductor driving oil tank
   Use the TCP assuming that the eductor driving oil is taken from the port side slop tank.

2) Final discharging line and pump
   a) Take the final discharging line as the line No. 1.
   b) Take the final discharging pump as the No. 1 cargo pump.
      (The TCP may also be used as-is as the final discharging pump.)
   c) Take the final discharging line of the stripping pump as the No. 1 line through the MARPOL line.

3) Close the gate valve.
   After discussing with the terminal, close all the gate valves.

4) Valve lineup

<table>
<thead>
<tr>
<th>Valve</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crossover valve</td>
<td>V331 (V.332 and V.333 kept open)</td>
</tr>
<tr>
<td>Direct filling valve</td>
<td>V312, V313 (V.311 kept close)</td>
</tr>
<tr>
<td>Deck master valve</td>
<td>V321, V332, V323</td>
</tr>
<tr>
<td>Crossover gas intake valve</td>
<td>V388, V389</td>
</tr>
<tr>
<td>Deck main gas intake valve</td>
<td>V382, V383, V386</td>
</tr>
<tr>
<td>TCP operating status</td>
<td></td>
</tr>
<tr>
<td>a) Suction line: V.173 and V.143 open</td>
<td></td>
</tr>
<tr>
<td>b) TCP operation</td>
<td></td>
</tr>
<tr>
<td>c) Discharge line: V.145, V.176, V.174, No. 2 eductor and V.183 open</td>
<td></td>
</tr>
<tr>
<td>d) Eductor suction line: Through V.180</td>
<td></td>
</tr>
<tr>
<td>COW line</td>
<td></td>
</tr>
<tr>
<td>COW line gas intake valve open</td>
<td></td>
</tr>
</tbody>
</table>

5) Stripping of COW line (through No. 2 COP)

<table>
<thead>
<tr>
<th>Valve</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suction line valve</td>
<td>V512, V515, V195, V124, V522, V525, V161</td>
</tr>
<tr>
<td>Eductor suction valve</td>
<td>V180</td>
</tr>
</tbody>
</table>

(No. 2 COP V.573 and V.574 may be open)

8) Stripping of deck line, riser and around the No. 2 and No. 3 pumps
   If the vacuum is large, adjust the capacity by adjusting the TCP rpm or the valve V.174 at the eductor inlet.
<table>
<thead>
<tr>
<th>Suction line valve</th>
<th>V123, V522, V573, V574, V525, V161, V180</th>
<th>Open</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suction line valve</td>
<td>V133, V523, V575, V576, V525, V161, V180</td>
<td>Open</td>
</tr>
</tbody>
</table>

9) Stripping of the No. 2 tank main line through the direct filling line

<table>
<thead>
<tr>
<th>V186, V188, V180</th>
<th>Open</th>
</tr>
</thead>
<tbody>
<tr>
<td>V121, V122, V522, V573, V574, V152, V163, V525, V161, V180</td>
<td>Open</td>
</tr>
</tbody>
</table>

10) Stripping of the No. 3 tank main line through the direct filling line

<table>
<thead>
<tr>
<th>V187, V188, V180</th>
<th>Open</th>
</tr>
</thead>
<tbody>
<tr>
<td>V283, V284, V186, V187, V188, V180</td>
<td>Open</td>
</tr>
</tbody>
</table>

11) Stop the TCP when the stripping operation using the eductor has been completed.
   a) Notify the Engine Department the stoppage of the TCP.
   b) Start throttling the discharge valve V.145 while gradually lowering the TCP rpm.
      When the discharge valve has been throttled to below 50%, operate carefully.
   c) Just before the eductor suction pressure becomes positive, fully close V.180 and prevent the
      back flow oil from the slop tank to the line stripped.
   d) Fully close the delivery valve when the rpm reaches the minimum rpm approximately.
   e) Reduce the rpm to the minimum rpm at which the TCP pump governor is no longer
      effective.
   f) Notify the Engine Department and stop the pump.
   g) At this stage, the IG oxygen concentration may sometimes rise abruptly due to temporary
      load fluctuations of the boiler and an alarm may be issued.
   h) Close the TCP delivery line valves V.176, V.174 and 183
   i) When TCP stops, close the suction line valves V.173 and V.143
   j) Fully close all the other valves used for stripping using TCP.
5. Discharging of the stripped oil

5.1 Handling of eductor driving oil/gathered oil

At terminals where fresh oil is a requirement, the gathered oil should be discharged before discharging the fresh oil. However, at terminals where fresh oil is not a requirement, the gathered oil for each grade of oil may be discharged finally. During the final stripping using the eductor of a tank that has been subjected to COW, note that this gathering tank will not normally be treated as a fresh oil tank. The stages up to this point are given below.

1) Sequence of discharging eductor driving oil/gathered oil.
   At terminals where fresh oil is a requirement, the oil should be discharged finally at the end of discharge of each grade of oil after stripping the tank.

2) If fresh oil is a requirement of the terminal and multiple grades of cargo oil are to be discharged, then the discharging of the gathering tank should be performed after the stripping of the relevant grade of oil is completed. However, during the discharge of the final grade of oil, the gathering tank should be discharged before the discharge of fresh oil.

3) The gathering tank to be finally discharged should be the port side or the starboard side slop tank. Tanks other than the gathering tank and pumps and lines that are not used should be stripped. The pumps and lines other than those used for discharging the slop tank should be stripped first and then discharged.

5.2 Tank stripping by eductor and check for dryness

(Refer to "Line Diagram" in Fig. D-5-5 of P2-31 and "Line Diagram" in Fig. D-5-6 of P2-32 in the "Documents Section."

Strip the tank and check the dryness according to the procedure given below.

1) Stripping of tank other than the gathering tank (slop tank)
   Strip tanks other than the slop tanks at least five times.

2) Draining the manifold line
   a) If the gathered oil can be discharged using the No. 1 pump or the TCP through the No. 1 line, use only the TCP as operating equipment. Discuss with the terminal and close the gate valves of the No. 2, No. 3 and No. 4 manifolds.
   b) Open the manifold inner drip valve and manifold master drip valve on both port and starboard sides of the No. 2, No. 3 and No. 4 lines and drain out the oil remaining in the cross line on the inside of the gate valve. Confirm that the gas intake valve mentioned earlier is open.

<table>
<thead>
<tr>
<th>Starboard side manifold inner drip valve</th>
<th>V353, V357, V359, V361</th>
<th>Open</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port side manifold inner drip valve</td>
<td>V354, V358, V360, V362</td>
<td>Open</td>
</tr>
</tbody>
</table>

c) The manifold drip line has a U-shaped seal. Similar to a surface valve, it is designed to drain oil by gravity even if the tank pressure is existing.

d) The oil drained into 3P&S is stripped by the eductor and recovered in the gathering tank.
   * At some terminals, the oil remaining in the shore Chiksan arm that is unused, can also be drained to the ship's tank. In this case, the oil in the shore arm should be drained out before draining the ship's manifold lines. (Oil can be drained out faster if an equalizer valve is used)

3) Checking the dryness of tank
   a) When oil in the manifold line has been recovered, the tank should be checked for dryness in the presence of a representative of the terminal.
   b) Currently, the dryness of the tank is generally checked using the eductor suction pressure. If a problem in the discharging quantity is anticipated, actual measurements may also be carried out by MMC.
   c) Set the eductor suction pressure below -26.6 kPa (about -200 mmHg) and open the stripping
valve of the tank to be checked for dryness.

d) If the tank is dry, the eductor suction pressure becomes zero (strictly speaking, becomes equally to the tank pressure) from negative pressure in a short period. If oil remains in the tank, negative pressure is indicated for a while, which then slowly changes to zero. The presence of oil remaining in the tank can also be concluded when the suction gauge fluctuates up and down on the negative pressure side. Tanks that are suspected of not being dry should be checked again for dryness.

e) When checks of dryness of tanks other than the slop tank are completed, stripping of pumps and lines should be started.

*32 What is a U-shaped seal? (See Fig. D-5-6)

The drip line has a U-shaped seal constructed such that oil is drained into the tank without releasing pressure in the tank and equalizing it to the atmospheric pressure. Although the construction may vary slightly from shipyard to shipyard, the basic concept remains the same.

The U-shaped seal tube is about 3 m vertically below the deck, and is bent appropriately to a 180-degree turn by 1.3 m. When viewed in this condition from the side, it looks like the character “J.” However, if such a seal is used in tankers carrying heated crude oil, oil may solidify within the tube. Therefore, this method is not used in such tankers, where a straight tube is used instead.

An equalizer valve is installed on the outside of the manifold gate valve. The gas (pressure) of the tank is led into this line and the pressure is equalized. This arrangement enables oil to be drained out quickly.

*33 What is a surface valve?

A surface valve is a device used for recovering to the slop tank oil that has flowed out on the upper deck. The pipe below this valve is a U-shaped seal pipe, and has the same construction as the U-shaped seal of the manifold. Thus, even if pressure exists in the slop tank, the oil can be recovered. The U-shaped seal tube should be filled with liquid so that the integrity of the seal is preserved. This point should always be confirmed before the ship enters the loading/discharging port. If the surface valve is cracked open and gas leaks out, then fresh water should be filled to maintain the integrity of the seal. For recovery of oil on the deck, a diaphragm-type air pump may also be used and the oil recovered in the slop tank.
Fig. D-5-6 U-shaped seal pipe
5.3 Handling of fresh oil

Fresh oil is new crude oil that is used to replace the oil in submarine pipelines and other pipelines.

1) Roles of fresh oil
Sludge, rust and other impurities accumulate in the slop tank or 5C tank, which is the gathering tank after COW. If this oil is discharged finally, the impurities mentioned above remain in submarine pipelines and other lines. Fresh oil is oil that has not been used as the driving oil for COW (contains no impurities) and is new oil used to replace oil that contains these impurities.

2) Quantity of fresh oil to be remained
The quantity of fresh oil to be remained varies depending on the length and volume of the submarine pipelines. This information is given in the port restrictions of each port. The quantity of fresh oil required and the storage tank volume should be formulated based on this information when preparing the discharging plan.

3) Fresh oil storage tank
Since fresh oil is to be finally discharged, the volume of the storage tank should be decided after adequate studies otherwise excessive trim may occur and ballasting work may be delayed considerably.

4) Oil shifting method
Oil can be shifted to tanks that have become empty, in crude oil tankers. In most cases however, the shifting method is restricted to transfer of oil between tanks by gravity. Oil can be shifted to slop tanks using a pump since this can be accomplished without passing the oil through deck lines. The notification of shifting of oil should be given beforehand when submitting the discharging plan.

5) Stripping of fresh oil
A part of the fresh oil has to be shifted to the slop tank before discharging to ensure availability of eductor driving oil for the discharging and stripping of fresh oil storage tanks.

6) Final check of dryness
At terminals where fresh oil is a requirement, the stripping of almost all tanks other than fresh oil storage tanks is completed using the gathering tank (slop tank) used for COW. After discharging oil in the gathering tank, the fresh oil is used and the final check for dryness is performed.

5.4 Discharging the gathered oil

The procedure for discharging the port side slop tank using the No. 1 cargo pump is described below. The slop remaining in the slop tank is 1,700 m$^3$ and the discharging time is about one hour.

5.4.1 Valve lineup and discharging of the gathering tank
(Refer to "Fig. D-5-7 Line Diagram" on P2-33 and "Fig. D-5-8 Line Diagram" on P2-34 in the "Documents Section.")

1) Valve lineup

<table>
<thead>
<tr>
<th>Valve Type</th>
<th>Valve Numbers</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deck master valve</td>
<td>V322, V323</td>
<td>Close</td>
</tr>
<tr>
<td>Crossover gas intake valve</td>
<td>V388, V389</td>
<td>Close</td>
</tr>
<tr>
<td>Main line gas intake valve</td>
<td>V381, V382, V383, V385, V386</td>
<td>Close</td>
</tr>
</tbody>
</table>

Close fully the tank valve, tank sub main valve and crossover valve in the pump room.

* Perform “zero start.”

2) Starting the No. 1 cargo pump and discharging

a) Request the Engine Department beforehand to make preparations for starting the No. 1 pump and the stripping pump. Notification should be given at least one hour before using the stripping pump.

b) Cargo pump suction line V111, V112: Open
(Discharging) 5- 26

<table>
<thead>
<tr>
<th>Pump delivery valve</th>
<th>V113</th>
<th>Fully closed</th>
</tr>
</thead>
<tbody>
<tr>
<td>c) Crack open the tank valve of the port side slop tank.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tank valve of port side slop tank</td>
<td>V274</td>
<td>Slightly open</td>
</tr>
</tbody>
</table>

Perform priming in the crack-open condition while guarding against the water hammer phenomenon. Monitor the pump suction pressure, and when the pressure rises, open the slop tank valve to about 10%. When the suction pressure becomes approximately equal to the tank head pressure, carefully and gradually open the tank valve so that it is fully open.

d) Start the No. 1 pump.

e) After discussing with the terminal, open fully the No. 1 gate valve.
f) Confirm that the deck master valve V.321 is open.

<table>
<thead>
<tr>
<th>Deck master valve</th>
<th>V321</th>
<th>Check that it is open</th>
</tr>
</thead>
</table>

g) Confirm that the governor of the pump is working effectively. Then slightly open the delivery valve and start discharging the port side slop tank. Generally, the slop tank line diameter is smaller than the diameter of lines in other cargo tanks. Decide the discharging rate after carefully considering the permissible velocity of flow in the pipeline. The shape of the slop tank in a single hull ship varies depending on the shipyard. The shape may be broadly divided into following two types.
h) Tank constructed with a shape that follows the hull shape and extends to the tank bottom. The internal construction of such tanks is extremely complex, the inclination at the bottom is large, and if the scallop is not large, sludge accumulates and oil flow deteriorates.
i) Tanks with flat bottoms.

Sludge accumulation in such tanks is comparatively little and the tanks can be discharged easily.

On the other hand, the outer tanks of slop tank in double hull ships are ballast tanks. Thus, both shape and internal construction are simple. Discharging is also easy and very little oil remains after discharging. If the tank is stripped by the main pump, it may not be required to strip the tank using a stripping pump.

j) When the oil level reaches 3 m from the bottom, reduce the pump rpm and switch over to stripping the tank.

k) If the No. 1 main pump is operated carefully, the tank can be stripped easily, moreover, practically all the oil remaining in the tank main line can stripped.

In the final discharging stage, the pump rpm should be nearly the same as the minimum rpm and the discharge valve opened by about 10% or less.
l) After tank stripping is completed, and the pump subsequently stripping the oil remaining in the tank main line. The pump operates in this condition until gas is drawn in.
m) The pump delivery pressure drops abruptly. When the suction pressure becomes zero, it indicates gas inclusion. When this condition is reached, immediately close the discharge valve fully, reduce the pump rpm to the minimum rpm, and request the Engine Department to stop the pump.
n) When the pump stops, close the No. 1 gate valve after obtaining permission from the terminal.
o) Stop the supply of inert gases. At this stage, the IG fan is still in operation but IG is discharge to the atmosphere.

3) Circulation in the MARPOL line (gas bleed)

At terminals where oil is to be circulated in the line, the circulation of oil in the MARPOL line (gas bleed) used at the final discharging stage should be carried out when discharging the gathering tank. Oil circulation should be carried out returning part of the oil to be discharged to the gathering tank (slop tank) through the MARPOL line. To avoid abrupt operations, the oil circulation should be carried out at the minimum pump rpm simultaneously with the start of the discharging operation.
a) Use a part of the discharged oil to carry out oil circulation. The pump should be at the minimum rpm and the delivery valve should be slightly open.

b) Confirm that the MARPOL line is filled with oil and then slowly close V.344.

c) Close V.183. The sequence of closing is: close V.344 and then close V.183. However, this operation should be linked with that in c). This is to allow the filled oil to remain in the line.
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