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Fire in Scavenge Air Box

1. Cause

If flakes of burning or glowing carbon deposits drop into the oil sludge at the bottom of the scavenge air box, this sludge can be ignited and, if very combustible material is found here, serious damage can be done to the piston rod and the scavenge air box walls, the latter possibly causing a reduction in the tension of the staybolts.

Ignition of carbon deposits in the scavenge air box can be caused by:

- prolonged blow-by,
- "slow combustion" in the cylinder, owing to incorrect atomization, incorrect type of fuel valve nozzle, or "misaligned" fuel jets.
- "blow-back" through the scavenge air ports, owing to an incorrectly adjusted exhaust cam disc or large resistance in the exhaust system (back pressure).

  To keep the exhaust resistance low, heavy deposits must not be allowed to collect on protective gratings, nozzle rings and turbine blades, and the back pressure after the turbocharger must not exceed 350 mm WC.

Warning !

If the auxiliary blowers do not start during low-load running (due to faults, or the switch for the blowers not being in "AUTO"-position), unburned fuel oil may accumulate on top of the pistons.

This will involve the risk of a **scavenge air box fire**.

In order to avoid such fire:
- obtain permission to stop the engine
- stop the engine
- remove any unburned fuel oil from the top of the pistons
- re-establish the supply of scavenge air
- start the engine.

Note: the switch for the auxiliary blowers should be in **"AUTO"-position** during all modes of engine control, i.e.:

- remote control
- control from engine side control console.

2. Warnings of Fire

A fire in the scavenge box manifests itself by:

- an increase in the exhaust temperature of the affected cylinder,
- the turbocharger may surge,
- smoke from the turbocharger air inlet filters when the surging occurs,
- the scavenge air box being noticeably hotter.

If the fire is violent, smoky exhaust and decreasing engine revolutions will occur.

Violent blow-by will cause smoke, sparks, and even flames, to be blown out when the respective scavenge box drain cock is opened - therefore keep clear of the line of ejection.

Monitoring devices, *Chapter 701, pos. 415, 416* (80°C), in the scavenge air space give alarm and slow-down at abnormal temperature increase.

3. Measures to be taken

Owing to the possible risk of a crankcase explosion, do not stand near the relief valves - flames can suddenly be violently emitted.

1) Reduce speed/pitch to SLOW, if not already carried out automatically, *see above,* and ask bridge for permission to stop.

2) When the engine STOP order is received, stop the engine and switch-off the auxiliary blowers.

3) Stop the fuel oil supply.

4) Stop the lub. oil supply.

5) Put the scavenge air box fire extinguishing equipment into function. *See plate 70405.*

Do not open the scavenge air box or crankcase before the site of the fire has cooled down to under 100 °C. When opening, keep clear of possible fresh spurts of flame.

6) Remove dry deposits and sludge from all the scavenge air boxes.
See also Chapter 701 `Sealing Materials'.

7) Clean the respective piston rods and cylinder liners, and inspect their surface condition, alignment, and whether distorted. If in order, coat with oil.
Repeat the checking and concentrate on piston crown and skirt, while the engine is being turned (cooling oil and water on).
Inspect the stuffing box and bottom of scavenge box for possible cracks.

8) If a piston caused the fire, and this piston cannot be overhauled at once, take the precautions referred to in *Chapter 703, Item 4.2,`Supplementary comments', Point 7 (blow-by).*

   If heating of the scavenge air box walls has been considerable, the staybolts should be retightened at the first opportunity.

   Before retightening, normal temperature of all engine parts must be reestablished.

4. Scavenge Air Drain Pipes

Plate 70402

To ensure proper draining of oil sludge from the scavenge air boxes, thereby reducing the risk of fire in the scavenge air boxes, we recommend:

- **Daily check during running**
- **Cleaning of drain pipes at regular intervals**

4.1 Daily checks during running:

1) Open the valve between the drain-tank and the sludge-tank.

2) Close the valve when the drain-tank is empty.

3) Check the pipes from flange **AV** to the drain-tank venting pipe:

Does air escape from the drain-tank venting pipe?	
YES	This indicates free passage from flange **AV** to the drain-tank venting pipe.
NO	Clean the pipes as described below, at the first opportunity.

4) Check the pipes from the test-cocks to flange **AV**:

   Open the test cocks, one by one, between the main drain pipe and the scavenge air boxes and between the main drain pipe and the scavenge air receiver/auxiliary blowers.

Begin at flange AV, and proceed towards flange BV.

Use this procedure to locate any blocking.

Does **air** or **oil** blow-out from the individual test-cock?	
AIR	The scavenge air space is being drained correctly. *This indicates free passage from the actual test-cock to flange **AV**.*
OIL	The scavenge air space is **not** being drained correctly. *This indicates that the main drain pipe is blocked between the test-cock which blows-out oil, and the neighbouring test-cock towards flange AV.* Clean the drain pipe as described below, at the first opportunity.

4.2 Cleaning of drain pipes at regular intervals:

The intervals should be determined for the actual plant, so as to prevent blocking-up of the drain system.

Clean the main drain pipe and the drain-tank discharge pipe by applying air, hot water or steam during engine standstill.

Note: If leaking valves are suspected, dismantle and clean the main drain pipe manually,

If hot water or steam is used, consider the risk of corrosion on the piston rods, if a valve is leaking.

1) Check that the valve between flange **AV** and the main drain pipe is open.

2) Close **all** valves between the main drain pipe and the scavenge air boxes, and between the main drain pipe and the scavenge air receiver/auxiliary blowers.

   If hot water or steam is used, it is **very important** to close all valves, to prevent corrosion on the piston rods.

3) Open the valve at flange **BV** on the main drain pipe.

   This leads the cleaning medium to the main drain pipe.

4) When the main drain pipe is sufficiently clean, open the valve between the drain-tank and the sludge-tank.

   This will clean the drain-tank discharge pipe.

5) When the drain tank discharge pipe is sufficiently clean, close the valve between the drain tank and the sludge tank.

6) Close the valve at flange **BV**.

7) Finally, open all valves between the main drain pipe and the scavenge air boxes, and between the main drain pipe and the scavenge air receiver/auxiliary blowers.

Ignition in Crankcase

1. Cause

When the engine is running, the air in the crankcase contains the same types of gas (N_2-O_2-CO_2) in the same proportions as the ambient air, but there is also a heavy shower of coarse oil droplets being flung around everywhere.

If abnormal friction occurs between the sliding surfaces, or heat is otherwise transmitted to the crankcase (for instance from a scavenge air fire via the piston rod/stuffing box, or through the intermediate bottom), "Hot spots" on the heated surfaces can occur. The "hot spots" will cause the oil falling on them to evaporate.

When the oil vapour condenses again, countless minute droplets are formed which are suspended in the air, i.e. a *milky-white oil mist* develops, which is able to feed and propagate a flame if ignition occurs. The ignition can be caused by the same "hot spot" which caused the oil mist.

If a large amount of oil mist has developed before ignition, the burning can cause a tremendous rise of pressure in the crankcase (explosion), which forces a momentary opening of the relief valves. In isolated cases, when the entire crankcase has presumably been full of oil mist, the consequential explosion has blown off the crankcase doors and set fire to the engine room.

Note !
In the event that a crankcase explosion has occurred, the complete flame arrester of the relief valves must be replaced.

NB: Similar explosions can also occur in the chain casing and scavenge air box.

Every precaution should therefore be taken to:

A) avoid "hot spots"
B) detect the oil mist in time.

A. "Hot Spots" in Crankcase

Well-maintained bearings only overheat if the oil supply fails, or if the bearing journal surfaces become too rough (owing to the lubricating oil becoming corrosive, or being polluted by abrasive particles).

For these reasons, it is very important to:

- purify the lubricating oil correctly,
- make frequent control analyses *(see Chapter 708)*,
- ensure that the filter gauze is maintained intact.

Due to the high frictional speed of the thrust bearing, special care has been taken to ensure the oil supply to this bearing.

Monitoring equipment is arranged to give an alarm in cases of low circulating oil pressure and/or high temperature of thrust bearing segments. Keep this equipment in tip-top condition.
(See Chapter 701: Lub. Oil Pressure, pos. 331, 334, 335; Thrust Segment Temperature, pos. 350, 351, 352).

Feel over moving parts (by hand or with a "thermo-feel") at suitable intervals (15-30 minutes after starting, one hour later, and again at full load, *(see Chapter 703, Item 3.2, 'Checks during Loading', Check 9 'Feel-over Sequence').*

Check A1, *Chapter 702*, is still the best safeguard against "hot spots" when starting up after repairs or alterations affecting the moving parts, and should never be neglected. *If in doubt, stop and feel over.*

B. Oil Mist in Crankcase

In order to ensure a reliable, and quick warning of oil mist formation in the crankcase, constant monitoring is obtained with an "Oil Mist Detector", which samples air from each crankcase compartment.

The detector will give alarm and slow-down, *see Chapter 701, pos. 436, 437,* at a mist concentration which is only a fraction of the lower explosion limit, LEL, to gain time to stop the engine before ignition of the oil mist can take place.

See also the special instructions from the supplier of the oil mist detector.

For CPP-plants with engaged shaft generator, an auxiliary engine will be started automatically and coupled to the grid, before the shaft generator is disengaged and the engine speed reduced, *see 'Sequence Diagram', Plate 70311.*

2. Measures to be taken when Oil Mist has occurred

Warning!
Do not stand near crankcase doors or relief valves – nor in corridors near doors to the engine room casing in the event of an **alarm** for: a) oil mist b) high lube oil temperature c) no piston cooling oil flow, or d) scavenge box fire Alarms b, c and d should be considered as pre-warnings of a possible increasing oil mist level. *See also our Service Letter SL97-348/ ERO.*

1) Reduce speed/pitch to slow-down level, if not already carried out automatically, (Pos. 437), *see above.*

2) Ask the bridge for permission to stop.

3) When the engine STOP order is received:
   - stop the engine
   - close the fuel oil supply.

4) Switch-off the auxiliary blowers and engine room ventilation.

5) Open the skylight(s) and/or "stores hatch".

6) Leave the engine room.

7) Lock the casing doors and keep away from them.

8) Prepare the fire-fighting equipment.

Do not open the crankcase until at least 30 minutes after stopping the engine. When opening up, keep clear of possible spurts of flame. Do not use naked lights and do not smoke.

9) Stop the circulating oil pump. Take off/open all the lowermost doors on one side of the crankcase. Cut off the starting air, and engage the turning gear.

10) Locate the "hot spot". Use powerful lamps from the start.

    Feel over, by hand or with a "thermo-feel", all the sliding surfaces (bearings, thrust bearing, piston rods, stuffing boxes, crossheads, telescopic pipes, chains, vibration dampers, moment compensators, etc.). *See also point 14.*

    Look for squeezed-out bearing metal, and discolouration caused by heat (blistered paint, burnt oil, oxidized steel).
    Keep possible bearing metal found at bottom of oil tray for later analyzing.

11) Prevent further "hot spots" by preferably making a permanent repair.
    In case of bearings running hot, *see Chapter 708, Item 7.1, point g).*
    See also Chapter 701, `Sealing Materials'.

Ensure that the respective sliding surfaces are in good condition.

Take special care to check that the circulating oil supply is in order.

12) Start the circulating oil pump and turn the engine by means of the turning gear.

Check the oil flow from all bearings, spray pipes and spray nozzles in the crankcase, chaincase and thrust bearing *(Check A1, Chapter 702)*.

Check for possible leakages from pistons or piston rods.

13) - Start the engine.

After:

- 15-30 minutes,
- one hour later,
- when full load is reached:

- Stop and feel over.
- Look for oil mist.

Especially feel over (by hand or with a ''thermo-feel") the sliding surfaces which caused the overheating. *See Chapter 703, `Checks during Loading', Item 3.2, Check 9, `Feel-over Sequence'.*

14) In cases where it has not been possible to locate the ''hot spot", the procedure according to Point 10 above should be repeated and intensified until the cause of the oil mist has been found and remedied.

There is a possibility that the oil mist is due to ''atomization" of the circulating oil, caused by a jet of air/gas, e.g. by combination of the following:

- Stuffing box leakages (not air tight).
- Blow-by through a cracked piston crown or piston rod (with direct connection to crankcase via the cooling oil outlet pipe).
- An oil mist could also develop as a result of heat from a scavenge fire being transmitted down the piston rod or via the stuffing box. Hot air jets or flames could also have passed through the stuffing box into the crankcase.

Turbocharger Surging

1. General

During normal operation, a few 'shots' of surging will often occur, e.g. at crash stop or other abrupt manoeuvrings. This sporadic surging is normally harmless, provided the turbocharger bearings are in a good service condition.

However, continuous surging must be avoided, as there is a risk of damaging the rotor, especially the compressor blading.

All cases of turbocharger surging (stalling) can be divided into three main categories:

1. Restriction and fouling in the air/gas system.
2. Malfunction in the fuel system.
3. Rapid variations in engine load.

However, for convenience, the points in the "check lists" below are grouped according to specific engine systems.
See also Plate 70404.

2. Causes

2.1 Fuel Oil System

- Low circulating or supply pump pressure.
- Air in fuel oil
- Water in fuel oil
- Low preheating temperature
- Malfunctioning of deaerating valve on fop of venting tank
- Defective suction valve
- Detective puncture valve
- Sticking fuel pump plunger
- Sticking fuel valve spindle
- Damaged fuel valve nozzle
- Defect in overflow valve in fuel return pipe
- Camshaft timing, faulty load distribution.

2.2 Exhaust System

- Exhaust valve not opening correctly
- Damaged or blocked protective grating before turbocharger
- Increased back pressure after T.Ch.
- Pressure pulsations after T.Ch.
- Pressure pulsations in exhaust receiver
- Damaged compensator before T.Ch.

2.3 Turbocharger

- Fouled or damaged turbine side
- Fouled or damaged compressor side
- Fouled air filter boxes
- Damaged silencer
- Bearing failure.

2.4 Scavenge Air System

- Fouled air cooler, water mist catcher, and/or ducts
- Stopped water circulation to cooler
- Coke in scavenge ports
- Too high receiver temperature.

2.5 Miscellaneous

- Hunting governor
- Rapid changes in engine load.
- Too rapid rpm change:

  a) when running on high load
  b) during manoeuvring
  c) at shut downs/slow downs
  d) when running ASTERN.
  e) due to "propeller racing" in bad weather.

3. Countermeasure

Continuous surging can be temporarily counteracted by "blowing-off" from the valve at the top of the air receiver. However, when doing this the exhaust temperatures will increase and must not be allowed to exceed the limiting values, *see Chapter 701.*

Running with Cylinders or Turbochargers out of Operation

1. General

The engine is designed and balanced to run with all cylinders as well as all turbochargers working. If a breakdown occurs which disables one or more cylinders, or turbochargers, repair should preferably be carried out immediately.

If this is not possible, the engine can be operated with one or more cylinders or turbochargers out of operation, but with reduced speed owing to the following:

1. As, in such cases, the air supply is no longer optimal, the thermal load will be higher.
   Therefore, depending upon the actual circumstances, the engine will have to be operated according to the restrictions mentioned in Items 4 and 5 further on in this Chapter.

   Note that the exhaust temperatures can sometimes be high at about 30-40% load, corresponding to 67 to 73% of MCR speed. It may be necessary to avoid operating in this range.

2. Pressure pulsations may occur in the scavenge and exhaust receivers, which can give a reduced air supply to any one of the cylinders, consequently causing the respective exhaust temperatures to increase.

   The fuel pump index for these cylinders must therefore be reduced to keep the exhaust temperatures (after valves) below the value stated in *Chapter 701. However, see ''Note" under point 1 above.*

3. Since the turbochargers will be working outside their normal range, surging may occur.

   This can generally be remedied by ''blowing off" from the scavenge air receiver. The increased temperature level caused by this must be compensated for by a reduction of the engine revolutions, until the exhaust temperatures are in accordance with the values stated in *Chapter 701.*

   If more than one cylinder must be cut out of operation, and the engine has two or more turbochargers, it may be advantageous to cut out one of the turbochargers. However, *see ''Note" under point 1 above.*

4. When cylinders are out of operation, governor hunting may occur. When this happens, the fuel pump index must be limited by operating the electronic governor on ''index control".

   For some electronic governors, it is not recommended to use the mechanical stop for max. index. These governors have a built-in electronic max. index control.

   Regarding the mechanical/hydraulic governor (Woodward) the stop screw, mounted at the change-over mechanism, *see Plate 70301*, is screwed slightly downwards, until the hunting just ceases.
   Before this is carried out, measure or mark the position of the stop screw, so that it can be returned to the original position, when max. index is no longer needed.

5. With one or more cylinders out of operation, torsional vibrations, as well as other mechanical vibrations, may occur at certain engine speeds.

   The standard torsional vibration calculations cover the following conditions:
   - normal running
   - misfiring of one cylinder

   The latter leads to load limitations, *see Item 4 further on*, which in most cases are irrespective of the torsional vibra-

tion conditions; additional restrictions may occur depending on the specific conditions.

The above-mentioned calculations do not deal with the situation where reciprocating masses are removed from the engine or where the exhaust valve remains open. In such specific cases the engine maker has to be contacted.

Should unusual noise or extreme vibrations occur at the chosen speed, this speed must be further reduced.

Because the engine is no longer in balance, increased stresses occur in crankshaft, chain and camshaft. However, if abnormal vibrations do not occur, the engine can usually be run for a short period (for instance some days) without suffering damage.

If the engine is to be run for a prolonged period with cylinders out of operation, the engine builder should always be contacted in order to obtain advice concerning possible recommended barred speed ranges.

When only the fuel for the respective cylinders is cut off, and the starting air connections remain intact, the engine is fully manoeuvrable.

In cases where the starting air supply has to be cut off to some cylinders, starting in all crankshaft positions cannot always be expected.

If the engine does not turn on starting air in a certain crankshaft position, it must immediately be started for a short period in the opposite direction, after which reversal is to be made to the required direction of rotation.

Should this not give the desired result, it will be necessary to turn the engine to a better starting position, by means of the turning gear. Remember to cut off the starting air before turning, and to open the indicator cocks.

2. How to put Cylinders out of Operation *(Plate 70401)*

See Volume II, 'Maintenance' for the respective procedures.

The following points **(A-E)** describe five different "methods" of putting a single cylinder out of operation.

The extent of the work to be carried out depends, of course, on the nature of the trouble.

NB In cases where the crosshead and crankpin bearings are operative, the oil inlet to the crosshead must not be blanked-off, as the bearings are lubricated through the crosshead.

A summary of the various cases is given on *Plate 70401.*

A. Combustion cut out. Piston and exhaust valve gear still working Compression on

Reasons:
Preliminary measure in the event of, for instance: blow-by at piston rings or exhaust valve; bearing failures which necessitate reduction of bearing load; faults in the injection system.

Procedure:
Cut out the fuel pump by lifting and securing the roller guide. *(See Vol. II, Procedure 909-5).*

Note: Piston cooling oil and cylinder cooling water must not be cut off.
See also Item 4, 704.11.

B. Combustion and compression cut out Piston still working in cylinder

Reasons:
This measure is permitted in an emergency where, for instance, water is leaking into the cylinder from the cooling jacket/liner or cylinder cover.

Running in this way must as soon as possible be superseded by the precautions mentioned under D or E.
See also Item 3, 704.11.

Procedure:

1) Cut out the fuel pump by lifting and securing the roller guide.
See Vol. II, Procedure 909-5.

2) Put the exhaust valve out of action and lock it in **open** position.
See Vol. II, Procedure 908-6.

Shut-off the air supply to the exhaust valve, and stop the lube oil pumps. Dismantle and block the actuator oil pipe. Restart the lube oil pumps.

3) Blank off cooling water inlet and outlet pipe for the cylinder. If necessary, drain the cooling water spaces completely.

4) Dismantle the starting air pipe, and blank off the main pipe and the control air pipe for the pertaining cylinder.

5) When operating in this manner, the speed should not exceed 55% of MCR speed *see also 'Note' below.*

Note: The joints in the crosshead and crankpin bearings have a strength that, for a short time, will accept the loads at full speed without compression in the cylinder. However, to avoid unnecessary wear and pitting at the joint faces, it is recommended that, when running a unit continuously with the compression cut-out, the engine speed is reduced to 55% of MCR speed, which is normally sufficient to manoeuvre the vessel.

During manoeuvres, if found necessary, the engine speed can be raised to 80% of MCR speed for a short period, for example 15 minutes.

Under these circumstances, in order to ensure that the engine speed is kept within a safe upper limit, the over-speed level of the engine must be lowered to 83% of MCR speed.

C. Combustion cut out.
Exhaust valve closed.
Piston still working in cylinder.

Reasons:
This measure may be used if, for instance, the exhaust valve or the actuating gear is defective.
See also Item 4, 704.11.

Procedure:

1) Cut out the fuel pump by lifting and securing the roller guide. *(See Volume II, Procedure 909-5).*

2) Put the exhaust valve out of action *(See Volume II, Chapter 908-5)* so that the valve remains **closed** (lift the guide or stop the oil supply and remove the hydraulic pipe).

Note: The cylinder cooling water and piston cooling oil must not be cut out.

D. Piston, piston rod, and crosshead suspended in the engine.
Connecting rod out

Reasons:
For instance, serious defects in piston, piston rod, connecting rod, cylinder cover, cylinder liner and crosshead.
See also Item 3, 704.11.

Procedure:

1) Cut out the fuel pump by lifting and fixing the roller guide.
See Vol. II, Procedure 909-5.

2) Put the exhaust valve out of action *(Volume II, Chapter 908-5)* so that the valve remains closed.

3) Dismantle the starting air pipe
Blank off the main pipe and the control air pipe for the pertaining cylinder.

Note: In this case the blanking-off of the starting air supply is particularly important, as otherwise the supply of starting air will blow down the suspended engine components.

4) Suspend the piston, piston rod and crosshead, and take the connecting rod out of the crankcase, in accordance with the directions in *Volume II, Chapter 904.*

5) Blank off the oil inlet to the crosshead.

6) Set the cylinder lubricator for the pertaining cylinder, to "zero" delivery.

E. Piston, piston rod, crosshead, connecting rod, and telescopic pipe out

Reasons:
This method is only used if lack of spare parts makes it necessary to repair the defective parts during the voyage.
See also Item 3, 704.11.

Procedure:
1) Cut out the fuel pump by lifting and locking the roller guide.
See Vol. II, Chapter 909).

2) Put the exhaust valve out of action *(See Volume II, Chapter 908)* so that the valve remains **closed**.

3) Dismantle the starting air pipe, and blank off the main pipe and the control air pipe for the pertaining cylinder.

4) Dismantle piston with piston rod and stuffing box, crosshead, connecting rod and crankpin bearing. Blank off the stuffing box opening with two plates (towards scavenge air box and crankcase). Minimum plate thickness 5 mm.

5) Blank off the oil inlet hole from the telescopic pipe.

6) Set the cylinder lubricator for the pertaining cylinder to "zero" delivery.

3. Starting after putting Cylinders out of Operation

Checking of Oil Flow

After carrying out any of the procedures described under points B, C, D, and E, it is, before starting, absolutely necessary to check the oil flow through the bearings, and the tightness of blanked-off openings.

After 10 minutes' running, and again after one hour, the crankcase must be opened for checking:

- the bearings,
- the temporarily secured parts,
- the oil flow through bearings,
- the tightness of blanked-off openings.

Load Restrictions:

Cases A and C, *see Item 4 below.*
Cases B, D and E, always contact the engine builder for calculation of allowable output and possible barred speed range.

Emergency Procedure of Starting

See 704.14.

4. Running with one Cylinder Misfiring (Cases A and C)

Misfiring is defined as:
- no injection and
- compression present.

If only **one** cylinder is misfiring, it will most likely be possible to run the engine, i.e. the remaining and working cylinders, with a mean indicated pressure, pi, up to 90% of the specified MCR-value of pi for the actual engine. In such cases, the following r/min and shaft powers may be obtained with a fixed-pitch propeller.

Total No. of Cylinders	% r/min (of MCR)	% Load (of MCR)
4	83	57
5	86	63
6	88	67
7	89	71
8	90	73
9	91	75
10	91	77
11	92	78
12	92	78

NB Only valid for misfiring, i.e. Item 2, points A and C, *see Pages 704.09-10 and Plate 70401.*

With a CP-propeller, the same values apply when running according to the design pitch.

If more than one cylinder is misfiring, the engine builder must be contacted.

Running Limitations in Cases B, D and E

In cases B, D and E, the engine builder must always be contacted for calculation of allowable output and possible barred speed range.

5. How to put Turbochargers out of Operation

(See also special instruction book for turbochargers).

If heavy vibrations, bearing failure, or other troubles occur in a turbocharger, preliminary measures can be taken in one of the following ways:

A. If the ship must be instantly manoeuvrable:

Reduce the load until the vibrations cease.

B. If the ship must be instantly manoeuvrable, but the damaged turbocharger cannot run even at reduced load:

Note: This mode of operation is only recommendable if no time is available for carrying out the procedures described in Item **'C'**, 'Running for an extended period with a Turbocharger out of Operation'.

Refer to the T/C manual regarding the maximum time of operation in condition **'B'**, before the bearings will be damaged.

Engines with **one** turbocharger:

1. Stop the engine.
2. Lock the rotor of the defective turbocharger. *(See T/C manual).*
3. Remove the compensator between the compressor outlet and the scavenge air duct.
   This reduces the suction resistance.
4. **Load restrictions:** *See Plate 70403.*

Engines with **two or more** turbochargers:

1. Stop the engine.
2. Lock the rotor of the defective turbocharger. *(See T/C manual).*
3. Insert an orifice plate in the compressor outlet.
   A small air flow is required through the compressor to cool the impeller.
4. **Load restrictions:** *See Plate 70403.*

   Note: The load limit can be increased considerably if an orifice plate is also inserted in the turbine inlet, as described in Item **C**, 'Engines with **two or more** Turbochargers'.

C. **Running for an extended period with a turbocharger out of operation**

Engines with one turbocharger:

- Engines with exhaust by-pass (Option).

1. Stop the engine.
2. Lock the turbocharger rotor. *(See T/C manual).*
3. Remove the blanking plate from the exhaust by-pass pipe.
4. Remove the compensator between the compressor outlet and the scavenge air duct. *This reduces the suction resistance.*
5. **Load restrictions:** *See Plate 70403.*

- Engines without exhaust by-pass.

1. Stop the engine.
2. Remove the rotor and nozzle ring of the turbocharger. *(See T/C manual)*
3. Insert blanking plates. *(See T/C manual)*
4. Remove the compensator between the compressor outlet and the scavenge air duct. *This reduces the suction resistance.*
5. **Load restrictions:** *See Plate 70403.*

Engines with **two or more** turbochargers:

1. Stop the engine.
2. Lock the rotor of the defective turbocharger. *(See T/C manual)*
3. Insert orifice plates in the compressor outlet and the turbine inlet. *A small air flow is required to cool the impeller, and a small gas flow is desirable to prevent corrosion.*
   Alternatively, insert an orifice plate in the compressor outlet and a blank plate at the turbine inlet without locking the rotor.
4. **Load restrictions:** *See Plate 70403.*

D. **Repair to be carried out during voyage.**

Engines with **two or more** turbochargers:

1. Stop the engine.
2. Insert blanking plates in compressor outlet, turbine inlet and turbine outlet.
3. **Load restrictions:** *See Plate 70403.*

Engines with **one** turbocharger, equipped with exhaust by-pass (Option):

1. Stop the engine.
2. Insert blanking plates in turbine inlet and turbine outlet.
3. Remove the blanking plate from the exhaust by-pass pipe.
4. Remove the compensator between the compressor outlet and the scavenge air duct.
5. **Load restrictions:** *See Item 'C', 'Engines with exhaust by-pass (Option)'.*

6. Putting an Auxiliary Blower out of Operation

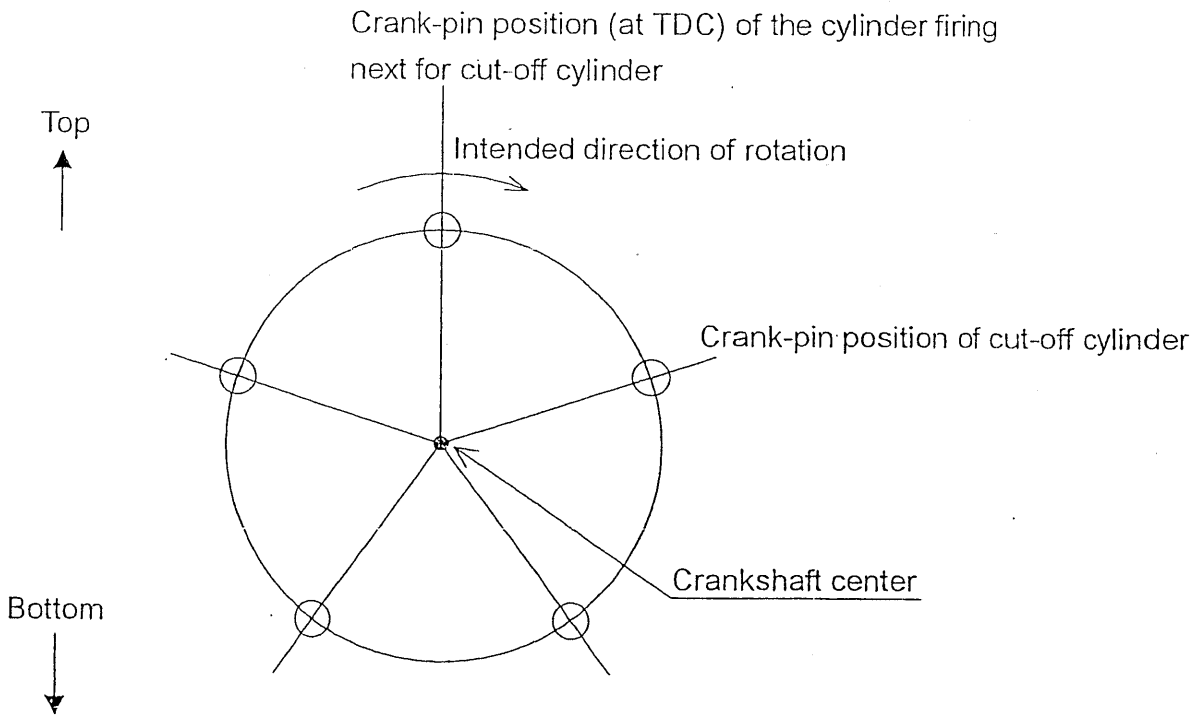
If one of the auxiliary blowers becomes inoperative, it is automatically cut out by the built-in non-return valve, and there are no restrictions in the operation of the engine.
See also Vol. III, 'Components Descriptions', Chapter 910.

For 5 cylinders engine

Emergency Starting Procedure for Engine with One Cylinder Cutting-off

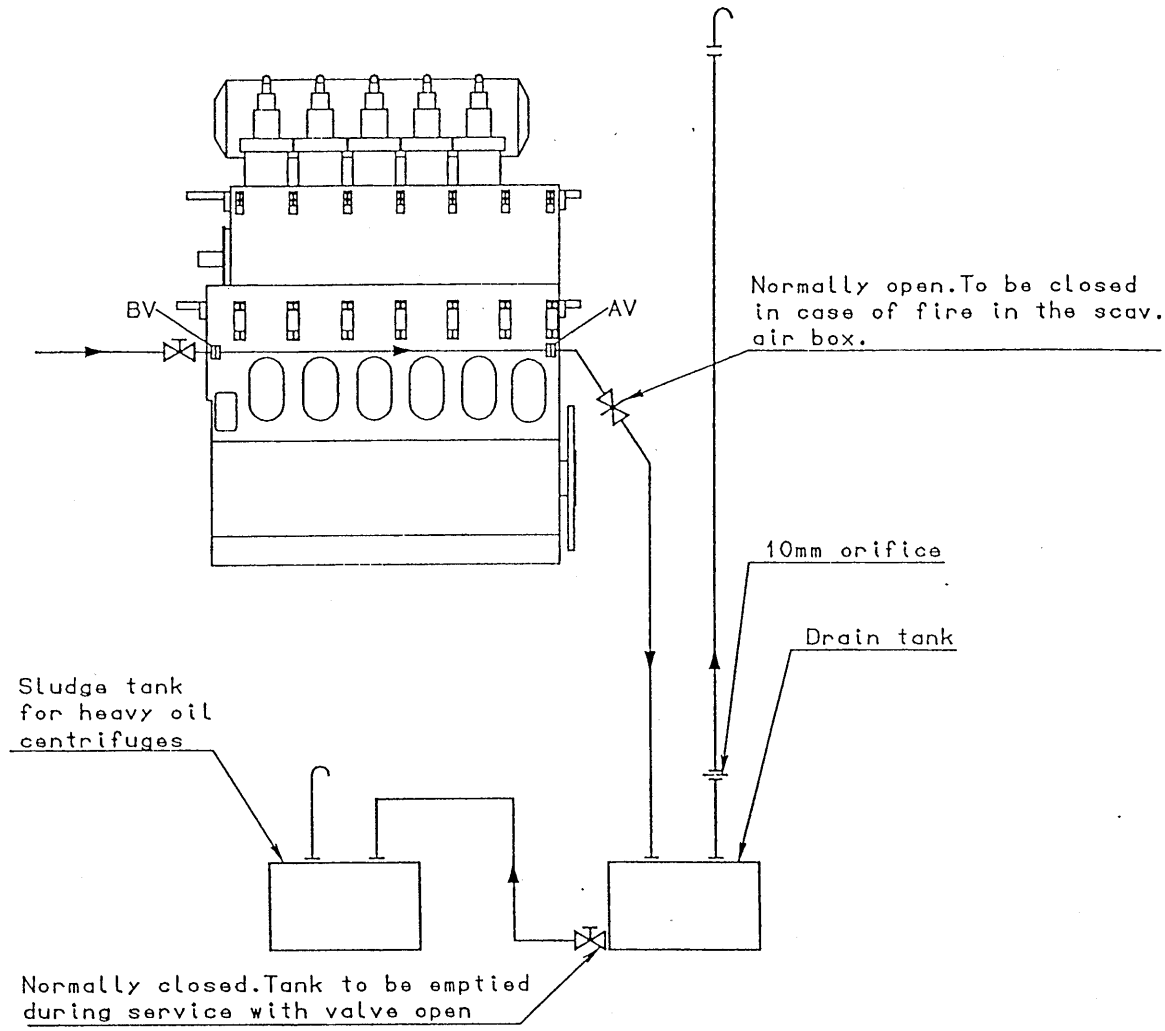
In case the engine with one cylinder cutting-off cannot be started by usual way, following procedure is to be taken.

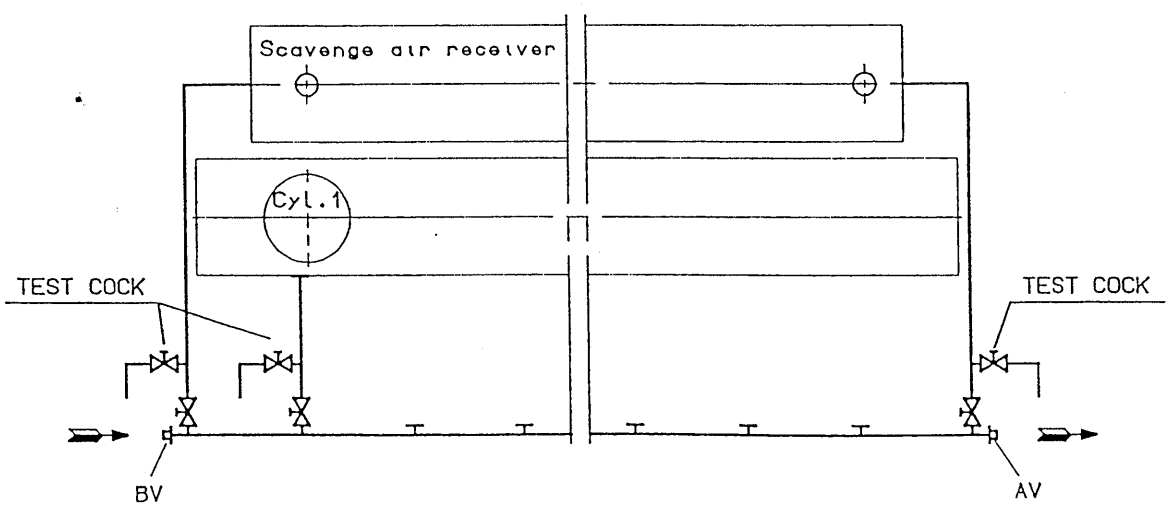
1) Turn the crankshaft until a piston of the cylinder, which fires next to cut-off cylinder, comes up to TDC position.
2) Try to start the engine by usual way.
3) If fail, repeat procedure of 1)-2).



	Case A	Case B	Case C	Case D	Case E
Nature of emergency action	Combustion to be stopped	Compression and combustion to be stopped	Combustion to be stopped (due to faulty exhaust valve)	All reciprocating parts suspended or out	All reciprocating parts out
Some reasons for emergency action	Blow-by at piston rings or exhaust valve. Reduction of load on bearings. Faulty injection equipment.	Leaking cylinder cover or liner.	Exhaust valve, or exhaust valve actuating gear, malfunction	Quickest and safest measure in the event of faults in large moving parts, or cylinder cover or cylinder liner	Only of interest if spare parts are not available
Fuel pump with roller guide	Lifted	Lifted	Lifted	Lifted	Lifted
Exhaust valve	Working	Held open	Closed	Closed	Closed
Air for air spring	Open	Closed	Open	Open	Open
Exhaust valve actuator with roller guide	Working	Out or lifted	Out or lifted	Out or lifted	Out or lifted
Oil inlet for actuator	Open	Pipe dismantled and blocked	Open	Open	Open
Starting valve	Working	Blanked	Working	Blanked	Blanked
Piston with rod	Moving	Moving	Moving	Suspended	Out
Crosshead	Moving	Moving	Moving	Suspended	Out
Connecting rod	Moving	Moving	Moving	Out	Out
Crankpin bearing	Moving	Moving	Moving	Out	Out
Oil inlet to crosshead	Open	Open	Open	Blanked	Blanked
Cooling oil outlet from crosshead	Open	Open	Open		
Cylinder lubricator	Working	Working	Working	"Zero" delivery	"Zero" delivery

Plate 70402-40B Scavenge Air Drain Pipes





Component	Case B		Case C [1]			Case D
	Engines with **one** T/C	Engines with **two or more** T/C	Engines with **one** T/C		Engines with **two or more** T/C	(Engines with **two or more** T/C)
			With by-pass	Without by-pass		
Rotor [2]	Locked	Locked	Locked	Removed	Locked	
Nozzle ring [2]				Removed		
Compressor outlet		Orifice plate			Orifice plate	Blanking plates
Turbine inlet					Orifice plate	Blanking plates
Turbine outlet						Blanking plates
Compensator after compressor outlet	Removed		Removed	Removed		
By-pass blanking plate			Removed			
T/C housing [2]				Blanking plates		
Max % of MCR load/ (speed):						
1 T/C of 1	15/(53) [3]	-	20-(58) [4]	15/(53) [3]	-	-
1 T/C of 2	-	15/(53) [3] [5]	-	-	50/(79) [3] [6]	50/(79) [3] [6]
1 T/C of 3	-	20/(58) [3] [5]	-	-	66/(87) [3] [6]	66/(87) [3] [6]
1 T/C of 4	-	20/(58) [3] [5]	-	-	75/(91) [3] [6]	75/(91) [3] [6]
1 Aux. bl. of 2 [7]	10/(46) [4]	15/(53) [4]	10/(46) [4]	10/(46) [3]	[8]	[8]
1 Aux. bl. of 3 [7]	-	15/(53) [4]	-	-	[8]	[8]
1 Aux. bl. of 4 [7]	-	15/(53) [4]	-	-	[8]	[8]

[1] The engine builder will, in each specific case, be able to give further information about engine load possibilities and temperature levels.

[2] See T/C manual.

[3] The exhaust temperatures must **not**, however, exceed the value(s) stated in Chapter 701. *See also the Note in Item 1, 'General', page 704.08.*

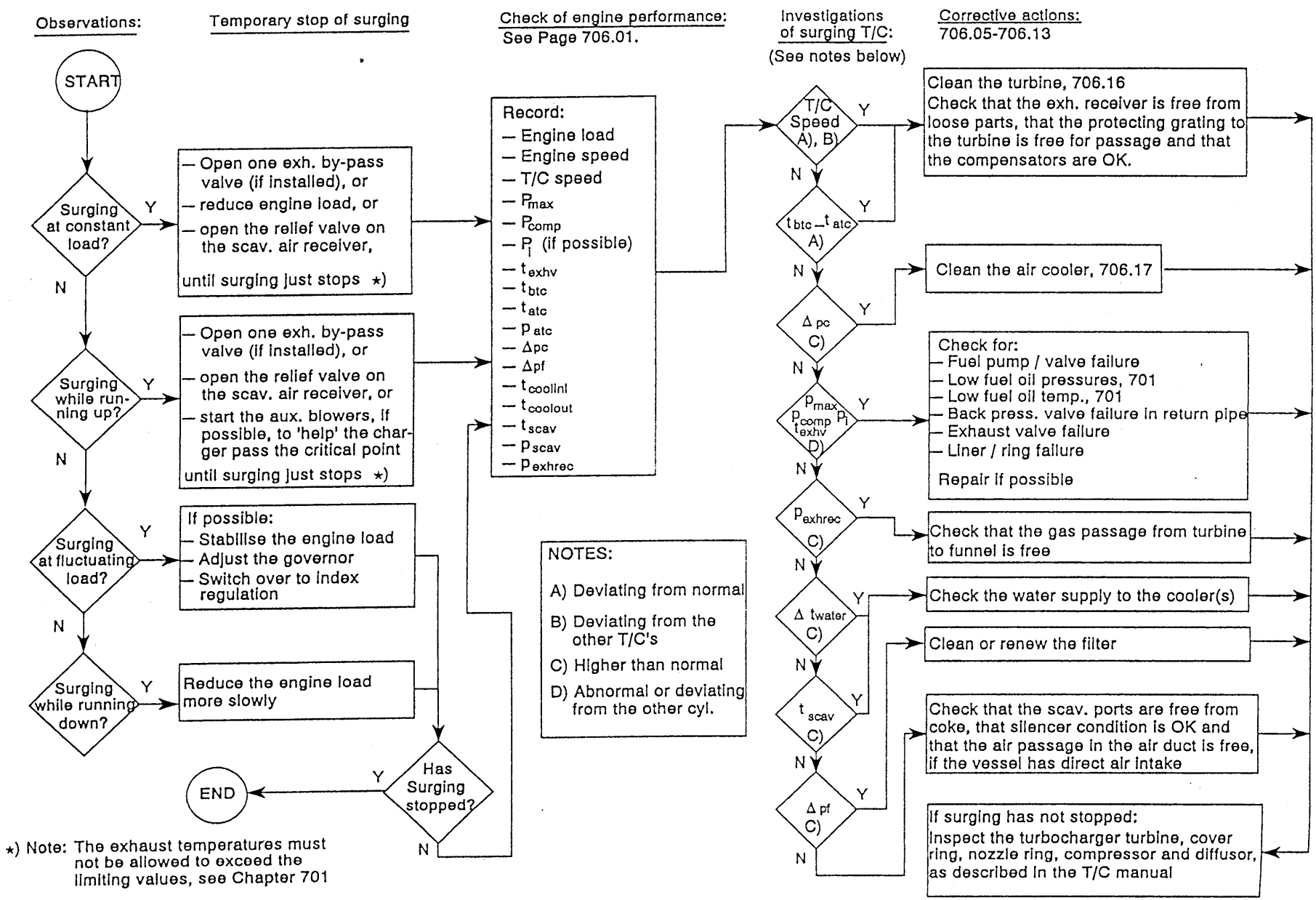
[4] The exhaust temperature must **not** exceed 430°C.

[5] This is due to the loss of exhaust gas through the damaged turbocharger.

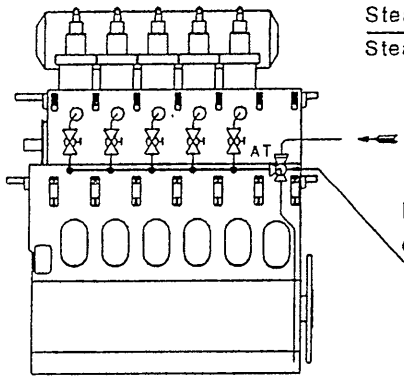
[6] The mentioned exhaust temperature limit is an average value for the whole load range.

[7] Simultaneous with 1 T/C out of operation. There are no load restrictions with 1 aux. blower out of operation and all T/C's in operation.

[8] See the limits given under '1 T/C of 2', '1 T/C of 3' and 1 T/C of 4, above.



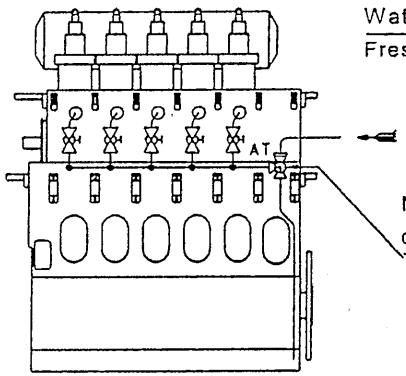
*) Note: The exhaust temperatures must not be allowed to exceed the limiting values, see Chapter 701



Steam extinguishing

Steam pressure 3-10 bar

Normally position
open to bilge

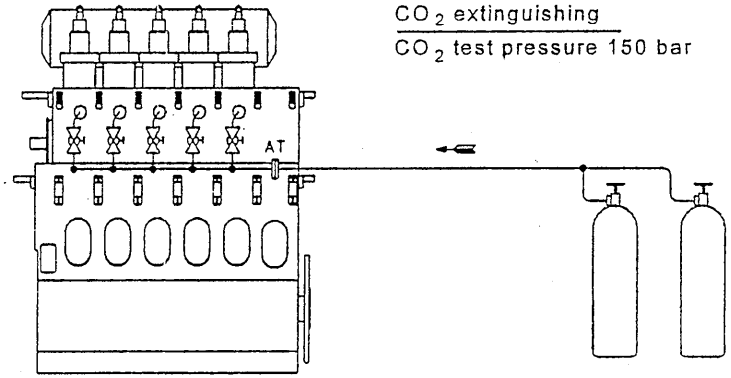


Water mist extinguishing

Fresh water pressure min. 3.5 bar

Normally position
open to bilge

To prevent the fire from spreading to the next cylinder(s), the ball-valve of the neighbouring cylinder(s) should be opened in the event of fire in one cylinder



CO_2 extinguishing

CO_2 test pressure 150 bar

At least two bottles ought to be installed. In most cases, one bottle should be sufficient to extinguish fire in three cylinders, while two or more bottles would be required to extinguish fire in all cylinders