CHAPTER 6

ENGINEERING CASUALTY CONTROL - For Engineering Personnel (Lesson Plan)

Section 6.1

INTRODUCTION TO ENGINEERING CASUALTY CONTROL

I. OBJECTIVES.

A. To develop an understanding of the principles relating to engineering casualties.

B. To stress the importance of engineering personnel's responsibilities in the prevention and control of engineering casualties.

C. To aid responsible engineering personnel plan practical engineering casualty control exercises and drills.

II. MATERIALS.

A. Training Aids.

1. Ship's standard station bill.

2. Chief engineers' organization manual.

3. Machinery and equipment operating instructions.

4. Machinery history and record cards.

5. Engineering log and machinery operating data record sheets.

6. Engineers' work books.

7. Ship's training log.

B. References.

1. COMSTS INSTRUCTION P3120.2, (effective edition).

2. BUSHIPS Manual, Chapters 41, 42, 51, 60 to 65 inclusive, and Chapter 88, Section III.

3. COMSTSPACAREA Engineering Casualty Exercise Book.

4. Manufacturers' Instruction and Operating Manuals.

5. Section 1.6, Engineering Casualty Bill.

III. INTRODUCTION.

A. Introduce self and subject (Introduction to Engineering Casualty Control).

B. Define "Engineering Casualty Control" as action to prevent or to minimize and correct those failures of the main and auxiliary machinery, and the electrical and piping systems of the ship which can be controlled and repaired at sea.

C. Outline the scope of Chapter 6 as:

6.1 Introduction to Engineering Casualty Control.

6.2 Boiler and Boiler Feeding Machinery Casualties.

6.3 Casualties of Engine Room Machinery.

6.4 Electrical Casualty Control.

D. Outline scope of lesson.

1. Objectives of engineering casualty control.

2. Aids for controlling engineering casualties.

E. Arouse interest.

1. The main reasons for establishing an engineering casualty control program are to overcome the inattention of engineering personnel to standard operating procedures, and to assure the proper maintenance and operation of equipment and systems.

2. The size of ship and the type of propulsion will determine the amount and size of equipment for which engineering personnel are responsible. Textbooks have not been able to keep up with the developments in marine design and application. For instance, in the early days following the sailing ship era, steam was introduced as a great advancement in ship propulsion. It was thought by many engineers at the time that no other satisfactory means of propulsion could be developed. Then, Diesel motor ships came into the picture and many licensed steam engineers shipped in them solely to gain experience and an additional license. Now, the first nuclear merchant ship, the SAVANNAH, incorporates an entirely new concept of developing steam. This, of course, will require additional training and another license or endorsement for engineering personnel who wish to sail in this type of ship.

3. Experience, licenses and endorsements mean nothing if personnel are inattentive to their duties and responsibilities, for an effective engineering casualty control program is the best insurance for a ship's successful operation.

4. Engineering casualty control reaches its maximum efficiency through a combination of sound design, careful inspection, thorough plant maintenance, and effective training and organization of personnel.

IV. PRESENTATION. Because of the many facets of engineering casualty control, only general aspects will be covered here. For more detail, it is suggested that the references be used as guides.

A. Objectives. The objectives of engineering casualty control are to assure:

1. Proper maintenance of boilers, propulsion and auxiliary machinery, electrical machinery, lighting, interior and exterior communications, firemain supply and miscellaneous services.

2. Prevention or minimizing of personnel casualties and damage to vital machinery.

B. Controlling Engineering Casualties. Knowledge is the keystone of effective engineering casualty control. The details of the engineering installation and thorough instruction in normal operating procedures are important in preventing and controlling engineering casualties. This is accomplished through instruction, demonstrations, and drills. Although drills should be as realistic as possible, the state of training and technical ability of the crew must be taken into consideration. Possible errors and the resulting consequences must also be visualized before attempting simulated drills. To prevent damage, "dry runs" under careful supervision should precede simulated drills which require shutting down of machinery and equipment. Other vitally important aids for controlling engineering casualties are:

1. The chief engineers' departmental organization chart, which delegates individual responsibilities for the operational maintenance of machinery, equipment and systems.

2. The Engineers' Workbook which provides for maintaining records of completed repairs and inspections.

3. Machinery history cards, record cards, manufacturers' manuals and instruction books. These guides show when service and repair have been made to machinery, equipment and systems; also, when next inspection is due, the location of parts and the final assembly.

4. The posting of operating and safety instructions adjacent to machinery, equipment and systems. If these instructions are followed correctly, personnel and engineering casualties should be avoided.

5. The engineering log and operating data sheets for use by engineering personnel to check the overall functions of the operating machinery, equipment, and systems.

C. Action in Engineering Casualties. Engineering casualties occur as a result of either personnel or material failure. If a casualty occurs, immediate remedial action must be taken by the engineering watch personnel as follows:

1. If the ship is operating in open waters, the bridge and the chief engineer must be notified. It is then imperative and permissible to secure the affected equipment before serious damage occurs.

2. If operating in restricted waters, it is imperative that continuity of service be maintained. Damaged units must be removed from service and stand-by or alternate units put into operation before searching for the cause of trouble.

3. Even though it is expected that the engineering personnel in MSTS ships have the "know how" to cope with all types of engineering casualties, a continuing training program using this chapter and the references listed herein must be used to maintain the high degree of operational readiness for which MSTS is noted.

V. SUMMARY. Review key factors in engineering casualty control.

A. The engineering organization; specific responsibilities of individuals covering maintenance, inspections, etc.; keeping of records and operational data.

B. Engineering operation personnel's knowledge of the engineering plant and systems.

C. Training of operating personnel in engineering casualty control methods.

IV. TEST AND APPLICATION.

A. Test. Use these and additional questions as an oral quiz.

1. Q. What are the principal objectives of engineering casualty control?

   A. To prevent, minimize or correct the effects of operational failures of the main and auxiliary, electrical and piping systems of ships.

2. Q. How does engineering casualty control attain its highest degree of effectiveness?

   A. Through casualty prevention. By a combination of sound design, careful inspection, thorough plant maintenance, and effective organization and training.

3. Q. What is the purpose of the chief engineer's departmental organization chart?

   A. To delegate responsibilities covering the operational maintenance inspections for various machinery, equipment and systems.

4. Q. For what purpose are machinery history, record cards, manufacturers' manuals and instruction books maintained?

   A. To guide engineering operating personnel as to when machinery, equipment and systems require service and repair, and for location of parts and final assembly.

5. Q. Where should operating instructions for machinery, equipment and systems be posted?

   A. Adjacent to the machinery, equipment, and systems.

6. Q. What two failures contribute most to engineering casualties?

   A. Personnel failures and material failures.

7. Q. When maneuvering in restricted waters, it is imperative that continuity of service be maintained. How can this be done?

   A. Damaged units must be removed from service and standby or alternate units put into operation before searching for the cause of trouble.

8. Q. What are the objectives of engineering casualty control?

   A. (1) The proper maintenance of boilers, propulsion and auxiliary machinery, lighting, interior and exterior communications, firemain supply and miscellaneous services.

   (2) The prevention or minimizing of personnel casualties, and secondary damage to vital machinery.

9. Q. What is considered the "keystone" of effective casualty control?

   A. Complete knowledge of the engineering installation and the normal operating procedures.

10. Q. What considerations and precautions should be taken when conducting a realistic casualty drill?

    A. (1) The state of training and ability of the crew.

(2) Visualize possible errors and the consequences which may result.

(3) Dry runs should always be conducted before actually attempting to simulate any involved casualty, regardless of the state of training of the engineering personnel.

B. Application. Apply these concepts in continuing shipboard engineering casualty exercises and drills.

CHAPTER 6

ENGINEERING CASUALTY CONTROL - For Engineering Personnel (Lesson Plan)

Section 6.2

BOILER AND BOILER FEEDING MACHINERY CASUALTIES

I. OBJECTIVES.

A. To explain typical boiler and boiler feeding machinery casualties.

B. To instruct engineering personnel in the basic procedures and standards to follow in controlling and minimizing major and minor boiler and boiler feeding machinery casualties.

C. To emphasize the importance of observing sound engineering and safety practices when performing casualty control remedial action.

II. MATERIALS.

A. Training Aids.

1. The chief engineers' organization manual.

2. Engineers' standard watch list.

3. The machinery and equipment operating instructions.

4. Manufacturers' instruction and operating manuals.

5. MSTSPACAREA Engineering Casualty Exercise Book.

6. Ship's blue prints.

B. References.

1. Section 1.6, Engineering Casualty Bill.

2. BUSHIPS Technical Manual, Chapters 51, 55, and 56.

3. Engineering Operating and Maintenance (NAVPERS 10813-A).

4. Maintenance Manual, MSTSPAC INSTRUCTION 4700.3.

5. U. S. Coast Guard Regulations.

6. Safety Manual for Marine Oil-Fired Watertube Boilers, National Safety Council.

III. INTRODUCTION.

A. Introduce self and subject - Boiler and Boiler Feeding Machinery Casualties.

B. Establish scope of lesson as including the remedial actions to be taken by engineering personnel for the following casualties:

1. Low water in the boiler.
2. Main feed pump failure.
3. Loss of fuel oil pressure.
4. Damaged tube or boiler pressure part.
5. High water in the boiler.
6. Forced draft blower failure.
7. Failure of automatic combustion control.
8. Water in the fuel oil.
9. High salinity in the boiler water while steaming.
10. Broken water gage glass.
11. The brick work or plastic falls out of the boiler furnace wall.
12. Flareback.
13. Stack uptake fires.
14. Boiler casing fires.

C. Arouse Interest. The primary cause of engineering casualties is the inattention of engineering personnel to standard operating procedures and to maintenance of equipment and systems.

1. For instance, because a night relief engineer in the USNS SCHUYLKILL thought he saw water in a gage glass, the Government paid $58,000 for boiler repairs. Had the glass been blown down with steam, this could have been avoided.

2. In another case, the relieving chief engineer did not familiarize himself with the critical condition of the starboard boiler in the USNS MARINE FIDDLER prior to the acceptance of the ship, and the relief night engineer did not ascertain reasons for the rapid drop in the boiler water before lighting off the boiler a second time during the day. The boiler suffered severe damage, resulting in a $96,000 cost to the Government for repairs.

3. Boilers may be compared with the human heart in that both supply energy for propulsion. Therefore, the importance of boiler and boiler feeding machinery casualty control cannot be over emphasized.

IV. PRESENTATION.

A. Initial Action. In the event of a casualty, several initial actions must be taken immediately. These will include:

1. Notifying the bridge via telephone and/or engineroom telegraph if the maneuvering capabilities of the ship are impaired, or if a change of speed is necessary to aid in correcting or minimizing the casualty.

2. Notifying the chief engineer.

3. Controlling the casualty to prevent further damage.

4. Restoring the normal operating effectiveness of the ship as soon as possible by using isolation or bypassing methods, or by utilizing available standby units.

B. Types of Boiler Casualties and the Remedial Procedures Required.

1. Low water in the boiler. This is a major casualty which can seriously damage a boiler. It will require the following remedial procedures to control the casualty:

a. Secure the fuel oil supply to the burners of the affected boiler immediately.

b. Close the feed water check valves.

c. Blow down the water level gage glass to determine the true water level in the boiler.

d. Secure the blower leading to the boiler and secure all steam stop valves of the affected boiler.

e. Reduce the steaming requirements of the engineering plant to the capabilities of the remaining operating boiler or boilers.

f. Relieve the affected boiler of its pressure by the use of the hand releasing gear of the boiler and super heater safety valves.

g. No attempt should be made to put the boiler back in service until it has been inspected for damage from over-heating of the pressure parts.

h. Let boiler cool slowly and carry out instructions of Bureau of Ships Technical Manual, Chapter 51.

2. Main feed pump failure. This is a major casualty because it will affect the water level in a boiler and can result in a boiler failure due to low water. The effectiveness of engineering watch personnel in controlling this casualty can alter its classification from a major casualty to a minor casualty. The following remedial procedures should be taken:

a. Start the standby feed pump, which should have been lined up in advance and readied for immediate use.

b. The capacity of the standby feed pumps must be considered, and the operating load adjusted accordingly.

c. Until the plant is operating satisfactorily, the cause of the casualty to the feed pump is secondary.

d. As soon as possible after the plant is back in normal operation, a thorough check of the pump should be made to determine the cause of the failure, and repairs should be made immediately.

3. Loss of fuel oil pressure. Loss of fuel oil pressure to the burners can result in a shutdown of the boilers and machinery if not corrected immediately. The following corrective action by the engineering watch may prevent a serious casualty from developing:

a. If the fires are out, secure the burner valves and shift the combustion control to manual.

b. Reduce the boiler load to conserve steam.

c. Shift the fuel oil pump suction to the other settling tank.

d. If pump failure, shift to the standby fuel oil service pump.

e. When the fuel oil pressure is restored, the fires may be relighted and combustion control placed on automatic.

f. If the fuel oil pressure cannot be restored at once, it may become necessary to secure the boiler steam stops to prevent the complete loss of steam while the cause is being determined and remedies effected.

4. Damaged tube or boiler pressure part. When a damaged tube or other pressure part of a boiler carries away, a serious casualty will result. Proper control must be employed immediately to prevent secondary casualties and/or injury to personnel. The following remedial action should be taken:

a. Secure the fuel oil to the burners and speed up the blowers for carrying steam up the smokestack.

b. Adjust the boiler load.

c. Secure the boiler stops and release the steam pressure by operating the safety valves by hand.

d. While the boiler is hot, continue feeding to maintain the water level except where the failure was caused by low water level.

e. The blowers may be secured when the pressure has decreased and the steam is no longer escaping into the fireroom.

f. Allow the boiler to cool slowly until a man can enter to determine the extent of damage.

5. High water in boiler. This condition can cause a major casualty to main propulsion turbines and turbine generators. Water carried over with the steam may impinge on the turbine blades causing vibration, slowdown and possible broken blades. Therefore carry-over must not be allowed to occur. The following remedial action should be taken:

a. Close the boiler feed checks.

b. Adjust the boiler load.

c. It may be necessary to cut out the boiler and use the bottom blow to lower the water level. Blow the gage glass frequently to determine the true water level. Never blow down the water-wall headers.

d. Check the feed pump pressure regulator, the water level regulator, and adjust or repair them before returning the boiler to the line.

6. Forced draft blower failure. A loss of air pressure for combustion will cause the boiler to pant and possibly create a casing or boiler mounting casualty. The following remedial procedures should be taken:

a. Secure the oil to the burners.

b. If two blowers are in operation, speed up the unaffected blower and open the crossover dampers, if so fitted. If available, put the standby forced draft blower into operation. Reduce the speed to meet the lower steaming rate.

c. Purge the furnace thoroughly with fresh air and relight the fires using a torch.

d. Where the draft is insufficient for all boilers, secure the affected boiler and operate at a reduced speed.

e. It may be possible to operate the boiler on natural draft for an auxiliary steam supply.

7. Failure of the automatic combustion control. When the automatic combustion control fails, the air-oil ratio may become unbalanced and cause serious secondary casualties. Unless proper corrective measures are taken immediately, the steam pressure will be reduced, possibly resulting in the loss of main propulsion and auxiliary machinery. The following remedial action should be taken:

a. Shift to direct manual control.

b. Regulate the air supply leading to the furnace by use of the hand lever and locking device on the forced draft damper control.

c. Adjust the fuel oil pressure by use of the hand jack on the fuel oil control valve, or through use of the control valve bypass.

d. Regulate the water level in the boiler by use of the feed water control valve hand jack, or by the main or auxiliary feed checks.

e. If the steam pressure is reduced considerably, it may be necessary to slow the main engine until the pressure is restored.

f. Check out the control system thoroughly. When repairs have been made, the unit may again be shifted to automatic control.

8. Water in the fuel oil. This condition may lead to a casualty which will require securing the main propulsion and auxiliary machinery. This may be averted if prompt action is taken by the engineering watch personnel. The following remedial action should be taken:

a. Shift the fuel oil pump suction from low to high suction, or shift to the other settling tank.

b. If the fires continue to sputter or go out, slow the main engine to conserve steam.

c. Put the fuel oil transfer pump on the low suction of the contaminated settling tank and pump overboard if at sea, or into the sludge tank, cofferdam or empty fuel oil tank if in port.

d. Small amounts of water may be burned out if the fires can be kept burning.

9. High salinity in the boiler water while steaming. This condition will result in the severe priming and scaling of the boiler shell and tubes. It may also lead to boiler casualties or secondary casualties due to the carry-over to the main and auxiliary machinery.

a. High salinity may result from salt water leaks in the following:

(1) Main and/or auxiliary condensers.

(2) Salt water cooled air ejectors.

(3) Distilling plants.

(4) Salt water cooled gland exhaust condensers.

b. High salinity may be detected before a casualty occurs, by:

(1) High reading of the salinity indicators.

(2) Loss of superheat.

(3) Chemically testing the boiler water.

c. When high salinity is detected, the following procedures should be followed:

(1) Reduce the boiler load to prevent priming.

(2) Remove the boilers from the line one at a time and freshen up by use of the bottom blow and by feeding with uncontaminated water.

(3) Do not let the water get below a safe level in the water gage glass.

(4) Locate the source of salinity and correct the cause.

(5) Compound the boilers to restore the chemical ratio within the boilers.

(6) The boilers may be put on continuous blow to the evaporators when steaming.

(7) When salinity has been reduced to a safe level, restore the plant to normal operation.

10. Broken water gage glass. When a water glass on a boiler carries away, serious injury may result to personnel close to the gage glass. Remedial action should be as follows:

a. Secure the top and bottom of the water column of the damaged glass by using the quick closing valves. (Pull chains.)

b. Open the drain on the water column of the broken glass.

c. Remove the broken gage glass assembly and replace it with a properly assembled gage glass.

d. Use the other gage glass to maintain the proper water level.

11. The brickwork or plastic falls out of the boiler furnace wall. When this casualty occurs, the boiler casing is subjected to overheating, and may result in severe warping. If this condition is noticed in time, a serious casualty may be averted by the following action:

a. Secure the fuel oil to all burners on the affected boiler.

b. Reduce the steaming load on the boiler and cut out the affected boiler.

c. If it is necessary to continue operating the boiler, the burners adjacent to the brick or plastic fall-out should be secured to avoid any possible damage to the boiler casing.

d. When the boiler has cooled sufficiently, the brickwork or plastic may be patched, and the boiler put back on the line.

12. Flareback. This casualty may cause injury to personnel, damage to the boiler and fittings, or fires in the uptakes or casings.

a. This casualty may be the result of:

(1) Temporary interruption of the fuel supply.

(2) Insufficient draft.

(3) Unburned combustible gases in the furnace, uptakes, or air casings.

(4) Pressure in the furnace momentarily exceeding that of the air casing.

(5) Failure to use a torch when relighting a fire.

b. Remedial action should be taken as follows:

(1) Close the quick-closing master oil valve leading to the burner manifold and the burner oil supply valves.

(2) Reduce the load on the boilers and, after carrying out the initial action in paragraph IV.A., cut out the boiler.

(3) Use firefighting equipment if necessary.

(4) Adjust the feed check valves or stop the feed pump as necessary.

(5) Speed up the forced draft blowers to clear the furnace.

(6) Inspect the affected boiler for damage and test it prior to returning it to service.

13. Stack uptake fires. A casualty of this nature will reduce the steaming capacity and will burn out the air heaters and economizers if fitted. It is important that soot does not accumulate in the uptakes. The regular use of soot blowers and the periodic cleaning of the stack and uptakes will accomplish this.

a. Stack uptake fires are caused by:

(1) Poor and incomplete combustion.

(2) Accumulation of soot due to insufficient soot blowing and cleaning of tubes and uptakes.

(3) Defective soot blowers, or the improper sequence of tube blowing.

b. The following procedure should be followed immediately upon detecting a fire in the uptakes:

(1) Secure the oil supply leading to the burners and close the air registers.

(2) Secure the forced draft blower on the affected unit, or close damper.

(3) Reduce the load on the boilers as necessary and cut out the boiler, making sure that the superheater circulating line is open.

(4) Raise the water level as high as is practical to insure that the pressure parts of the boiler are filled with water.

(5) Carefully open the uptake door and smother the fire using CO^2 or a hose equipped with a fog spray nozzle. The semi-fixed CO^2 system in the fire room may be used.

(6) DO NOT USE THE STEAM SOOT BLOWERS at this time, because severe gas explosion may result.

(7) After the fire is out, inspect the area thoroughly before returning the boiler to the line.

14. Boiler casing fires. These fires are caused by unburned combustible material accumulating in the casing, usually from dripping or leaking burners. The following procedure should be followed in the event of a boiler casing fire:

a. Secure the fires in the affected boiler immediately.

b. Secure the forced draft blower and close the air registers.

c. Reduce the load on the boiler as necessary.

d. Turn on the smothering steam leading to the air casing containing the fire.

e. Cut out the affected boiler, making sure the superheater circulating line is open.

f. After the fire is extinguished, examine the air casing thoroughly to determine the extent of damage before returning the boiler to the line.

g. Determine the source of accumulation of combustible material in boiler casing and take corrective action.

V. SUMMARY. Review key aspects of boiler and boiler feeding machinery casualties.

A. Personnel Failures.

1. Improper maintenance.

2. Inattention to standard operating practices and procedures.

B. Material Failures. Breakdowns by deterioration not due to personnel.

C. Initial Action.

1. Notify the bridge of all casualties requiring speed changes or casualties affecting the maneuvering capabilities of the ship.

2. Notify the chief engineer.

3. Control the casualty.

4. Restore the ship to normal operation as soon as possible.

D. Types of Casualties and Remedial Action. Review briefly the key points of the following boiler and boiler machinery casualties and remedial action:

1. Low water in the boiler.

2. Main feed pump failure.

3. Loss of fuel oil pressure.

4. Damage to pressure part.

5. High water in the boiler.

6. Forced draft blower failure.

7. Automatic combustion control

8. Water in the fuel oil.

9. High salinity in the boiler.

10. The water glass carries away.

11. The brick or plastic falls out of the furnace wall.

12. Flarebacks.

13. Stack uptake fires.

14. Boiler casing fires.

E. Prompt Action. Stress the importance of prompt action and proper procedures in correcting or controlling a casualty. There isn't time, in a boiler casualty, to open the book and determine the proper action. You've got to know this in advance.

VI. TEST AND APPLICATION.

A. Test. Use the following and additional questions as an oral quiz.

1. Q. What is the result of improper maintenance or inattention to standard operating procedures?

   A. Operating failures.

2. Q. What initial action must be taken when an engineering casualty occurs?

   A. (1) If the maneuvering capabilities of the ship are impaired or if speed changes are required when correcting or minimizing the casualty, the bridge must be notified immediately; by telephone and/or the engine order telegraph.
   (2) Notify the chief engineer.
   (3) Control the casualty to prevent secondary effects resulting from the casualty.
   (4) Restore the ship to its normal operating effectiveness as soon as possible by isolating and bypassing methods and/or by using available standby units.

3. Q. Upon the discovery of a loss of water level in a boiler, what is the first action that should be taken?

   A. Secure the fuel oil supply to the burners immediately.

4. Q. How may a main feed pump failure affect the boilers?

   A. A main feed pump failure may cause a low water level in the boilers, resulting in the loss of the boilers from overheating.

5. Q. If the main feed pump fails, what should be done to insure a supply of boiler feed water?

   A. The standby feed pump should be lined up and ready.

6. Q. If the fuel oil pressure to the burners cannot be restored at once, is it advisable to secure the boiler steam stops? Why?

   A. Yes, to conserve steam while the cause is being determined and the remedies effected.

7. Q. When a boiler pressure part carries away, why is it necessary to speed up the blowers?

   A. The blowers must be sped up to carry the steam up the smokestack, thus keeping it out of the fireroom.

8. Q. What is the prime danger of high water level in the boilers?

   A. Water may carry over with the steam and impinge on the turbine blades causing vibration, slow down, and possible broken blades.

9. Q. What condition would indicate a forced draft blower failure?

   A. Low pressure on draft indicator, black smoke and boiler panting.

10. Q. When the automatic combustion control fails, what must be done to regulate the fuel oil pressure?

    A. After shifting to the direct manual control, the fuel oil pressure may be regulated by the use of a hand jack on the fuel oil control valve or by the control valve bypass.

11. Q. When water in the fuel oil is encountered, what initial action should be taken?

    A. Shift the fuel oil pump suction from low to high suction, or shift to the other settling tank.

12. Q. How may salt water contaminate boiler water, and how is it detected?

    A. Salt water may leak into the condensate through the main or auxiliary condensers, salt water cooled air ejectors, distilling plants, or through salt water cooled gland exhaust condensers. It may be detected by the high reading of the salinity indicator, by loss of superheat, or by chemically testing the boiler water.

13. Q. List at least three causes of a flareback.

    A. (1) Temporary interruption of the fuel supply.
    (2) Insufficient draft.
    (3) Unburned combustible gasses in the furnace, uptakes, or air casing.
    (4) Pressure in the furnace momentarily exceeding that of the air casing.
    (5) Failure to use a torch when relighting fires.

14. Q. An accumulation of soot due to insufficient soot blowing and inadequate cleaning of tubes and uptakes may lead to what type of casualty?

    A. Stack uptake fires.

15. Q. Would it be advisable to use steam soot blowers on stack uptake fires? Why?

    A. No. A severe gas explosion may result.

B. APPLICATION. Check engineering personnel's identification of these boiler casualties and ability to control them during required practical engineering casualty control exercises and drills.

Boiler Fires

By Cdr. H. W. A. Derlin, USN
Boilers & Heat Exchangers Branch
Bureau of Ships

Those who have seen an uncontrolled boiler fire, or its results, know that it is a serious matter. Damage ranges from minor casing distortion up to complete boiler destruction.

Disregarding the controlled firing for which the boilers were built, there are basically two sorts of undesired fires: those contained within the air casing, and those contained within the furnace and gas passages.

Of the first type—in boiler casings—these ordinarily occur as a result of oil accumulations within the casing which originate from burner drips. There are, of course, those exceptions where trash remains under a boiler after workmen leave or where accumulated oil in a furnace actually leaks through floor refractory and defective brickpans. All of these sources can be eliminated by proper inspection.

The greatest offender, burner drip, can be controlled by: proper burner assembly, maintaining clean tips, insuring complete shut off of idle burners and keeping poke holes clear. Air casings are provided with illumination and periscopes where necessary which permit surveillance of the drip area to insure detection of any oil that may accumulate under burners. Of course, failure to maintain these aids in working order is like allowing your insurance to lapse. Innumerable boilers have been observed to have these safety aids so neglected as to make them useless. As an assist to proper viewing of the drip area, white painting of the region is recommended. Aluminum paint is next best.

Extinguishing a casing fire is relatively simple, provided that the installed steam smothering system has been properly maintained. All that is necessary is securing fires in the furnace to permit securing the blowers and turning on the smothering system steam. If your insurance is paid up; i.e., smothering system intact and operable, this will defeat the fire. Stubborn fires that may reflash due to gross accumulations of oil in the casing can be subdued by steam and secured by introducing foam through the various inspection ports on the boiler front.

Obviously the first line of defense must be workable. Smothering lines have a tendency to rust internally and this both weakens the pipe and plugs the distribution holes. Testing at regular 600-hour fireside cleaning intervals should include poking the holes clear with a piece of stiff wire, removal of the cap from the end of each run of distribution piping and blowing through with steam to remove loose accumulations. Follow this by reinstalling the pipe caps and testing the system with full available steam pressure. Mirrors can be used to observe discharge from the distribution pipe and can be best observed if condensate is allowed to accumulate in the steam line before testing. It is simply easier to see water discharge than steam discharge.

A more serious fire is the uncontrolled fire that occurs within the furnace or gas passage. During 1962 there were at least two fires so disastrous as to totally melt the generating tubes and economizers. In one instance, even the mud drum was burned. This fire is believed to have originated in a heavy soot formation which was deposited in gas passages during a protracted period of incomplete fuel combustion.

The other serious casualty also resulted from improper combustion but, in this case, the cause was directly determinable. A burner had been installed with no sprayer plate and simply poured a large quantity of oil onto the furnace deck. Despite heavy black smoke, it took this crew nearly an hour and a half to locate the offender. At this time, burners were secured but the fire continued. Assuming that this was a casing fire, the boilerroom crew wrapped up the boiler—fuel, blowers, feed stops, steam stops and all. Since the fire continued to rage within the boiler and no cooling fluid (water/steam) could flow through the tubes, the boiler naturally burned down.

These fires were preventable. Even after fires started, major boiler damage was preventable.

Prevention of Fire

The fires were preventable in that proper combustion can be maintained in all Naval boilers. Admittedly, someone has to check on furnace conditions from time to time. Black smoke is certainly a strong indication that the boiler is not digesting its fuel properly. Black smoke is a soot maker. Soot will burn like coke and if allowed to accumulate in the upper reaches of a boiler, it may burn where there is no refractory to contain it. Routine

(REPRINTED FROM BUSHIPS JOURNAL, JUNE 1963)

observations of stack discharge, and smoke periscopes and through furnace peep holes can be relied upon to detect improper combustion. Correction, however, must be more prompt than the occasion where it is reported to have taken an hour and a half to find a burner with no tip installed.

Cleanliness in boilers is essential, not only for economy and good operation but to eliminate sources of fire. Economizers should always be inspected and cleaned following any period of known bad combustion.

Prevention of Damage

There is bound to be some damage from an uncontrolled fire. It is even possible that more damage will result from firefighting than from the fire. However, it should be possible to minimize the damage by prompt and proper treatment.

Experience has shown that economizer (soot) fires invariably occur immediately after a boiler is either lit-off or secured. These are periods when the economizer tubes may be dry due to failure to test feed-pump line-up prior to light off or drainage of the economizer to the steam drum after securing. So long as water remains in the economizer tubes, it is practically impossible to attain the necessary ignition temperature.

Similarly, with uncontrollable fire in a furnace, fluid flow must be maintained through the waterside circuits to prevent tubes from reaching destructive temperatures.

The use of blowers must be decided by the location of the fire. If in economizer or uptakes, blowers should be stopped so as to help smother the fire. If the fire is from an oil bath in a furnace, a moderate air supply should be maintained to prevent soot formation in the economizer area. If the fire is in the boiler casing, blowers should be secured. In any case, however, feed water flow should continue. If the boiler has pressure, continue to extract steam. Steam may be delivered to the normal system, to the superheater protection system, to high pressure drains or even to bilge. If there is no pressure on the boiler, drains to bilge can be opened to maintain a flow of water through the waterside circuits even though superheaters are flooded. So long as water is kept within the tubes, they cannot be damaged by the fire (provided, of course, that watersides are not so heavily scaled as to prevent heat transfer).

In controlling a boiler fire, the most immediate problem is to locate the fire. Having done this, the method of attack is as follows:

- *Casing.* Secure fires and blowers. Maintain water/steam flow. Use steam smothering followed by foam application if required.
- *Economizer.* Secure fires and blowers. Maintain water/steam flow. Attack fire with water through uptake access next above the economizer. After wetting as thoroughly as possible by this means, use soot blowers to assist with steam from below. Premature use of soot blowers will simply stir up more soot and may create an explosive mixture.
- *Furnace Fire.* Secure oil supply and minimize air supply. Maintain flow of water/steam. Allow accumulated fuel to burn off.

CHAPTER 6

ENGINEERING CASUALTY CONTROL - For Engineering Personnel (Lesson Plan)

Section 6.3

CASUALTIES OF ENGINE ROOM MACHINERY

I. Objectives	IV. Presentation
II. Materials	V. Summary
III. Introduction	VI. Test and Application

I. OBJECTIVES.

A. To describe typical casualties of engine room machinery on turbine, turbo-electric and Diesel-powered ships.

B. To instruct engineering personnel in procedures to control or minimize engine room machinery casualties.

C. To emphasize the importance of observing safe engineering practices during casualty control.

II. MATERIALS.

A. Training Aids.

1. The Chief Engineers' Organization Manual.

2. Engineers' standard watch list.

3. The machinery and equipment operating instructions.

4. Manufacturers' instruction and operating manuals.

5. MSTSPACAREA Engineering Casualty Exercise Book.

6. Ship's blue prints.

B. References.

1. Section 1.6, Engineering Casualty Bill.

2. BUSHIPS Technical Manual, Chapters 41 and 43.

3. Engineering Operation and Maintenance (NAVPERS 10813-A).

4. Maintenance Manual, MSTSPAC INSTRUCTION 4700.3.

5. U. S. Coast Guard Regulations.

III. INTRODUCTION.

A. Introduce self and subject, Casualties of Engine Room Machinery.

B. Establish scope of the lesson. Personnel failures are the prime factors that cause casualties. This is generally due to the improper maintenance of equipment and the inattention of engineering personnel to standard operating practices and procedures. The following engineering casualties and remedial procedures for coping with them will be covered:

1. Loss of or low lubrication oil pressure.
2. Loss of vacuum on the main unit.
3. Jammed main engine throttle.
4. Leak in the main condenser.
5. Main turbine vibration.
6. Propeller or shaft damage.
7. Hot bearings.
8. Deaerating feed tank casualty.
9. Oil in the condensate system.
10. Air compressor casualty.
11. Loss of forward or after engine room (P-2).
12. Fire in the propulsion motor or generator (P-2).
13. Fire in the propulsion control cubicles or cable (P-2).
14. Engine slows down (Diesel).
15. Engine stops suddenly (Diesel).
16. Low lube oil pressure (Diesel).
17. Governor failure (Diesel).
18. High fresh water cooling temperature (Diesel).

C. Arouse interest by pointing out that most casualties to engine room machinery will shut down the plant and will affect other systems such as lighting, heat, ventilation and sanitation. Prevention of casualties is the most effective form of casualty control. By preventing casualties, the possibility of a loss of propulsion or of other engineering systems is greatly reduced.

IV. PRESENTATION.

A. Initial Action. In the event of a casualty, the following initial action must be taken immediately:

1. Notify the bridge via telephone and/or engine room telegraph if the maneuvering capabilities of the ship are impaired, or if a change of speed is necessary to correct or minimize the casualty.

2. Notify the chief engineer.

3. Control the casualty to prevent further damage.

4. Restore the normal operating effectiveness of the ship as soon as possible by using isolation or by-passing methods, or by utilizing available standby units.

B. Casualties and Remedies. Types of engine room machinery casualties and their remedial procedures follow:

1. Loss of or low lubricating oil pressure. This condition may lead to a serious bearing or reduction gear casualty.

a. Symptoms. Any of the following conditions will indicate loss or reduction of lubricating oil pressure, and must be investigated immediately:

(1) Pressure falls off on the lube oil pressure gage.

(2) Oil is not passing the bull's eye of the overflow from the gravity tank.

(3) Ringing of the low lube oil pressure alarm.

(4) Closing of the ahead throttle by the action of the lube oil pressure governor.

b. Causes. Some of the causes of loss of lube oil pressure are:

(1) Main lube oil pump failure and standby lube oil pump fails to start.

(2) Restriction in lube oil piping, strainers or pump.

(3) Low or empty lube oil sump or gravity tank.

(4) Lube oil too hot for the pump to maintain the required discharge pressure.

(5) Large lube oil leak.

(6) The purifier dumping oil to bilge.

c. Remedy. An uniterrupted supply of the lube oil must be maintained at all times while the main unit is operating. If the lube oil pressure falls off or is lost, the following action should be taken:

(1) Stop the unit as soon as possible.

(2) Check out the causes of the casualty and correct them.

(3) Ensure the flow of oil to all bearings, gears, etc., before returning the unit to service.

(4) After the unit is back in service, check periodically for hot bearings.

2. Loss of vacuum on the main unit. A loss of vacuum is accompanied by a loss of or greatly reduced power output of the main propulsion unit.

a. Symptons. Indications of a loss of vacuum are:

(1) Reduced or no reading on the vacuum gage.

(2) Main unit slows.

(3) A temperature rise in LP exhaust of main unit.

b. Causes. Some of the causes of loss of vacuum are:

(1) Loss of gland seal.

(2) Defect in the air ejector.

(3) Insufficient cooling water through the condensers.

(4) Insufficient circulating water through the air ejector.

(5) Air leaks from:

(a) Make-up feed system.

(b) Piping systems.

(c) Loop seal.

(d) Drain tank float valve.

c. Remedy. It is essential that a high vacuum be maintained to ensure the continued efficient operation of the plant. The following procedure should be followed when a loss of vacuum is discovered:

(1) Slow the main engine.

(2) Determine the reason for the loss of vacuum by checking:

(a) The gland seal.

(b) Cooling water through condenser.

(c) Circulating water through air ejector.

(d) For possible air leaks.

(e) The loop seal.

(3) Change to standby air ejector.

(4) When the vacuum has been restored, the main engine may be brought up to speed.

3. Jammed main engine throttle. The inability of the main throttle valve to function properly presents a casualty involving a loss of maneuverability of the ship, and could lead to collision or grounding. Remedial procedures are as follows:

a. If the throttle sticks open, use the main steam line stop valve for throttling.

b. In an emergency, use the astern throttle to stop the shaft.

c. If the astern throttle valve sticks, use the astern guarding valve for the astern throttle.

d. Check out the cause of the sticking valve and make repairs as soon as possible.

4. Leak in the main condenser. If a leak develops in the main condenser, salt water will leak into the condensate, and will be returned to the boilers. High salinity of the boiler water may cause serious scaling of the tubes and other heating surfaces. This may lead to priming or reduced steaming ability, with a loss or reduction of main propulsion power.

a. Causes. Leaks in the main condenser may be due to:

(1) Overheating of the condenser.

(2) Split or cracked tubes.

(3) Tubes leaking at tube sheet due to packing failure.

(4) Tubes in need of re-expanding.

(5) Electrolysis or erosive action of cooling water, causing pin holes in tubes.

b. Remedy. When high salinity is indicated by the salinity indicator, or by boiler water tests, determine that the condenser is leaking by testing condensate sample. If the condenser is leaking, the following procedures should be followed:

(1) If it is believed that the leak is small and arrival in port will be within hours:

(a) Pump sawdust through the cooling water side of the condenser.

(b) Keep the boilers fresh by blowing down as indicated by tests.

(2) If the leak is large and cannot be controlled by using sawdust:

(a) Secure the main engine.

(b) Shift all condensates to the auxiliary condenser.

(c) Secure main injection, overboard and vent valves when condenser is cool.

(d) Fill the fresh water side with warm distilled water.

(e) Remove inspection plates or condenser heads and inspect for leaks.

(f) Plug all leaks with approved type plugs, or reroll tubes leaking at the tube sheet.

(3) Return the plant to normal operation.

5. Main turbine vibration. Vibration of the main turbine will cause a reduction or loss of propulsion power, and may lead to serious secondary casualties if allowed to continue.

a. Causes. Vibration of the main turbine may be due to any of the following:

(1) Carryover of water with steam from the boilers.

(2) Damaged turbine blading.

(3) Distortion of the turbine due to uneven expansion.

(4) Damaged propeller or shafting.

b. Remedy. Turbine vibration must not be allowed to continue. The following action is necessary:

(1) Reduce the turbine speed.

(2) If the vibration is due to carryover, lower the water level in the boilers to a safe operating level.

(3) If due to damaged turbine blading, propellers or shaft, operate the unit at a speed where vibration is minimized as much as possible.

(4) If due to distortion, operate at slow speed until an even temperature is attained throughout the turbine.

6. Propeller or shaft damage. A casualty of this nature may cause serious secondary casualties to adjacent sections of shafting, bearings, reduction gears and engine, with accompanying reduction or complete loss of main propulsion power.

a. Symptons. Indications of this casualty are:

(1) Vibration of the shaft.

(2) Abnormal noises in the engine and reduction gears.

(3) Possible heating of the line shaft bearings.

(4) Possible heating of the stern tube bearing.

b. Remedy. The following procedures may be followed when this casualty exists:

(1) Reduce engine speed to minimize vibrations.

(2) Check through shaft alley to determine the cause of vibrations.

(3) If the casualty is in shafting or bearings in the shaft alley, make temporary repairs if possible.

(4) If repairs cannot be made, operate the engine at speeds which will minimize vibration as much as possible.

(5) Continue a check of bearings and shafting to prevent the spread of the casualty to unaffected parts.

7. Hot bearings. Abnormal temperature of bearings indicates a bearing casualty and may lead to a reduction or loss of propulsion power.

a. Symptoms. Check all abnormal temperatures or hot oil smells.

b. Causes. Overheating of bearings may be caused by the following:

(1) Failure of the lube oil system.

(2) Foreign matter in the lube oil system.

(3) Excessive wear or misalignment of the bearings.

c. Remedy for reduction gear bearings. Remedial procedures for casualties to the turbine, Diesel and reduction gear bearings are as follows:

(1) Reduce engine speed.

(2) Check quantity of lube oil to bearings, and clear any restrictions.

(3) Start purifier on lube oil system.

(4) Operate at reduced speeds which avoid abnormal temperatures.

(5) When operating conditions permit, inspect bearings for wear or misalignment.

d. Remedy for line shaft bearings. Remedial procedures for casualties to the line shaft bearings are:

(1) Reduce the engine speed.

(2) Check the lube oil level, wick feeds, and the oil rings.

e. Caution. Do not put cold water on the hot bearings.

8. Deaerating feed tank casualty. The ability of the D.A. tank to properly deaerate feed water and deliver it to the feed pump suction is of great importance in maintaining the plant's efficient operation. Any interruption in this process will cause loss of or reduced steaming capabilities of the ship.

a. Loss of heat. Remedial procedures to cope with the loss of heat in the deaerating heater are:

(1) Bleed live steam into the exhaust system to provide sufficient steam to keep D.A. temperature up.

(2) Check the exhaust steam regulator valve for proper operation.

b. Loss of water. Remedial procedures to cope with the loss of water in the deaerating heater are:

(1) Shift feed pump suction to the distilled water tank, and secure suction from D.A. tank.

(2) Check the following possible causes for loss of water in the D.A. heater:

(a) Condensate pump failure - mechanical or electrical.

(b) Adjustment of makeup feed or dump valve.

(c) Adjustment of condensate recirculating valve.

(d) Condensate spray nozzles in deaerator.

(e) Rupture in piping to or from deaerator, or in the tank itself.

9. Oil in the condensate system.

a. Causes. The condensate system may become contaminated with oil by any of the following:

(1) Leak in the bunker heating coils.

(2) Fuel oil heater leak.

(3) Leak in the cargo heating coils.

(4) Lube oil purifier heating coil leak.

(5) Sump tank heater coils.

(6) Gravity tank heater coils.

(7) Settling tank heater coils.

b. Remedy. A close watch should be maintained on the contaminated drain tank for indications of oil in the system.

(1) If oil is observed, isolate the drain tank and dump the drains into the bilge.

(2) Isolate the source of contamination and clean the drain tank before returning condensate to the tank.

(3) If oil is observed in the boiler gage glasses, secure the boilers one at a time and use surface blow until the glass shows clear.

(4) If oil shows in the deaerator, cut out and clean the heater.

10. Air compressor casualty. If the main air compressor fails, a standby compressor is usually set to cut in automatically and take the load.

a. If the standby compressor fails to cut-in, it may be started by hand; then the regulator is adjusted to cut in and out at the proper pressure.

b. Check the following parts of the main air compressor:

(1) The prime mover.

(2) Operation of the pressure controller and unloader.

(3) Intake filters, if dirty, clean with washing soda solution.

(4) Check for leaks in the piping, coolers and relief valves.

(5) Check "V" belt drive tension and set up on it if necessary.

11. Loss of forward or after engine room (P-2 type). A one generator, or two-motor operation may be necessary due to mechanical or electrical failure of the turbine or generator in one of the engine rooms. Remedial action should be as follows:

a. Maintain propulsion and steerage with unaffected unit unitl shift to one generator, two-motor operation is put into effect.

b. Set up motor transfer and disconnect switches for a one generator, two-motor operation as described by the manufacturer's instruction manual (available aboard ship for each particular unit).

c. Make temporary repairs within the ship's personnel capabilities.

12. Fire in the propulsion motor or generator (P-2 type). In addition to the possibility of fire spreading to the engine room, fire in a propulsion motor or generator causes an interruption in normal plant operation with the accompanying loss of maneuverability. Remedial action should be as follows:

a. Stop the unit and de-energize the motor or generator.

b. Secure the ventilation to the unit and trip the installed CO^2 fire extinguishing system on the motor. Use the portable CO^2 on the generator (unless a system is installed on the generator).

c. When the generator is affected, put in the jacking gear as soon as possible to prevent warping of the unit.

d. Maintain propulsion and steerage using the unaffected unit.

e. Make temporary repairs within the ship's personnel capabilities.

13. Fire in the propulsion control cubicles or cables (P-2 type). Short circuits, loose connections, accumulation of dirt and oil or moisture on or around electrical wiring of control hookups can cause a fire. Fire in the controller circuit could spread to other parts of the engine room, causing loss of the propulsion unit and reduced maneuverability if immediate action is not taken. The following remedial actions should be taken:

a. Stop the unit and de-energize the control circuits.

b. Extinguish the fire with CO^2.

c. Make necessary repairs to the controller circuit; operate at reduced load until assured the control circuit is functioning properly and the insulation tests are in accordance with the manufacturer's recommendations.

d. Maintain propulsion and steerage with the unaffected unit.

14. Engine slows down (Diesel). Power output and maneuverability of ship is reduced. Remedial action should include reducing the speed of the unit and checking:

a. The governor and controls.

b. Fuel oil system, strainers, filters, etc.

c. Fuel pump operation.

d. Exhaust system for obstructions.

15. Engine stops suddenly (Diesel). If twin screw, the power output and the maneuverability of ship is reduced. Remedial action should be as follows:

a. Check out the fuel system for obstructions or determine if air bound.

b. Check out the governor and controls.

c. Jack over the unit to see if the bearings are seized or frozen.

16. Low lube oil pressure (Diesel). This condition will cause overheating of the unit and burned out or seized bearings, shafting or pistons, etc., and may lead to the eventual loss of the unit.

a. Remedial action should include securing the unit immediately and checking the following:

(1) Lube oil level in the sump.

(2) Lube oil strainers and filters.

(3) Lube oil pump operation.

(4) For broken lube oil lines.

b. Caution. Do not start the engine again until the cause of low lube oil pressure is determined and repairs made.

17. Governor failure (Diesel). If the governor fails, the engine may either race or stop suddenly, causing excessive engine RPM or loss of power. The following remedial action should be taken.

a. If the engine starts to overspeed, secure the engine by the emergency stop control.

b. Check the governor oil level.

c. Check the setting of the needle valve.

d. Check the pilot valve and actuating linkage.

e. Flush out the governor and refill it with the proper oil.

f. Check the speed drop settings and correct as necessary in accordance with the manufacturer's instructions.

18. High fresh water cooling temperature (Diesel). Fresh water cooling of cylinder heads, cylinder jackets, exhaust valves, exhaust manifolds, etc., is an essential requirement in Diesel engine operation. Interruption of the cooling system may result in a serious casualty to the engine, producing reduced or complete loss of power output of the unit. Remedial action should be as follows:

a. Reduce the engine speed.

b. Check the fresh water level and pump operation.

c. Check the temperature regulator, valves and bypass regulator.

d. Vent air from the system and check for air leaks.

e. Check the system for obstructions in the suction and discharge sides.

f. Check the cylinders for cracks or gasket leaks between the fresh water side and compression side.

* NOTE: See effective revision of COMSTS INSTRUCTION 3540.5 covering operation of salt water and fresh water cooling systems for main and auxiliary engines in C1-ME2-13a class ships.

V. SUMMARY.

A. Personnel failures cause casualties through:

1. Improper maintenance.

2. Inattention to standard operating practices and procedures.

B. Action of engineering watch personnel during casualties includes:

1. Notifying the bridge of all casualties requiring speed changes or affecting the maneuvering capabilities of the ship.

2. Notifying the chief engineer.

3. Controlling the casualty.

4. Restoring the ship to normal operation as soon as possible.

C. Review briefly the key points of the following engine room machinery casualties:

1. Loss of or low lubricating oil pressure.

2. Loss of vacuum on the main unit.

3. Main engine throttle jammed.

4. Leak in the main condenser.

5. Main turbine vibration.

6. Propeller shaft damage.

7. Hot bearings.

8. Deaerating feed tank casualty.

9. Oil in the condensate system.

10. Air compressor casualty.

11. Loss of forward or after engine room (P-2 type).

12. Fire in the propulsion motor or generator (P-2 type).

13. Fire in the propulsion control cubicles, or cables (P-2 type).

14. Engine slows down (Diesel).

15. Engine stops suddenly (Diesel).

16. Low lube oil pressure (Diesel).

17. Governor failure (Diesel).

18. High fresh water cooling temperature (Diesel).

D. Stress the importance of prompt action and proper procedures in containing or controlling a casualty and of knowing beforehand how to cope with any casualty that may occur.

E. Emphasize that casualty prevention is the most effective form of casualty control.

VI. TEST AND APPLICATION.

A. Test. Use the following, and additional, questions as an oral quiz:

1. Q. What is the most effective form of casualty control?

   A. The prevention of casualties.

2. Q. What two failures contribute most to engineering casualties?

   A. Personnel failures and material failures.

3. Q. What action must be taken by the engineering watch personnel when a casualty occurs?

   A. (1) If the maneuvering capabilities of the ship are impaired, or speed changes are required when correcting or minimizing the casualty, the bridge must be notified immediately via the telephone and/or the engine order telegraph.
   (2) Notify the chief engineer.
   (3) Control the casualty to prevent secondary effects resulting from the casualty.
   (4) Restore the ship to normal operating effectiveness as soon as possible, by isolating methods, bypassing and/or using available standby units.

4. Q. What conditions will indicate a loss or a reduction of lubricating oil pressure to the main engine and reduction gears?

   A. (1) Pressure falls off on lube oil gage.
   (2) Oil not passing bull's eye of overflow from gravity tank.
   (3) Ringing of the low lube oil pressure alarm.
   (4) Closing of the ahead throttle by action of the lube oil pressure governor.

5. Q. A temperature rise in the LP exhaust of the main unit would indicate what condition?

A. A loss of vacuum on the main unit.

6. Q. If the main engine throttle stuck in an open position, how would you shut down the main engine?

A. By use of the main steam line stop valve.

7. Q. When high salinity is indicated by the salinity indicator, or by boiler water tests, how do you determine if the condenser is leaking?

A. By testing condenser condensate sample.

8. Q. What must be done immediately when main turbine vibration is encountered?

A. Reduce engine speed to minimize vibrations.

9. Q. What is the cause of abnormal termperatures of turbine, Diesel engine and reduction gear bearings?

A. (1) Failure of the lube oil system.
(2) Foreign matter in lube oil system.
(3) Excessive wear of misalignment of bearings.

10. Q. What effect would a leak in bunker heating coils have on the condensate system?

A. The condensate system would become contaminated with oil.

11. Q. Where would an oil leak to the condensate system show up first?

A. At the contaminated drain tank.

12. Q. What is a one generator two-motor operation in a P-2 type ship?

A. Where two motors are operated from one generator due to mechanical or electrical failure of the turbine or generator in one of the engine rooms.

13. Q. How would you combat a fire in a main propulsion motor in a P-2 type ship?

A. Segure the ventilation to the unit and trip the installed CO^2 fire extinguishing system leading to the motor.

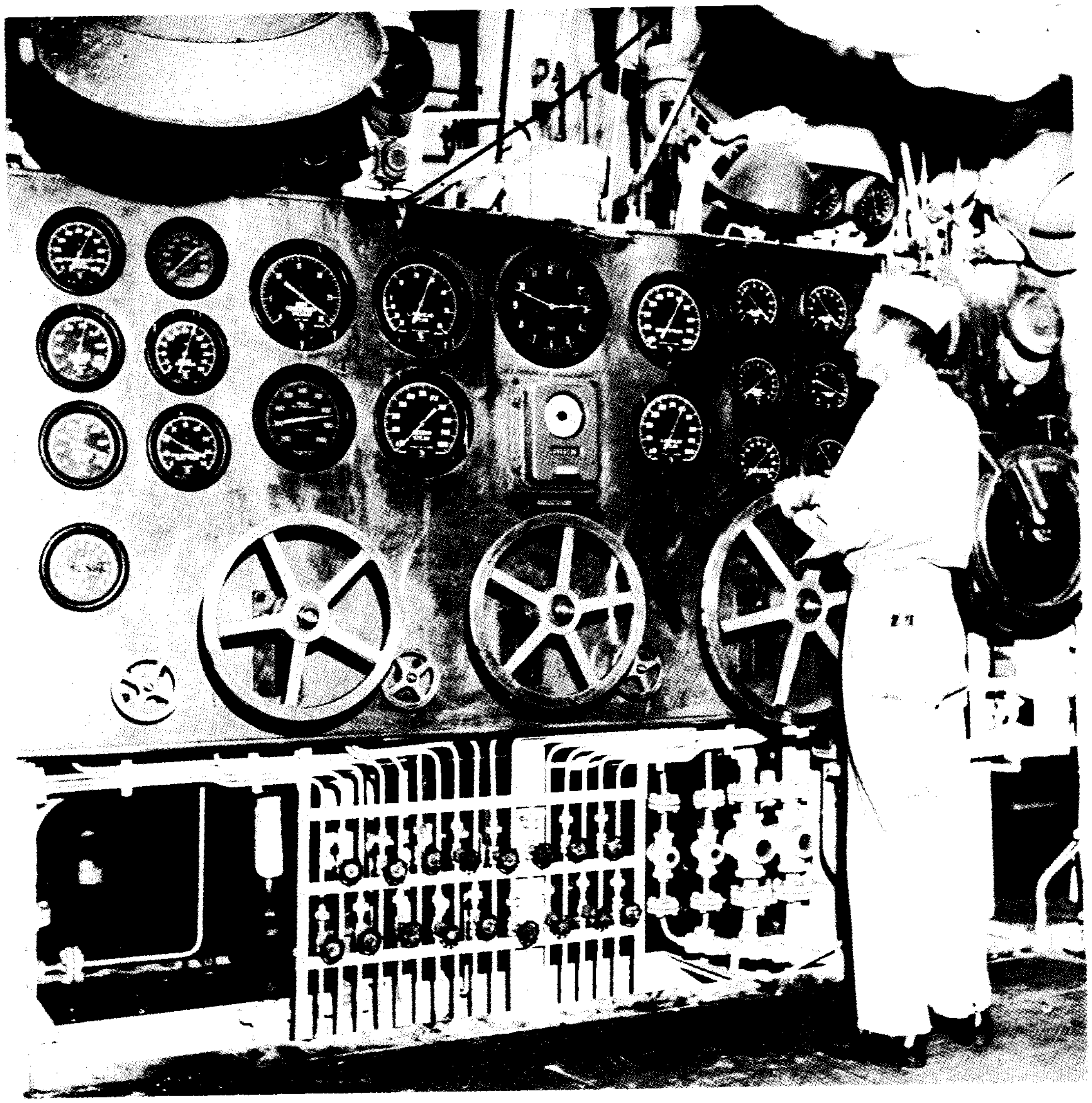
14. Q. What are the principal causes of fire in the propulsion control cubicles on P-2 type ships?

A. Short circuits or loose connections, accumulation of dirt, oil or moisture on or around electrical wiring of control hookups.

15. Q. On a Diesel engine, what would be the results of low lube oil pressure?

A. Overheating of the unit, burned out or seized bearings, shafting, pistons, and possible the eventual loss of the unit.

B. Application. Apply knowledge of these symptoms, causes and remedies during engineering casualty exercises and drills for each watch so that they can demonstrate their ability to cope with these casualties. In those cases where casualties can only be simulated, questions should be asked on their symptoms, causes and remedies.



CHAPTER 6

ENGINEERING CASUALTY CONTROL - For All Engineering Personnel (Lesson Plan)

Section 6.4

ELECTRICAL CASUALTY CONTROL

I. OBJECTIVES.

A. To describe typical casualties of the ship's electrical equipment.

B. To instruct all engineering personnel in the basic practices and procedures to follow in controlling or minimizing electrical casualties.

C. To emphasize the importance of observing sound engineering and safety practices when performing casualty control action.

II. MATERIALS.

A. Training Aids.

1. The Chief Engineers' Organization Manual.

2. Engineers' standard watch list.

3. Machinery and equipment operating instructions.

4. Manufacturers' instruction and operating manuals.

5. MSTSPACAREA Engineering Casualty Exercise Book.

6. Ship's blue prints.

B. References.

1. BUSHIPS Technical Manual, Chapters 60, 61, 62, 63, 64.

2. Engineering Operation and Maintenance (NAVPERS 10813-A).

3. U. S. Coast Guard Regulations.

III. INTRODUCTION.

A. Introduce self and subject - Electrical Casualty Control.

B. Establish the scope of the lesson.

1. Initial action by engineering watch personnel.

2. Types of electrical casualties.

a. Ship's service generator casualties.

b. Emergency Diesel generator casualties.

c. Loss of electric power (generator failure).

d. Fluctuating voltage (ship's service switchboard).

e. Overheated ship's service generator.

f. Overheated ship's service generator bearings.

g. Short circuit in the main circuit breaker.

h. Loss of electric power to the steering engine.

i. Rudder angle indicator failure.

j. Fire behind the ship's service switchboard.

C. Safety precautions to be observed when handling electrical casualties.

IV. PRESENTATION Engineering casualties are generally a result of personnel failure. The best casualty control is casualty prevention.

A. Initial Action. In the event of a casualty, the following initial action must be taken immediately:

1. Notify the bridge via the telephone and/or engine room telegraph if the maneuvering capabilities of the ship are impaired, or if a change of speed is necessary to correct or minimize the casualty.

2. Notify the chief engineer.

3. Control the casualty to prevent further damage.

4. Restore the normal operating effectiveness of the ship as soon as possible by using isolation or bypass methods, or by utilizing available standby units.

B. Types of Electrical Casualties. The types of electrical casualties and their remedial procedures are:

1. Ship's service generator casualties. In the event of a casualty to the ship's service generator, it is necessary to start the standby generator and cut out the affected generator. The following general procedures may be used as a guide:

a. Direct current generators.

(1) To start the standby generator:

(a) Check both the steam and electrical ends to make sure all rotating parts are clear.

(b) Check the lube oil for correct level.

(c) See that all switches are open and that the rheostat is set so that all field resistance is cut in.

(d) Crank hand lube oil pump.

(e) Start the steam end according to the manufacturer's instructions.

(f) Bring the machine up to its rated speed.

(g) Check for normal voltage with rheostat in low voltage position.

(h) Test the overspeed trip. (Do not allow the speed to exceed that prescribed for overspeed tripping.)

(i) Turn up the rheostat to bring the voltage to three or four volts above the bus voltage.

(j) Throw in the circuit breaker.

(k) If the machine is of the compound type, throw in the equalizer switch.

(l) Close the positive and negative switches.

(m) Regulate the voltage and transfer the load to the incoming machine.

(2) To cut off the affected direct current generator:

(a) Take the load off the machine by rheostat.

(b) Trip the curcuit breaker.

(c) Open the positive and negative seitches.

(d) Open the equalizer (if installed).

(e) Secure the steam end.

(f) Continue lubrication by use of the hand pump until the machine has stopped.

b. Alternating current generators.

(1) To start the standby generator:

(a) Make sure all rotating parts are clear and that the lube oil level is correct.

(b) Start the steam end according to manufacturer's instructions.

(c) Bring the machine up to rated speed and test the overspeed tripping mechanism.

(d) Adjust the exciter voltage and close the field switch.

(e) Adjust the generator field resistance so that the generator voltage will be the same as the bus-bar voltage.

(f) Synchronize the machines and close the circuit breaker.

(g) Transfer the KW load to the incoming machine by increasing speed on the incoming machine; at the same time decrease speed on the other machine using the speed-governor control.

(2) To cut out the affected alternating current generator:

(a) After all load has been transferred to the incoming machine, trip the circuit breaker of the machine being secured.

(b) Turn the voltage regulator switch to the "Manual" position.

(c) Secure the steam end.

(d) Continue lubrication by use of hand pump until the machine has stopped.

c. Emergency Diesel generator and switchboard. When the ship's service generator fails, the emergency Diesel generator should automatically cut in and energize the emergency switchboard.

(1) Keep the emergency generator and the emergency switchboard lined up for automatic start and transfer of emergency circuits.

(2) When the ship's service generator fails:

(a) Clear the main switchboard.

(b) Energize the main switchboard from the emergency board.

(c) Operate auxiliaries within capabilities of the emergency generator.

(3) When the ship's service generator power is restored, the emergency generator should stop automatically.

2. Loss of electric power (generator failure). When the generator fails, the emergency Diesel generator will provide lights and a limited amount of power if lined up for automatic operation. To remedy the generator failure, take the following action:

a. Close the throttle valve to the main engine (if the engine is operating).

b. Conserve all possible steam by securing all unnecessary supply systems.

c. Start the standby generator and put it on the line.

d. Secure the affected generator.

e. Start the forced draft fans and the fuel oil service pump.

f. Start the boiler feed pump, if electric, and secure the standby.

g. Start the remaining systems and auxiliaries as time and conditions permit.

3. Fluctuating voltage (ship's service switchboard). Usually this condition is accompanied by steady fluctuating of the lights and hunting of the generator governor; it may lead to overspeeding and tripping out of the machine, with a loss of electric power. When this condition occurs, the following control action should be taken:

a. Start standby generator and shift the electrical load to it.

b. Secure the affected unit.

c. Check out the following items on the affected unit and make repairs as necessary:

(1) Governor.

(2) Voltage regulator.

(3) Commutation and/or excitation generator.

(4) Check for loose connections, shorts or grounds in the system.

d. Clean the generator and regulator, and adjust as necessary in accordance with manufacturer's instructions.

4. Overheated ship's service generator. Overheating of generators may be caused by various conditions. If allowed to continue, a very serious casualty may result.

a. Causes. Some of the causes of overheating are:

(1) Insufficient or restricted ventilation.

(2) Running at an improper speed.

(3) Brushes not set properly.

(4) Restricted cooling water to the coolers.

(5) Short circuit in the armature or field coils.

b. Action. When it is discovered that a generator is operating above normal temperatures, the following action should be taken:

(1) Check the ventilation for restrictions.

(2) Check the speed of the generator.

(3) Check for overloading.

(4) Check the brushes for excessive sparking.

(5) Check for restriction of cooling water on water-cooled machines.

c. If heating continues after checking the machine thoroughly, start the standby generator and shift the electrical load to it. Secure the affected unit and make the following checks:

(1) Check for a short circuit in the coil.

(2) Check for a short ciucuit or ground in the armature or commutator.

(3) Check on air gaps and/or rotor rubbing on stator.

(4) Check for proper setting of brush rigging.

5. Overheated ship's service generator bearings.

a. Causes. Overheating of generator bearings may be due to one or more of the following:

(1) Lube oil pump failure.

(2) Restriction in the lube oil system.

(3) Insufficient cooling by the lube oil coolers.

(4) Worn bearings or misalignment of bearings.

b. Action. The following corrective measures should be taken:

(1) Check for proper lube oil level.

(2) See if the lube oil is being circulated to all bearings and gears.

(3) Shift the lube oil to clean strainer.

(4) Check the quantity of water leading to the lube oil coolers. Increase the supply, if possible.

c. If the bearings continue to overheat:

(1) Start the standby generator and shift the load to it.

(2) Secure the affected machine.

(a) Clean the lube oil coolers.

(b) Check the bearings for wear and alignment.

6. Short circuit in the main circuit breaker. If the main circuit breaker short circuits, a brilliant flash will probably occur, with the possibility of starting a fire at or near the area of the short circuit. The following procedure will serve to remedy this casualty:

a. Trip out or secure the generator in service.

b. If a fire exists, extinguish it with a CO^2 fire extinguisher. Do not use water.

c. Open the disconnect switches ahead of the circuit breaker.

d. Start the standby generator and cut it in.

e. Replace or repair the circuit breaker, observing all safety precautions.

7. Loss of electric power to the steering engine. A loss of electric power to the steering engine is accompanied by the sounding of an alarm, and the rudder and rudder angle indicator will not shift with the movement of the helm (wheel).

a. Causes. Listed are some of the causes for loss of electric power to the steering engine. The outlined causes and procedures are very general in order to apply to all types of ships. The systems and procedures for each individual ship should be checked out and personnel instructed in that particular system.

(1) Severance of power cables between the steering engine room and the engine room.

(2) Heavy shock from collision or explosion.

(3) Power failure due to overload, blown fuses, or tripping of the circuit breaker.

b. Result. A loss of power to the steering engine may result in:

(1) Loss of steerage.

(2) A derangement of the hydraulic telemotor system.

(3) A derangement of steering motors.

c. Action. The following procedures will be required to restore the steering engine to emergency operation:

(1) Check the control panel for electric power.

(2) Check the electric power leading to the steering motors.

(3) Shift to the alternate power supply (if available).

(4) Rig casualty power (jury rig jumper).

(5) Operate emergency hand-operated hydraulic pump to rams, if installed.

(6) Jury rig chain falls for emergency steering, if required.

8. Rudder angle indicator failure.

a. Cause. Failure of the rudder angle indicator may be due to any of the following:

(1) Blown fuse.

(2) Loss of power at the I.C. board.

(3) Opening in the circuit.

b. Action. A check of the following should be made to locate the source of failure:

(1) Power to the system at the I.C. board.

(2) Cut-out switches for open position.

(3) Fuses.

(4) Mechanical operation of the system.

(5) Opening in the circuit.

9. Fire behind the ship's service switchboard. Short circuits, loose connections and overloads are the principal causes of switchboard fires. Remedial action should be as follows:

a. De-energize the affected circuits.

b. Extinguish the fire with CO^2 or dry chemical. Use a portable extinguisher or the semi-portable installed hose and reel type extinguisher.

c. Where CO^2 is being used in a confined space, or if smoke and fumes are heavy, use an oxygen breathing apparatus when fighting fires.

d. Do not return circuits to use until they have been carefully checked out and repairs made.

C. Safety Precautions. The following safety precautions should be observed when handling electrical casualties:

1. De-energize circuits before attempting repairs. All circuits must be considered as energized until a personal check has been made.

2. Make sure all portable electric tools are grounded.

3. Before making electrical connections, be sure they are the correct ones.

4. Do not remove guards from equipment.

5. Be cautious when using hand tools in the vicinity of energized circuits.

V. SUMMARY.

A. Personnel failures cause electrical casualties because of:

1. Improper maintenance.

2. Inattention to standard operating practices and procedures.

B. Action required of engineering watch personnel during electrical casualties.

1. Notify the bridge of all casualties requiring speed changes or affecting the maneuvering capabilities of the ship.

2. Notify the chief engineer.

3. Control the casualty.

4. Restore the ship to normal operation as soon as possible.

C. Safety in handling electrical casualties. Stress safety precautions.

D. Review the key points in the following electrical casualties:

1. Ship's service generator casualties.

2. Emergency Diesel generator and switchboard.

3. Loss of electric power (generator failure).

4. Fluctuating voltage (ship's service switchboard).

5. Overheated ship's service generator.

6. Overheating of the ship's service generator bearings.

7. Short circuit in the main circuit breaker.

8. Loss of electric power to the steering engine.

9. Failure of the rudder angle indicator.

10. Fire behind the ship's service switchboard.

E. Stress the importance of a combination of prompt action, proper procedures, and safety in controlling casualties.

F. (Restate) Casualty prevention is the most effective form of casualty control.

VI. TEST AND APPLICATION.

1. Test. The following questions may be used for an oral quiz.

1. Q. State three causes of a rudder angle indicator failure.

A. (1) Blown fuse.
(2) Loss of power at the I.C. board.
(3) Opening in the circuit.

2. Q. If the maneuvering capabilities of the ship are impaired, or speed changes are required to correct or minimize a casualty, what action must be taken?

   A. The bridge must be notified immediately by telephone and/or the engine order telegraph.

3. Q. By what general means would you restore a ship to normal operating effectiveness?

   A. Through isolating methods, through by-passing and/or using available standby units.

4. Q. Would you attempt to make repairs to an electrical circuit which had not been de-energized?

   A. No. Circuits should always be de-energized before working on them.

5. Q. When the ship's service generator fails, what means are provided to allow electric auxiliaries to operate?

   A. Emergency diesel generator and switchboard.

6. Q. Fluctuating of the voltage on the ship's service switchboard may result in what casualty?

   A. Overspeeding and tripping out of the generator, with loss of electric power.

7. Q. What are some of the causes of overheating of the ship's service generator?

   A. (1) Insufficient or restricted ventilation.
   (2) Running at improper speed.
   (3) Brushes not set properly.
   (4) Restricted cooling water to coolers.
   (5) Short in armature or field coils.

8. Q. If the ship's service generator continued to heat up excessively and you could not correct the condition immediately, what control measure should be taken?

   A. Start up the standby generator and shift the electrical load to it; then cut out the affected machine.

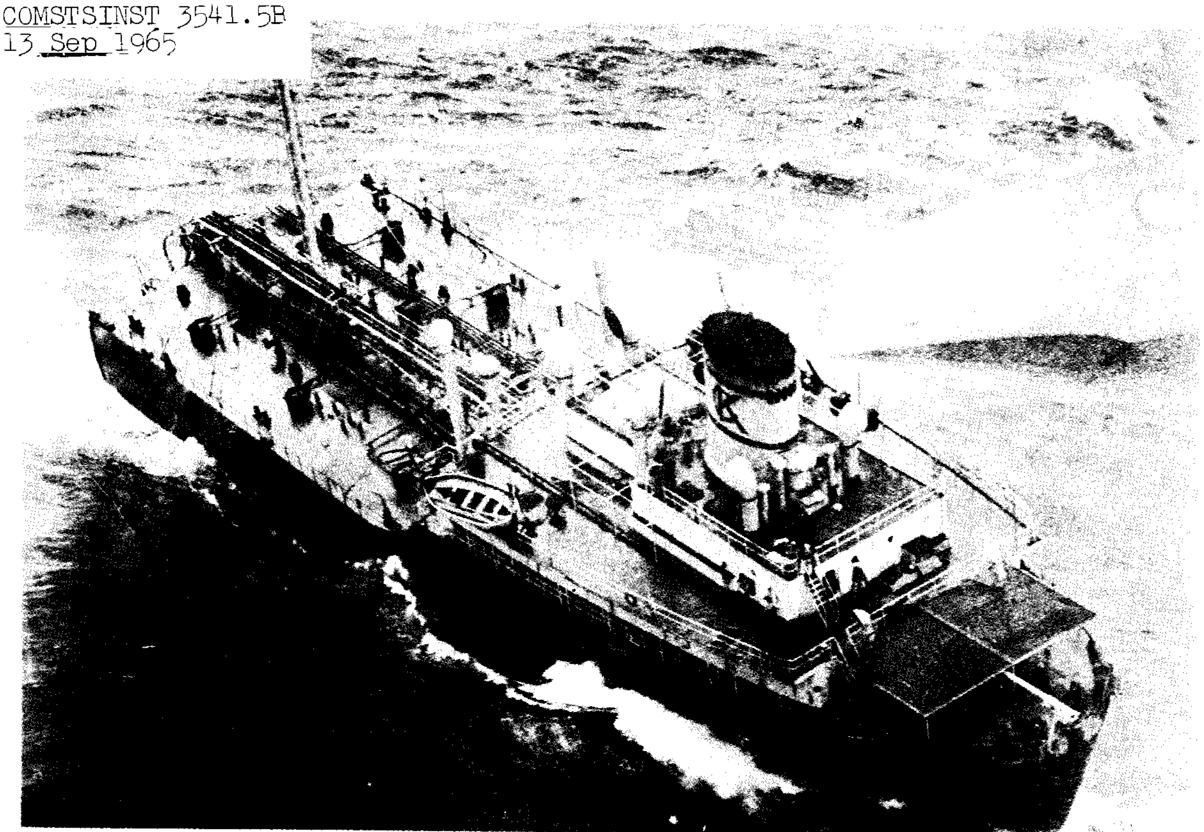
9. Q. What condition would indicate the failure of the rudder angle indicator?

   A. Failure of the rudder angle indicator is revealed when the electric indicator does not correspond to the mechanical angle indicator at the helm.

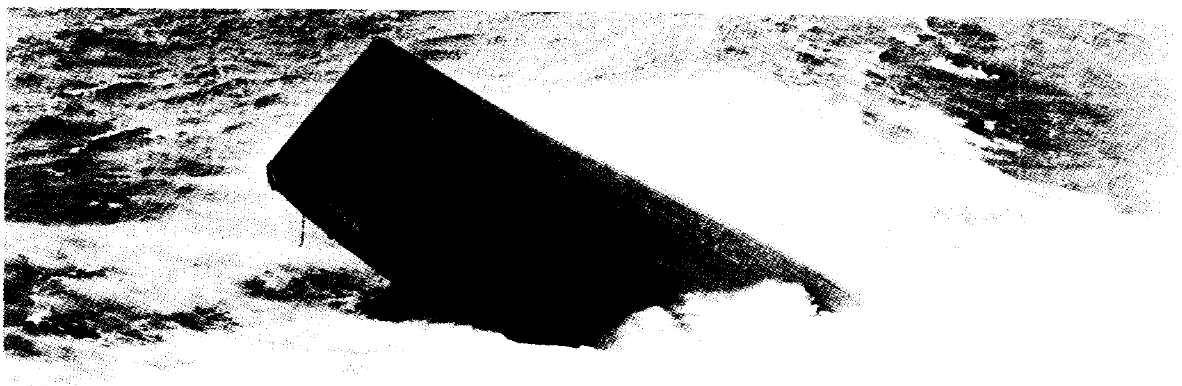
10. Q. What procedure is followed when a fire occurs behind the ship's service switchboard?

   A. De-energize the affected circuits and extinguish the fire with CO^2 or dry chemical. If the space is confined, or if smoke and fumes are heavy, use oxygen breathing apparatus. Then check and repair the affected circuits before returning them to use.

B. Application. Check the ability of engineering personnel to identify and cope with electrical casualties during continuing practical engineering casualty control excerises and drills conducted as part of the ship's regular program of instruction and drills.



AMERICAN TANKER "PINE RIDGE" BROKEN IN-TWO BY HEAVY SEAS OFF CAPE HATTERAS 21 DECEMBER 1960. 7 LOST IN BOW SECTION, 28 RESCUED BY HELICOPTER FROM STERN SECTION.



CHAPTER 7

LESSONS FROM CASUALTIES

These lessons from casualties and the MSTS casualty reviews in Chapter 8 will be most valuable if used as case studies. As case studies, they can help you to profit from the mistakes of others and to sharpen up your ability to make the best possible decisions in emergency situations.

To get the most out of these lessons from casualties and casualty reviews, consider them as case studies. That is, put yourself in the shoes of the officers and crews of the ships involved. Study each case to the point where you have all of the information which was available to the ship's personnel when the emergency arose and action was required. Then discuss the case and decide what you would do if you were aboard that ship and confronted with the same emergency. In some cases, where the casualty occurred progressively, you may have to refer back to the case for more information at each stage of the emergency.

Then check the action actually taken in the ship involved and compare it with your planned action. Compare the various courses of action and the alternatives with the objective of improving your ability to cope with similar emergency situations.

Additional lessons from casualties will be added to this chapter, as appropriate. It is suggested that all hands also study the lessons from casualties which appear periodically in "Proceedings of the Merchant Marine Council", USCG.

Section 7.1

THE PECULIAR FATE OF THE MORRO CASTLE

The most famous sea disaster of the early 1930s, which uselessly destroyed 134 lives. (Permission to condense and reprint this article was granted by William McFee, Author, and Simon and Shuster Inc., Publisher.)

I. SATURDAY, September 8, 1934, was a blustery autumn day along the Atlantic Coast. There was some rain, the leaves were falling, and so was the barometer. It was the kind of day on shore which indicates dirty weather at sea. September is the hurricane month.

Three days earlier, September 5, the twin-screw turboelectric liner MORRO CASTLE of the Ward Line sailed from Havana on her homeward run to New York. September 8, in a storm of wind and rain, she was three miles east of Barnegat, heading for Ambrose Channel, where she would pick up her pilot. It was nearly 3:00 a.m. and her 318 passengers and most of her crew of 231 men and women were asleep.

The usual Friday night conviviality, the "farewell dinner", the paper hats and toy balloons, the drinking, dancing, and love-making, the traditional culmination of a pleasure cruise in the West Indies, had been clouded by an unusual event. Captain R. Willmott was taken ill at dinner and died within a few hours.

It was a grave psychological strain for the chief officer, Mr. William F. Warms, who had come off watch at eight o'clock. He was about to turn in for he had a strenuous day ahead of him in New York, when he made the discovery. To find his captain dead in his bunk, to face the sudden responsibility of taking over the command of the ship, would impose a burden on the strongest of men.

Mr. Warms, moreover, had another anxiety. The gap between chief officer and master of any ship is wide enough, but in this particular case much of the executive authority usually assumed by a chief officer by custom and tradition had been retained by the dead captain. We have to keep this in mind when we come to the actions of Captain Warms, suddenly confronted with the most terrifying emergency to be faced by the master of a vessel crowded with helpless, sleeping passengers.

At five minutes to three Mr. Hackney, acting second officer, saw smoke issuing from the stokehole fidley. He called down from the bridge to the engine room to ask "if there was a fire in the engine room". Cadet engineer William F. Tripp, an eighteen-year-old Massachusetts Institute of Technology student, who was on duty near the telegraph and telephone, for they were about to pick up the pilot, replied in the negative. He knew of no fire. This is a highly important detail for, at 2:56, Mr. Hackney pulled the fire alarm, which would be relayed all over the ship.

By this time, of course, Captain Warms was on the bridge. Accepting the above official record, confirmed by Mr. Tripp's log sheet, we face the extraordinary facts that (1) some eighteen minutes elapsed before the captain ordered a radio call for assistance; (2) the radio operator, Mr. Rogers, whose cabin, fifty feet aft of the navigating bridge, was on fire, sent three times to ask for instructions; (3) other ships near by saw the fire and sent calls before the MORRO CASTLE's call went out; (4) the ship was kept steaming at nineteen knots, into a twenty-mile wind, in darkness, pouring rain, and pounding seas before being stopped.

By that time, around half past three, the fire had made such headway that the ship's upper structure, from the forward funnel to the mizzenmast, which rose abaft the deck ballroom and the veranda, was a furnace. The passengers were crowding to the tourist section of the ship, right on the stern rails, on B and C decks. They were pouring through the passageways. Some, who were later seen at portholes, screaming for help, had been trapped in their cabins and were to die horribly there. Six young ladies, who had been carried by stewardesses from the bar to their cabins at the end of the evening's festivities, were not seen again. Some, of course, probably less fuddled, more athletic, and more enterprising, squirmed their way through their portholes and dropped into the sea, and were lucky enough to be picked up by the boats.

Most of the passengers, however, suddenly awakened by the raucous loudspeakers, frightened by the roaring of the flames and the running of men who had lost their wits and had no one to command them, surged aft through the smoke-filled passages. In such a case the word "panic" is inadequate. It conveys nothing of the actuality. These people, running through corridors of a burning ship, half-clothed and many of them half-demented, were in a bad way. When they came out on the after rail it was raining in torrents. There was no light save the lurid flames leaping at them from the superstructure. Below them was the dark turbulence of the sea, dotted with crying people in life belts, calling to the boats dimly seen, standing off fearfully from the heat of the burning ship. Desperation came to these people, and a measure of courage too. Down they went, jumping, or sliding down ropes, and, being inexpert at such business, scorching their soft hands, so that some of them were forever incapacitated for their professional work. There were many women there too, and they threw off their flimsy shoes by the rail, discarding their lipsticks and compacts, their lighters and cigarettes and girdles, as though, when faced with the final, grim, eternal verities of the sea, they instinctively abandoned the nonessentials.

II. IT IS LOGICAL and even inevitable now to regard the events of that fatal morning off Barnegat, in a storm of wind and rain,as the classic modern example of a marine disaster. Nothing was wanting to complete the picture. There was incompetence, panic, evasion, ignorance, credulity, and avarice. And from the first moment of alarm, when the "CQ" signal went out (the radio call for immediate assistance), legend and myth began to crystallize around the stark facts of the tragedy.

There was, for instance, the rumor which inland radio listeners heard early on Saturday, that the MORRO CASTLE had been struck by lightning and had blown up, with a loss of five hundred lives. So incredible did it appear to the ordinary landsman for a fast modern liner, known to thousands who had made the cruise to Havana and to many more who hoped to make it, a liner with 173 voyages successfully and joyously completed, a liner often described as the safest ship afloat, to be destroyed by fire at sea, within sight of land, and surrounded by ships rushing to her assistance, that many people instinctively credited the disaster to natural causes and an "act of God". They thought it must be due to an unavoidable malignancy of the elements, or to sabotage, to spontaneous combustion of cargo--to anything, in fact, but what it was, panic and incompetence.

There was nothing remarkable about so many ships being on hand on this occasion. Every ship southbound from New York, every ship coming up from the Americas, is on this course to or from Ambrose Channel. What was remarkable was their inability to get a clear notion of what was going on aboard the MORRO CASTLE. It must have seemed to some of those skippers, peering through the rain, that there were lunatics on board. How otherwise explain a ship in flames driving full speed into a twenty-mile gale? How explain the delay in sending out a call?

How explain the inexplicable? There were the boats, which were rendered largely useless by the delay in getting them swung out, because they were all amidships or nearly so, and were burning in their chocks. There was the speed with which the fire, discovered in a locker in the writing room, upstairs on B deck, abeam of the forward funnel, became a roaring furnace. This speed the New York Times on the following Monday morning described as "a mystery." It remains a mystery if we accept the official contention that the fire started between two and three o'clock. There is reason to believe it began long before that, and did not originate in the locker. And when Mr. Hackney asked Mr. Tripp, down at the engineroom telegraph, if there was a fire down there, he may not have been so far off the track after all.

III. SOON AFTER, then, with his ship in flames twenty miles south of Scotland Light, where the voyage officially ends, Captain Warms authorized "CQ" signals to all ships. He was only fifty feet away from Mr. Rogers in his wireless cabin, but they might as well have been strangers who had not been introduced. Captain Warms, who had not had a command before, and whose predecessor lay dead in the master's cabin, was under a strain. You can go to sea in command for forty years and never face a crisis such as he confronted inside forty minutes, almost from the time he took charge. For a while he was rattled. He took too long to make his decisions. For many years it has been an unwritten law that a ship in trouble should avoid at all costs calling for assistance from outside ships. She should, if possible, get help from another ship of the company. It was a cruel predicament for Captain Warms. He seems never to have had the executive authority and responsibility a chief officer should possess. And his bosun was reported drunk at 2:30 A.M.

Among those who have had experience of ships like the MORRO CASTLE, the natural reaction to the extraordinary lethargy of the personnel would be, Where's the watchman? What was he doing all this time? Why was "a fire in the writing room," a public space on B deck, only a few feet away from the bridge, not reported? And why did not the automatic fire-detection system warn the officer of the watch?

Shrewd questions, but they have the simplest answers. The watchman, it was revealed at the inquiry, had so many other duties he had little time to watch. In ships under discipline, the watchman makes his rounds as in a factory or store on land. He has a key which he plugs into stations at various points on his itinerary, to record his vigilance. This is his duty and he has no others. But on the MORRO CASTLE, he said, he had many other duties, so that he was not really a watchman at all, in the legal sense.

The writing room where the watchman, if he had made his rounds, had noticed nothing unusual, had no fire-detection apparatus. Nor had any of the public rooms in the ship. The Darby fire-detecting system was installed in the private cabins, where fires sometimes start because women plug in electric toilet appliances and forget them, or drop cigarette butts into wastebaskets full of tissues, and these conflagrations would have given a warning in the wheelhouse. But this was not considered by the builders or the naval architect to be a fire hazard. Moreover, although the United States signed the 1929 Convention for Safety at Sea in London, the august United States Senate had not ratified that Convention in 1930, when the MORRO CASTLE was launched. So she was neither built nor operated in compliance with the Convention. Yet she was publicized as "the safest ship afloat."

So we have the picture of a splendid, modern ship, of fifteen thousand tons' displacement, steaming at nineteen knots toward Ambrose Channel, to pick up her pilot and dock early on Saturday morning, suddenly bursting into flames which roar along the alleyways and trap sleepers in their beds, and nobody seems to know what to do. The stories told by passengers sound like fiction of an unusually lurid type, yet they were corroborated so often, and they fit so closely into each other, that there can be no controversy. For a short time the ship had no direction at all. Members of the crew declared that the fire alarm in the crew quarters was feeble, "like an alarm clock". When the fire pumps were going and the hoses were brought into operation, we have the evidence of a passenger, an expert professional fire fighter, that the crew did not know how to lay them out. He had other things to say, this particular passenger, of great importance. He will be quoted again.

One of the wireless operators of the MORRO CASTLE, having come out of the affair with credit, went on a barnstorming tour as a hero. Anyone on that ship who did his simple duty was hailed as a hero by an uncritical press and public. But not Captain Warms. It was an appalling crisis, but shipmasters have been facing appalling crises for centuries, and many of them have left records of greater glory than Captain Warms. Why was this? Why did his chief engineer, Mr. Ebon S. Abbott, instead of staying with his commander, go off in lifeboat No. 1? Why did boat No. 3 get away with sixteen of the crew but no passengers? A boat certified to carry seventy persons!

IV. THE MORRO CASTLE was a first-class ship of the most modern design, and in spite of the fact that certain requirements of the 1929 Convention for Safety at Sea were not included, it is reasonable to accept her as one of the safest ships of her day as to structural design. The defects of the MORRO CASTLE lay in her personnel, afloat and ashore.

She was of 11,520 tons register, 6,449 tons net, 508 feet in length, 70.9 feet beam and 39 feet draft. She was a twin-screw, oil-fired ship with six Babcock and Wilcox water-tube boilers, General Electric turbo-electric generators driving electric motors on the two shafts. She developed 16,000-shaft horsepower, and her service speed was 20 knots. She was built to the highest classification of the American Bureau of Shipping, and she had been approved by the United States Navy as a naval auxiliary. It seems strange we should have heard talk, after the disaster, of her "faulty construction".

She had nine watertight, transverse bulkheads extending to the shelter dock, and her watertight doors were electrically operated. Her superstructure was three decks in depth, with a combined forecastle and bridge. All decks were of steel and laid with teak.

Her firefighting equipment was the best of its kind in 1930. The Darby fire detecting system was installed everywhere except in public rooms, as we have noted. Down below, the cargo space was equipped with smoke-detecting apparatus. Twenty-seven lines of piping connected the holds to a box on the bridge, where the officer of the watch could at once detect the origin of smoke. There was also a carbon-dioxide system for smothering fires in the engine room and boiler rooms. There were nearly a hundred fire extinguishers on brackets all over the ship. There were 2,100 feet of canvas fire hose.

There was criticism in some quarters because no sprinklers were installed. Sprinklers, as we find them on shore, are not the answer to marine risks. In any case they would have been useless in the MORRO CASTLE fire.

What more was needed? What more could any steamship owner provide for the protection of his patrons? The answer is, nothing except personnel of the same quality as his ship. There was nothing the matter with the MORRO CASTLE that night except personnel.

By comparing, in LLOYD'S REGISTER OF SHIPPING, the MORRO CASTLE and ORIENTE with the company's other vessels, such as the MOHAWK (5,896 tons, single-screw freighter with some passengers, 387 feet in length), we get the impression that there had not been a development of discipline on board and organization in the office to cope with liners of the MORRO CASTLE class, ships carrying several hundred passengers and a crew of 231. The voyage was short; the turnover in personnel 20 percent, which would have given any management with intelligence uneasy nights. The ship was of course adequately serviced in New York by shore staffs, but the time at sea was so short that it was almost impossible, remembering that 20 percent turnover, to develop any sense of solidarity. It was not, in a seaman's sense, a voyage at all, but a high-speed junket to a tropical port, where liquor was plentiful, potent, and cheap. The ship was a constant headache to the Narcotics Squad, Havana being what it was. The head of the Seaman's Union said that MORRO CASTLE "seamen" actually paid for their jobs instead of receiving wages, their profits on smuggled dope were so high.

There was, then, a musty odor of slackness in running the ship. According to Section 2 of the Seaman's Act, the crew should have been divided into day and night watches. There were only seven men on duty at night out of a total of 231 on board, when the fire started. If Captain Willmott tolerated this arrangement for his own reasons, nobody else was likely to make complaint.

Another astonishing feature of the way the ship was operated was that there was no list of rules, no book of company regulations, to which an officer could turn (if he did not already know them from long service) for guidance. This was so extraordinary that the question was put more than once to the vice-president in charge of operations. No, there were no printed regulations.

Now here was something which might be listed under the heading "faulty construction". In all first-class lines the traditions, experience, and policy, accumulated by generations of management, are crystallized, distilled, condensed, reduced to a set of rules and regulations, which have the authenticity and prestige of Holy Writ. In one company in which the writer served, it was actually known as "the Bible", without any intention of being irreverent. The captain and his heads of departments each had a numbered copy. In the hands of the literal-minded and possible malevolent commander such a code of laws could be used to further his own ends, exactly as other codes on land have been misapplied. The point is that a company of any quality almost inevitably evolves such a code, and prints it, and insists on its observance at sea.

But on the MORRO CASTLE, according to the first vice-president, there was nothing of this at all.

We have the statement of the night watchman that he had so many other duties he could not do much watching. There were not enough men on duty to comply with the law. We may ask here, What sort of Men? Who chose them for their work? What were their qualifications?

Here we come to grips with the reactions between the shipowners and the Bureau of Navigation and Steamboat Inspection. The MORRO CASTLE had been inspected for Voyage 174, which was her last, in May, 1934. She was reinspected on August 4, a month before the disaster. This meant, probably, that the May inspection had not been completed before she sailed. Anyway, she was inspected, just as the ill-fated VESTRIS was inspected, and the excursion steamer MACKINAC, whose boilers were inspected in New York not long before they blew up and killed forty-seven people.

These inspections had become largely routine, formal, and in the nature of gentlemen's agreements. It was assumed that the master and his officers would not knowingly go to sea with defects likely to jeopardize their own lives and ships, or at any rate their professional reputations. With a ship like the MORRO CASTLE the inspection was perfunctory. She was new; she was a first-class job; she was approved by the Navy, and she was underwritten by Lloyd's of London.

The Bureau had been issuing what were called lifeboat certificates to seamen, as well as certifying those seamen as "able" or otherwise. These documents were peices of paper, quite small; easily lost or stolen; easily sold, like the official American discharges. In the new legislation of 1936 discharge-books for seamen were authorized. Every other maritime nation on earth used these books. The continuous-discharge-book corresponded to the passports carried by passengers. But American seamen would have none of it. To have their records permanent and inviolable was, in their view, "un-American".

In 1934, however, it was common knowledge that these paper discharges and certificates were sold outside the Seaman's Institute on South Street to any who wanted to ship out. No chief officer or first assistant regarded them as having any meaning. He took what he could get, and if the men were no good he fired them and tried again. Or, in the case of the MORRO CASTLE, the crew were engaged by the Ward Line's shipping master.