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REVISION 2

NAVAL SHIPS' TECHNICAL MANUAL

CHAPTER 079 V3

DAMAGE CONTROL ENGINEERING CASUALTY CONTROL

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NOTE

THIS CHAPTER HAS BEEN REFORMATTED FROM DOUBLE COLUMN TO SINGLE COLUMN TO SUPPORT THE NSTM DATABASE. THE CONTENT OF THIS CHAPTER HAS NOT BEEN CHANGED.

CHAPTER 79

- DAMAGE CONTROL VOLUME 3 - ENGINEERING CASUALTY CONTROL

SECTION 46.

MACHINERY CASUALTY CONTROL

079-46.1 GENERAL

079-46.1.1 MISSION OF ENGINEERING CASUALTY CONTROL. Engineering casualty control is concerned with prevention, minimization, and correction of operational and battle casualties to machinery, electrical, and piping installations. Its mission is maintenance of all engineering services in a state of maximum reliability under all conditions of operation. The first objective under this mission is effective maintenance of propulsion, auxiliary, and electric power systems, lighting, communications, electronic services, ship control, firemain supply, and miscellaneous services, such as heating, air-conditioning, and compressed air.

079-46.1.1.1 Failure to provide all normal services will affect the ship’s ability to perform effectively as a fighting unit either directly, by reducing its mobility, offensive and defensive power (including ability to control fires, flooding, and hull and armament damage); or indirectly, by reducing habitability, thus reducing personnel morale and efficiency.

079-46.1.1.2 The second objective is to minimize personnel casualties and secondary damage to vital machinery, since these factors contribute to the successful and continued accomplishment of the first objective.

079-46.1.1.3 Maintenance procedures included in this volume supplement the Preventive Maintenance System (PMS). Preventive maintenance, including schedules, inspection, and overhaul cycles shall be conducted in accordance with the appropriate Maintenance Repair Cards (MRC’s). This volume is not intended to circumvent, supersede, abridge, or otherwise reduce in any degree, the importance of information contained in other chapters of the Naval Ships’ Technical Manual (NSTM), or other important sources of information made available to the ship.

079-46.1.1.4 It is impossible that every condition or situation which could possibly occur in connection with engineering casualties in ships could be included in this volume. Attempts are made to focus attention only on those phases of engineering casualty control that could be the result of sudden damage resulting from internal casualty, faulty maintenance, collision, or battle action. Even in these areas, any attempt to cover all the possibilities for damage to a ship’s engineering plant from these sources would be futile.

079-46.1.1.5 A shell, bomb, torpedo, or missile hit (or even a near miss by any of one of these) could negate the most carefully planned and executed preventive maintenance program. Action taken after such an episode, however, with prior knowledge and preparations for such an occurrence, will determine results.

079-46.1.2 INFLUENCING FACTORS. Basic factors influencing effectiveness of engineering casualty control are much broader than any immediate actions or routines applied when a casualty occurs. Engineering casualty control reaches its maximum efficiency through a combination of sound design, careful continued inspections, and thorough plant maintenance, including preventive maintenance, effective personnel organization and training.

NOTE

Casualty prevention is the most effective form of casualty control.

079-46.1.3 PERSONNEL. Personnel knowledge of the ship is the foundation of casualty control. Knowledge of the details of engineering installations, from the operating viewpoint, shall be emphasized to all personnel concerned, because conditions of darkness, extreme temperatures, toxic fumes, fire, and flooding may prevail after damage occurs.

079-46.1.3.1 General. Instruction in proper operating procedures is essential so personnel are completely familiar with normal operations prior to being drilled in simulated casualties. Operating personnel must make a continuing evaluation of all areas. In pre-damage preparation prior to combat action, the ship's forces must report upon and correct damage as it is discovered. The Naval Sea Systems Command (NAVSEA) desires suggestions and recommendations from operating and repair personnel for improvement of operations and control of casualties.

079-46.1.3.2 Organization. For the scope of casualty control organization, refer to NWP 62-1, **Surface Ship Damage Control** .

079-46.1.3.3 Training. Casualty control training must be a continuous step-by-step procedure with constant refresher drills. Realistic simulation of casualties must be preceded by adequate preparation. In planning and preparing even minor simulated casualties, consideration must be given to the possibility that the simulation could create an actual hazardous condition, or cause damage if the simulated casualty is handled improperly. Simulation of major casualties and battle damage must be preceded by a complete analysis, and by careful instruction of all participants.

079-46.1.3.3.1 Enthusiasm for realistic casualty drills must not outweigh sound judgment, or sound evaluation of the state of crew training. New crews must be given adequate opportunity to become familiar with the ship's piping systems and equipment prior to simulating any casualty.

079-46.1.3.3.2 In preliminary phases, dry runs are important for imparting knowledge of casualty control procedures. This is necessary so ship's equipment will not be endangered by a casualty simulation that is too realistic, before sufficient personnel experience has been gained. Under this procedure, a casualty is announced, and all personnel are required to take action reports as though the actions actually were taken, except for specific indication that actions were only simulated.

079-46.1.3.3.3 Definite, realistic, corrective action motions can be made under careful supervision and timing. Such dry runs always must be performed before actually attempting to realistically simulate any involved casualty, regardless of the current state of crew training. Similar rehearsal must precede relatively simple casualties whenever an appreciable portion of the crew is new to the ship, particularly after an interruption of regularly conducted casualty training, such as after an extensive overhaul period. After completion of each drill or actual casualty, a critique is to be conducted.

079-46.1.4 DESIGN. Sound design influences effectiveness of casualty control in two ways:

1. Elimination of weaknesses which lead to material failure.

2. Installation of alternate or standby means for supplying vital services in event of a casualty to the primary means.

079-46.1.4.1 Both design factors listed in paragraph 079-46.1.4 are employed to the maximum practical extent in ship design. The second of these is satisfied by either of two methods:

1. The split-plant design, which consists of installation of duplicate vital auxiliaries (by use of loop systems and cross-connections) and of a complete propulsion plant designed to operate with completely isolated auxiliaries.
2. Split-plant operation, which provides duplicate propulsion plants (port and starboard) designed to operate independently of each other.

079-46.1.5 INSPECTION. Continuous detailed inspection procedures are necessary to discover worn or partly damaged parts which may fail at critical times.

079-46.1.5.1 Similar Failures. In all cases where a material failure occurs in any unit, prompt inspection of all similar units shall be made to determine if identical incipient failures are present in the remaining units. This inspection may eliminate a series of repeated casualties.

079-46.1.5.2 Design or Material Deficiencies. Whenever a particular part fails by abnormal wear, fatigue, erosion, or corrosion, this may indicate either failure to operate the equipment within its designed limits of leading, velocity, and lubrication, or it may reveal a design or material deficiency.

079-46.1.5.3 Additional Inspections. Additional inspections to detect repeating damage shall be carried out as a routine practice, until corrective action is taken to ensure that no further failures will occur. These inspections are to be conducted within shorter-than-nominal periods of time, and within predictable failure-life of the part concerned, based upon past performance of such parts.

079-46.1.5.4 Preventive Maintenance. Preventive maintenance is vital to successful casualty control, because this will minimize occurrence of casualties caused by material failures, and help eliminate conditions that could lead to early failure, such as maladjustment, improper lubrication, corrosion, erosion, and other enemies of machinery reliability.

079-46.1.5.4.1 Particular and continuous attention must be given to external evidences of internal malfunctioning. Evidence of impending failure could be as follows:

1. Unusual noise
2. Vibration
3. Abnormal pressure
4. Abnormal temperature
5. Abnormal operating speed
6. Leakage from systems, or associated equipment, handling flammable fuels, lubricants, or other liquids under pressure

079-46.1.5.4.2 Capacity tests on pumps are to be run at reasonable intervals where metering devices have been installed. With careful planning, this can be performed in more cases than is commonly realized.

NOTE

Preventive maintenance, including schedules of tests, inspections, and overhaul cycles shall be conducted in accordance with the appropriate MRC's.

079-46.1.5.4.3 Operating personnel shall be familiar with the specific normal pressures, temperatures, and operating speeds of equipment corresponding to each normal operating condition, so departures from normal will be readily detected. It must not be assumed that an abnormal reading on a thermometer, gauge, or other instrument recording operating conditions of machinery, is caused by an error in the gauge (see paragraphs 079–49.5 to 079–49.6)). Each case must be investigated to establish the cause of the abnormal reading.

079-46.1.5.4.4 Installation of a spare instrument or performance of a calibration test will determine quickly the existence of instrument error. All other cases must be traced to their source if preventive maintenance is to be effective. Some specific examples of advanced warning of ultimate failure are described in the following paragraphs.

079-46.1.5.4.5 Because of the safety factor commonly incorporated in pumps and similar equipment, considerable loss of capacity can occur before any external evidence is apparent. Changes in operating speeds from normal for the existing load (in the case of pressure governor-controlled equipment), should be viewed with suspicion. Variations from the normal suction pressure, lubricating oil temperature, and system pressures reflect either inefficient operation or poor condition of machinery.

079-46.1.5.4.6 It may become necessary to start additional pumps, blowers, or other auxiliaries as ship's speed is increased. If past practice, or reference to available design data, indicates that these additional auxiliaries were not previously required at the increased speed, tests to determine cause shall be conducted at the first opportunity. This advance warning could come either from auxiliaries or the main unit of machinery they serve. Such departures from normal indicate internal wear or other degradation of equipment concerned, and are reason for disassembly and inspection of the questionable unit at the first opportunity.

079-46.1.5.5 Lubrication. Proper lubrication of all equipment shall be maintained, including frequent inspection and sampling to determine that the correct quantity of the proper lubricant is in the unit, and that the lubricant is in good condition.

079-46.1.5.5.1 Samples of lubrication oil shall be taken in all auxiliaries at least daily. Such samples are to be allowed to stand long enough for any water to settle. Where auxiliaries have been idle for several hours, and particularly overnight, a sample sufficient to remove all settled water is to be drained from the lowest part of oil sump. Replenishment with fresh oil to the normal level shall be done simultaneously.

079-46.1.5.5.2 Any quantity of water in the oil normally is indicative of poorly fitted or worn carbon packing on turbine-driven equipment. Seawater may enter the oil from seawater pump glands, seawater cooled oil coolers, or from seawater dripping or spraying on the unit.

079-46.1.5.5.3 Presence of seawater in the oil can be detected by drawing off settled water with a pipette and running a standard chloride test. A sample of sufficient size for test purposes can be obtained by adding distilled water to the oil sample, shaking vigorously, and then allowing it to settle before drawing off the test sample.

079-46.1.5.5.4 Seawater in the lubrication oil is more dangerous to a unit than an equal quantity of fresh water because of its corrosive effects. Seawater is particularly harmful in the case of units containing oil-lubricated ball bearings. Where such units have been subject to seawater contamination of the lubricating oil, it is essential that the oil be drained as soon as possible, and the unit be thoroughly flushed and refilled with fresh oil.

079-46.1.5.5.5 Early inspection of ball bearings must be done, since even minor corrosion leads to their rapid deterioration.

079-46.2 DAMAGED EQUIPMENT

079-46.2.1 CORRECTION. The speed with which corrective action is applied to an engineering casualty is extremely important. This is particularly true with casualties that affect main propulsion power, steering, and electric power generation and distribution. Casualties associated with these functions frequently become cumulative in nature if not quickly corrected, and may lead to serious damage to the engineering installation. Damage of this type cannot be repaired without loss of the ship's operating capabilities.

079-46.2.2 OPERATION. The Commanding Officer has responsibility for deciding whether or not to continue operation of equipment under casualty conditions, where possible risk of permanent damage exists. Continued operation can be justified only where risk of even greater damage, or loss of ship may be prevented by immediately securing the affected unit. In such cases every possible action must be taken to shorten the period of hazardous operation.

079-46.2.2.1 An example of this principle could be operation of the entire plant with abnormal salinity in order to evacuate an area threatened by enemy attack.

079-46.2.2.2 A lesser case would be operation of a main feed pump showing evidences of overheating, during the time required either to secure the engine or boiler concerned, or to establish standby service.

079-46.2.2.3 Whenever probability of greater risk is not involved, proper procedure is to secure the malfunctioning unit as quickly as possible. The Commanding Officer shall be immediately notified of casualties affecting ship's capabilities, or those which subsequently may develop. Speed in controlling a casualty is essential. Action must be predicated upon accurate information, or the casualty may be mishandled and cause irreparable damage and possible loss of the ship.

079-46.2.2.4 War experience has taught that the cross-connecting of intact plants with a partly damaged plant must be delayed until it is determined that such action will not jeopardize or impair the intact plant. Speed in handling casualties can be achieved only through knowledge of the equipment and associated systems, and by repeated training in the routine required to handle specific predictable casualties.

079-46.3 CASUALTIES

079-46.3.1 GENERAL. Operational casualties described in this volume are typical of problems encountered in steam, gas turbine, and diesel-propelled ships. The complexity of ship propulsion is such that each ship type has its own unique system with attendant problems and corrective capabilities.

079-46.3.2 REFERENCES. Corrective actions given are general in nature, and are not to serve as a substitute for the details to be included in the **Ship's Casualty Control Manual,** and **Engineering Department Instructions** as prescribed by NWP 62-1, **Surface Ship Damage Control.**

NOTE

Failure of the smallest component, from whatever cause, can quickly result in failure of an entire power system.

079-46.3.3 GUIDELINES. No attempt is made in this volume to describe these many machinery components. Other chapters in the NSTM, and other specific sources of information shall be referred to as necessary. This volume provides only guidelines from which operating personnel can develop plans of action for casualty control.

NOTE

Some ships have a specific Engineering Operational Casualty Control (EOCC) developed for them. This EOCC is the controlling document in such cases.

079-46.3.4 MINIMIZING CASUALTY. The handling of a casualty usually can be divided into three phases. The first is concerned with immediate control of casualty to prevent further damage to the unit concerned, and to prevent the casualty from spreading through secondary effects. This phase is concerned with minimizing the casualty.

079-46.3.5 RESTORE SERVICES. The second phase consists of restoration, as far as practicable, of services which were interrupted as a result of the casualty. In many cases, this phase, when completed, eliminates all operational handicaps except for temporary loss of standby units, and the inability to withstand further failure. If no damage to, or failure of machinery has occurred, this phase usually completes the operation.

079-46.3.6 MAKING REPAIRS. The third phase consists of making repairs, and completely restoring installation(s) to original condition.

079-46.3.7 PROCEDURES. Typical casualties, including general procedures recommended by NAVSEA for their control, are given in this volume. It is necessary that each ship's Engineering Department develop specific procedures applicable to its own plant, designating duties to be applied in controlling specific casualties.

079-46.3.8 DRILLS. Whenever engineering casualty drills are conducted, a record shall be maintained of the time required to perform all necessary operations. Knowledge of time required to effect repairs to machinery could be of importance to the Commanding Officer when estimating a casualty situation.

079-46.3.8.1 The EOCC subsystem of Engineering Operational Sequencing System (EOSS) provides correct actions to be taken for control of casualties.

079-46.3.8.2 It must be understood that in this volume, any description of a casualty, its causes, action to be taken to correct or repair, and probable associated or subsequent casualties can be only of the most general nature. This is particularly true for any description of symptoms.

079-46.3.8.3 Symptoms that can be seen and heard can be described, but no description can be given of the instinctive knowledge (sense of casualty) developed by engineering personnel through close association with the machinery and engineering plant. An immediate response to this instinct has forestalled many casualties.

079-46.3.8.4 In describing causes of a casualty, only certain possibilities are evident. If it could definitely be stated that certain conditions or situations would cause a casualty, then preventive action could be taken to eliminate such conditions (battle damage, collision, and stranding excepted). Thorough and continuing inspections, and preventive maintenance programs will disclose and correct most casualty-causing conditions.

079-46.3.8.5 In any attempt to list associated casualties or probable subsequent casualties, each such listing could be concluded by the words "**loss of ship** ." Any part of the engineering plant that fails will reduce maximum capability of the ship to press home an attack, evade superior forces, ride out or run with a storm, avoid collision, or prevent stranding. All of these situations could result in loss of ship.

079-46.3.8.6 Information contained in this volume describing engineering casualties is offered only as an outline. Details must be supplied according to the specific ship under consideration.

079-46.3.8.7 For information regarding organization and training for casualty control refer to NWP 62-1, **Surface Ship Damage Control** .

079-46.3.8.8 For information on preparation of the **Engineering Department Organization and Casualty Control Book** , refer to NWP 62-1, **Surface Ship Damage Control** .

079-46.4 COMMUNICATIONS

079-46.4.1 Communication is an important phase in control of casualties in the engineering plant of a ship. Prompt action to notify Central Engineering Control (CEC), and all other associated activities of the engineering plant can prevent additional damage from being more serious than the original casualty.

079-46.4.2 The sound-powered telephone system is considered to be the least vulnerable means of communication. It is essential that personnel be properly trained and the system maintained in best condition. An alternate system, either inter-communication systems, messenger, or some other arrangement should be staffed and ready for service if called upon.

079-46.4.3 Transmission of correct information regarding the casualty, and speed with which reports are made, are the principal values of any method of damage or casualty control communication.

079-46.4.4 Engineering communications shall be characterized by clarity, brevity, and conciseness; a cluttered and unmonitored circuit is useless. Trained telephone talkers should be personnel who are familiar with engineering phraseology.

079-46.5 REDUCTION OF MACHINERY COMPARTMENT OIL FIRE HAZARDS

079-46.5.1 FIRE PREVENTION. To reduce hazard of fires, which could occur because of leakage or malfunctioning of flammable fluid piping systems, a training, inspection, and maintenance program must be established and adhered to by ship's force. **NSTM Chapter 555, Volume 1, Surface Ship Firefighting, Section 6, Machinery Space Firefighting Doctrine for Class B Fires in Surface Ships** , contains additional discussion of fire prevention measures.

079-46.5.2 MANUFACTURE OF DAMAGE CONTROL EQUIPMENT. Like some other items of damage control gear, ship's force will occasionally need to manufacture some of the items described in the following paragraphs. If unable to do so, the items shall be requested at the earliest availability of the ship at a repair facility.

NOTE

Relative to fire hazard reduction, a surface temperature of 204°C (400°F) is classified as a hot surface when considering fuels, and 343°C (650°F) when considering lubricating and hydraulic oils. For insulated surfaces, the temperature under the insulation is the reference surface.

079-46.5.3 DUPLEX STRAINERS FOR FLAMMABLE LIQUID SERVICE. The following inspection and operational procedures will minimize danger of fire from incorrect operation of flammable liquid strainers such as fuel and lube oil strainers. Maintenance procedures included in this section supplement the PMS. Preventive maintenance, including schedules of tests, inspections, and overhaul cycles shall be conducted in accordance with the appropriate MRC's.

079-46.5.3.1 Inspection. Qualified personnel shall be assigned to inspect all flammable liquid strainers at routine intervals, to determine the following:

1. General mechanical condition of strainers:
   a. Gasket seating surfaces
   b. Cover hold down clamps and studs
   c. Valve integrity
   d. Drainability
   e. Operability without undue force
   f. Condition of screen
   g. Unusual leakage
2. Security of magnets in all lube oil strainers
3. Integrity of all piping connections
4. Use of proper cover gasket

5. General mechanical condition of duplex strainer safety shields (NAVSEA 0948-LP-102-2010) for security, spraytight integrity and damage

079-46.5.3.2 Correction and Follow-Up. Initiate steps as soon as practicable to correct any deficiencies noted as a result of inspections. Include an item on weekly check-off sheet of safety devices, requiring that the several strainers in the space or division are to be inspected for integrity and safe operation. A special check or inspection sheet should be developed.

079-46.5.3.3 Operating Procedure. A definite step-by-step procedure for shifting strainers shall be established to include general procedures, plus any other procedures compatible with the particular installation and service for which unit is installed. These procedures shall be posted in the immediate vicinity of each strainer installed.

NOTE

All personnel assigned to operate and clean oil strainers shall be trained and qualified.

079-46.5.3.3.1 Placement of basket covers applies only to strainers using a tab and groove. If the tab is not properly placed in the groove, the cover will be cocked and a dangerous condition will result. To avoid this, the bottom of the tab must be removed, so the remaining portion is above the top of the strainer housing at any placement of the cover. Since operation of strainer requires the cover to be properly installed, the remaining portion of the tab and the groove must be aligned visually before the cover is clamped. For strainer designs that may require complete removal of the tab, an arrow is to be stamped on top of the cover indicating location of the tab. The arrow and groove must be aligned visually to give proper placement of basket cover.

079-46.5.4 FLAMMABLE LIQUID STRAINER VALVES. Strainer valves (vent or drain) with open-ended piping must discharge in a safe direction. Vent, drain, and root valves attached to strainers must be welded, brazed or flanged to the strainers.

079-46.5.5 PRESSURE GAUGE AND INSTRUMENT PIPING. Pressure gauges are required to be case-supported or panel-mounted off the piping to prevent failure from vibrations or accidental damage. Piping from the pressure source to pressure gauge shall include a gauge valve, or a root valve and a test connection. Valves (gauge or root) shall be closed in the event of failure of the gauge sensing element, and when in-place testing is to be done. For additional details of pressure gauge refer to**NSTM Chapter 504, Pressure, Temperature, and Other Mechanical and Electromechanical Measuring Instruments,** and for pressure gauge piping refer to **NSTM Chapter 505, Piping Systems.**

079-46.5.6 FLANGE SHIELDING. Flange connections and unions in piping systems containing flammable fluids under pressure are provided with aluminized glass cloth shields to prevent impingement of such fluid on electrical equipment and hot surfaces, and formation of an atomized mist in event of a gasket leak or loose connection. Detailed requirements for shield location and installation are contained in **NSTM Chapter 505.**

079-46.5.7 ADDITIONAL SHIELDS. Shielding is also installed over the exposed closing mechanisms of fuel quick-closing valves to prevent debris from jamming the mechanism.

079-46.5.8 INSULATION REQUIREMENTS. In general, insulation is installed for all machinery piping and equipment having external surface temperatures of 52°C (125°F) or higher, where loss of heat in the unit or absorption of heat by its surroundings would be detrimental, or where protection for personnel is required. (See **NSTM Chapter 635, Thermal, Fire, and Acoustic Insulation,** for detailed insulation requirements.) Hot surface insulation must be in place for all hot propulsion plant operations. Service steam thermostatic steam traps and the two feet of piping ahead of the trap are to be covered in accordance with requirements of **NSTM Chapter 635.** In addition, shields are required where oil may impinge. Shielding should not interfere with ambient air flow around the trap.

079-46.5.9 FUEL OIL BURNER LEADS. Use of flexible-hose burner leads for propulsion boilers is a fire hazard, due to susceptibility to failure of the hose at the coupling joint. Flexible hose burner leads are to be replaced with seamless steel tubing.

079-46.6 FEEDWATER CASUALTIES

079-46.6.1 LOSS OF MAIN FEED PRESSURE. Symptoms, causes, actions to be taken, and other casualties that can occur with loss of main feed pressure are given in the following paragraphs.

079-46.6.1.1 Symptoms. Symptoms are as follows:

1. Difficulty is experienced in feeding boiler.
2. Normal steam drum water level cannot be maintained.
3. Feed pressure gauge pointer shows drop in pressure.

079-46.6.1.2 Causes. Casualty causes are as follows:

1. Failure of automatic feed control valve
2. Defective check valve
3. Main feed pump tripping off the line
4. Main feed booster pump tripping off the line
5. Deaerating Feed Tank (DFT) water flashes
6. Ruptured feed piping

079-46.6.1.3 Remedial Action. Remedial actions to be taken are as follows:

1. Notify and keep Main Engine Control informed of situation.
2. Monitor combustion and feedwater control system.
3. Monitor DFT water level.
4. Inspect main feed booster pump(s) for proper operation.
5. Inspect feedwater control valve(s) for proper operation.
6. Inspect main feed pump(s) for proper operation.
7. Slow affected shaft to conserve steam, when so ordered.

8. Secure affected boiler when feed pressure cannot be restored.

CAUTION

In event of boiler low water, do not attempt to restore water level.

079-46.6.1.3.1 Main Engine Control will perform the following:

1. Notify Bridge of casualty and report maximum speed available.
2. Notify Bridge of casualty cause, and action being taken; report estimated time to make repairs.
3. Order plant cross-connected, as required.
4. Order turbogenerators tripped, as required.

079-46.6.1.4 Possible Additional Casualties. Additional casualties that can occur are as follows:

1. Loss of boiler because of low steam drum water level or distortion of boiler heating surfaces
2. Loss of steam pressure

079-46.6.2 FAILURE OF EMERGENCY FEED PUMP TO TAKE SUCTION. Symptoms, actions to be taken, and other casualties that can occur when the emergency feed pump fails to take suction, are given in the following paragraphs.

079-46.6.2.1 Symptoms. Symptoms are as follows:

1. Operation of emergency feed pump has no effect upon boiler feed water level indicator.
2. Emergency feed pump is racing.
3. Emergency feed pump is noisy.

079-46.6.2.2 Causes. Casualty causes are as follows:

1. Emergency feed pump is air- or vapor-bound
2. Emergency feed pump malfunction
3. Emergency feed pump fails to pick up cold suction when shifted from hot suction
4. Reserve feedwater in tank is below minimum level

079-46.6.2.3 Remedial Actions. Remedial actions to be taken are as follows:

1. Notify and keep Main Engine Control informed of situation.

CAUTION

Be careful not to splash water into pump gland.

2. Expedite emergency feed pump cooling, when shifting from hot to cold suction, by directing stream of water around pump barrel.
3. Investigate all system components for damage including proper alignment, piping systems, and low reserve feedwater tank level.

079-46.6.2.4 Possible Additional Casualty. Loss of boiler can result from failure of emergency feed pump to take suction.

079-46.6.3 LOSS OF AUTOMATIC FEEDWATER CONTROL. Casualty and symptoms, actions to be taken, and other casualties that can occur with loss of automatic feedwater control, are described in the following paragraphs.

079-46.6.3.1 Symptoms. Symptoms are as follows:

1. Difficulty is experienced in feeding boiler.
2. Proper water level cannot be maintained.
3. Hunting of feed pressure or feedwater controls.

079-46.6.3.2 Causes. Casualty causes are as follows:

1. Failure of automatic feedwater control system component
2. Loss of control air supply
3. Contamination of control air supply

079-46.6.3.3 Remedial Actions. Remedial actions to be taken are as follows:

1. Notify and keep Main Engine Control informed of situation.
2. Shift to local manual control and maintain water level.

079-46.6.3.4 Possible Additional Casualties. Additional casualties than can occur are as follows:

1. Low water in boiler
2. High water in boiler
3. Loss of steam pressure

079-46.6.4 RUPTURED DEAERATING FEED TANK. Symptoms, actions to be taken, and other casualties that can occur when the Deaerating Feed Tank (DFT) ruptures are given in the following paragraphs.

079-46.6.4.1 Symptoms. Symptoms are as follows:

1. Steam/water is emitting from DFT.
2. Water drops out of sight of DFT gauge glass, or remote level indicator shows low water.
3. DFT shell pressure decreases.
4 Main feed suction low pressure alarm sounds.
5. Main feed booster pump loses suction.
6. Loss of feed booster pump discharge pressure.
7. Main feed pump trips off the line.
8. Loss of main feed pressure to boiler.

079-46.6.4.2 Causes. Casualty causes are as follows:

1. Failure of DFT relief valve
2. Filling hot DFT with cold water
3. Failure of DFT vacuum breaker

079-46.6.4.3 Remedial Actions. Remedial actions to be taken are as follows:

1. Notify and keep Main Engine Control informed of situation.
2. Evacuate space personnel, when DFT rupture is major (see paragraph 079–46.11.1).
3. Shift combustion and feedwater control to remote manual control (if installed).
4. Secure boiler(s).
   a. Shut boiler feed control valve(s).
   b. Shut boiler feed stop-check valves.
   c. Trip steam quick-closing valve to fuel oil service pump, or trip fuel oil quick-closing valve.
   d. Shut condensate inlet valve to DFT.
   e. Shut all air registers.
   f. Slow forced draft blowers to minimum speed.
   g. Shut boiler main steam stop valve(s).
   h. Shut boiler auxiliary steam stop valve(s).
   i. Open and adjust superheater protection bleeder valve to maintain minimum flow through superheater (uncontrollable superheater boilers only) until steam drum pressure is 1380 to 2070 kPa (200 to 300 lb/in) below operating pressure; then shut bleeder valve.
   j. Stop auxiliary operating machinery as required.
      (1) Stop fuel oil service pump(s).
      (2) Stop forced draft blowers.
      (3) Stop main feed pump.
      (4) Stop main feed booster pump(s).

k. Isolate and secure DFT.

079-46.6.4.3.1 Main Engine Control will perform the following:

1. Inform Bridge of casualty, maximum ship's speed available, and order main engine slowed, as required.
2. Notify Bridge of casualty cause, action being taken, and estimated time to make repairs.
3. Order plant cross-connected, as required.
4. Order turbogenerators tripped, as required.

079-46.6.4.4 Possible Additional Casualties. Additional casualties that can occur are as follows:

1. Personnel casualties
2. Space fills with steam, requiring evacuation of personnel
3. Damage to main feed booster, main pumps, or both
4. Low water in boilers

079-46.6.5 RUPTURED FEED PIPING. Symptoms, actions to be taken, and other casualties that can occur when feed piping ruptures are given in the following paragraphs.

079-46.6.5.1 Symptoms. Symptoms are as follows:

1. Steam/water is emitting from feed piping.
2. Water level drops out of sight in DFT gauge glass.
3. Main feed booster pump loses suction.
4. Loss of main feed booster pump discharge pressure.
5. Low feed suction alarm sounds.
6. Main feed pump trips off the line.
7. Loss of main feed pressure to boiler.

079-46.6.5.2 Causes. Casualty causes are as follows:

1. Feed piping line split, or carried away
2. Main feed piping line flange gasket ruptures

079-46.6.5.3 Remedial Actions. Remedial actions to be taken are as follows:

1. Notify and keep Main Engine Control informed of situation.
2. Evacuate space personnel when rupture is major (see paragraph 079–46.11.1).
3. Shift combustion and feedwater control to remote manual control (if installed).

NOTE

When cross-connect capability is installed and if rupture is minor and can be isolated, Main Engine Control may order feed system cross-connected.

4. Secure boiler(s).
   a. Shut boiler feed control valve(s).
   b. Shut boiler feed stop-check valve(s).
   c. Trip steam quick-closing valve to fuel oil service pump, or trip fuel oil quick-closing valve.
   d. Shut condensate inlet valve to DFT.
   e. Shut all air registers.
   f. Slow forced draft blowers to minimum.
   g. Shut boiler main steam stop valve(s).
   h. Shut boiler auxiliary steam stop valve(s).
   i. Open and adjust superheater protection bleeder valve to maintain flow through superheater (uncontrollable superheater boilers only) until steam drum pressure is 1380 to 2070 kPa (200 to 300 lb/in) below operating pressure, then shut bleeder valve.
   j. Stop auxiliary operating machinery as required.
      (1) Stop fuel oil service pump(s).
      (2) Stop forced draft blowers.
      (3) Stop main feed pump(s).
      (4) Stop main feed booster pump(s).
   k. Isolate ruptured feed piping.

079-46.6.5.3.1 Main Engine Control will perform the following:

1. Notify Bridge of casualty, give maximum ship's speed available, and order main engine slowed as required.
2. Notify Bridge of casualty cause, action being taken, and estimated time to make repairs.
3. Order plant cross-connected, as required.
4. Order turbogenerators tripped, as required.

079-46.6.5.4 Possible Additional Casualties. Additional casualties that can occur are:

1. Personnel casualties
2. Space fills with steam requiring evacuation of space personnel
3. Damage to main feed booster, main feed pumps, or both
4. Low water in boiler

079-46.6.6 LOW WATER IN DFT. Symptoms, actions to be taken, and other casualties that can occur are given in the following paragraphs.

079-46.6.6.1 Symptoms. Symptoms are as follows:

1. Main feed pump low suction alarm sounds.
2. Water level is out of sight in DFT gauge glass and remote level indicator shows low.
3. Main feed pump trips off the line.
4. Loss of feed pressure to boiler.

079-46.6.6.2 Causes. Casualty causes are as follows:

1. Makeup feed misaligned
2. Failure of automatic level controls
3. High DFT shell pressure
4. Condensate system misaligned
5. Failure or malfunction of operating condensate pumps
6. Failure of auxiliary exhaust, causing flashing

079-46.6.6.3 Remedial Actions. Remedial actions to be taken are as follows:

1. Notify and keep Main Engine Control informed of situation.

WARNING

Do not fill hot DFT with cold feedwater rapidly.

2. Inspect makeup feed alignment and automatic controls.
3. Inspect condensate pump for proper alignment.
4. Ensure vacuum drag makeup feed cutout valve to main condenser is open.
5. Inspect main condenser hot well level; when level is high start standby condensate pump.

NOTE

When cross-connect capability is installed, Main Engine Control may order feed system cross-connected.

CAUTION

Boiler must be secured, unless otherwise directed, when undeaerated feedwater is used in steaming boiler. Undeaerated feedwater should be used only for time required to secure boiler.

6. Start reserve feed transfer or emergency feed pump (when required to maintain water level) to feed boiler until the boiler can be secured.

079-46.6.6.3.1 Main Engine Control will perform the following:

1. Inform Bridge of casualty, give maximum ship's speed available, and order main engine slowed, as required.
2. Notify Bridge of casualty cause, action being taken, and estimated time to make repairs.
3. Order plant cross-connected, as required.
4. Order turbogenerators tripped, as required.

079-46.6.6.4 Possible Additional Casualties. Additional casualties than can occur are as follows:

1. Loss of main feed booster, main feed pumps, or both
2. Loss of feed pressure, resulting in low water in steaming boilers

079-46.6.7 HIGH WATER IN DFT. Casualties and symptoms, actions to be taken, and other casualties that can occur are given in the following paragraphs.

079-46.6.7.1 Symptoms. Symptoms are as follows:

1. Water level is out of sight in DFT gauge glass or remote level indicator shows high.
2. DFT rumbles loudly.
3. DFT shell pressure is low.
4. Water is running from vent condenser vent pipe.
5. Flooded gland exhauster condenser vent pipe

079-46.6.7.2 Causes. Casualty causes are as follows:

1. Failure of automatic level controls
2. Starting standby main condensate pump when main condenser hot well level is high
3. Condensate system cross-connect valves are open

079-46.6.7.3 Remedial Actions. Remedial actions to be taken are as follows:

1. Notify and keep Main Engine Control informed of situation.
2. Ensure makeup feed valve is shut and excess feed valve is wide open.
3. Cover electrical components, as necessary.
4. Inspect automatic controls for proper operation.
5. Ensure proper alignment of condensate system.
6. Monitor condensate for excess salinity.

079-46.6.7.4 Possible Additional Casualties. Additional casualties that can occur are as follows:

1. Low water casualty to DFT in adjacent space when condensate cross-connected
2. Improper deaeration of feedwater
3. Grounds in electric motors and controllers, from water spillage

079-46.6.8 HIGH CHLORIDE (SALINITY). Symptoms, actions to be taken, and other casualties that can occur are given in the following paragraphs.

079-46.6.8.1 Symptoms. Symptoms are as follows:

1. Salinity indicators in machinery spaces indicate above maximum chloride limits.
2. Test of boiler water indicates above maximum chloride limits.
3. Chemical test of water in condensate, distillate, and feedwater system indicate above maximum chloride limits.
4. Priming or carry-over in superheater (low superheater outlet temperature).
5. Erratic operation of superheater temperature gauge.

079-46.6.8.2 Causes. Casualty causes are as follows:

1. Leaking main or auxiliary condenser tubes
2. Contaminated reserve feed tank
3. Contaminated fresh water drain system
4. Failure of evaporator to function correctly
5. Improper operation of evaporator
6. Improper boiler blowdown
7. Leak in condensate suction piping which runs through bilges
8. Leaking bottom blow valves on idle boilers

079-46.6.8.3 Remedial Actions. Remedial actions to be taken are as follows:

1. Notify and keep Main Engine Control informed of situation. Main Engine Control will notify and keep Bridge informed of required speed changes.
2. Investigate source of contamination and isolate.
3. Surface blow affected boiler, as required.

079-46.6.8.4 Possible Additional Casualties. Additional casualties that can occur are as follows:

1. High salinity in DFT and feed system
2. 1034 kPa (150 lb/in) steam system salted from desuperheater feedwater spray
3. Reduced boiler firing rate required to prevent priming and carry over

4. Overheating of boiler tube metal surfaces, which can result in tube failure
5. Rapid clogging (scaling) of boiler tubes
6. Loss of boiler until retubing has been accomplished

079-46.6.9 MAIN FEED BOOSTER PUMP (MOTOR-DRIVEN) CASUALTIES. The motor driven main feed booster pump is subject to four different types of casualties, each caused by differing conditions and each requiring differing remedial action. The types of casualties and remedial action are described in the following paragraphs.

079-46.6.9.1 Pump Fails to Deliver Normal Discharge Pressure. When this casualty occurs it is because the pump loses suction or internal pump problems exist. Action to be taken in this casualty is to open vent line valve and ensure that DFT has normal water level. In addition, start standby pump. Stop and investigate affected pump.

079-46.6.9.2 Pump Stops Rotating. When this casualty occurs, it is caused by electrical failure or internal pump problems.

079-46.6.9.2.1 To remedy this casualty ensure that vent line valve is open and that DFT has normal water level. Start standby pump, then stop and investigate affected pump.

079-46.6.9.3 Pump Fails to Start from Standby Status. This casualty occurs when the cut-in switch fails. To remedy the condition, manually start pump. Ensure actuating line valves are open.

079-46.6.9.4 Unusual Noise or Vibration. Three conditions can cause unusual noise or vibration in this booster pump:

1. Water flashing into vapor in pump
2. Internal pump or motor problems
3. Misalignment of unit

079-46.6.9.4.1 The following steps shall be taken to eliminate these problems:

1. Ensure vent line valve is open.
2. Ensure proper shell pressure and normal water level within deaerating feed tank.
3. Start standby pump.
4. Stop and investigate affected pump.

079-46.6.10 MAIN FEED BOOSTER OR MAIN FEED PUMP (TURBINE-DRIVEN) CASUALTIES. Like the motor-driven main feed booster pump, a number of casualties can occur to the turbine-driven feed or feed booster pump. Methods of dealing with these problems are described in the following paragraphs.

079-46.6.10.1 Pump Fails to Deliver Normal Discharge Pressure. This casualty is caused by the following:

1. Turbine not up to speed
2. Speed limiting governor malfunction
3. Pump losing suction
4. Internal pump problems

079-46.6.10.1.1 Actions to be taken to remedy the casualty are as follows:

1. Open steam supply and throttle valve.
2. Start standby pump.
3. Stop and investigate affected pump.
4. Open vent line valve.
5. Ensure DFT has normal water level.

079-46.6.10.2 Pump Stops Rotating. Causes are as follows:

1. Loss of steam pressure
2. Internal pump turbine problems

079-46.6.10.2.1 Actions to be taken are as follows:

1. Start standby pump.
2. Restore steam pressure.
3. Start standby pump.
4. Stop pump and investigate affected pump.

079-46.6.10.3 Unusual Noise or Vibration. These casualties are caused by the following:

1. Internal pump/turbine problems
2. Water flashing into vapor in pump
3. Misalignment of unit

079-46.6.10.3.1 Actions to be taken are as follows:

1. Start standby pump.
2. Stop and investigate affected pump.
3. Ensure vent line valve is open.
4. Ensure proper shell pressure and normal water level within deaerating feed tank.
5. Start standby pump.

6. Stop and investigate affected pump.

079-46.6.10.4 Water in Lube Oil. This casualty is caused by the following:

1. Excessive condensation in gear case
2. Excessive carbon packing clearance
3. Leaking tube or tube sheet of lube oil cooler

079-46.6.10.4.1 Actions to be taken are as follows:

1. Start standby pump.
2. Stop affected pump, investigate, and change oil.

079-46.6.10.5 Loss of Lube Oil Pressure. This casualty is caused by the following:

1. Low lube oil in pump
2. Leaking seals, gasket, or piping
3. Shaft driven lube oil pump malfunction

079-46.6.10.5.1 Actions to be taken are as follows:

1. Restore oil level to high mark on dipstick.
2. Start standby pump.
3. Stop and investigate affected pump.

079-46.6.10.6 Excessive Lube Oil Temperature. This problem is caused by the following:

1. Insufficient cooling water to cooler
2. Obstructed cooler tubes
3. Bearing problems
4. Insufficient lube oil pressure

079-46.6.10.6.1 Actions to be taken are as follows:

1. Increase cooling water flow through cooler; vent cooler header and ensure proper alignment of cooling system.
2. Start standby pump; stop and investigate affected pump.
3. Start standby pump; slow affected pump until temperature drops, then stop pump and investigate.

079-46.6.11 OIL IN LUBE OIL HEATER DRAIN INSPECTION TANK. This equipment is subject to the presence of oil in the lube heater drain inspection tank.

079-46.6.11.1 Causes. This casualty is caused by the following:

1. Leakage of lube oil from oil side to steam side of lube oil purifier heater
2. Leakage of lube oil from oil side to steam side of lube oil heating coils in lube oil settling/storage tank

079-46.6.11.2 Remedial Action. Remedial actions are as follows:

1. Notify and keep Main Engine Control informed of situation.
2. Shut inspection tank discharge valve to DFT/fresh water drain main.
3. Open inspection tank drain valve to bilge/contaminated oil tank.
4. Isolate lube oil purifier heater/heating coils and determine cause of casualty.

079-46.6.11.3 Possible Additional Casualties. Possible additional casualties that can occur are as follows:

1. Contaminated drains
2. Lube oil in DFT/fresh water drain tank
3. Lube oil in feed system and boilers
4. Lube oil in feed bottom

079-46.7 BOILER CASUALTIES

NOTE

During single boiler (per fireroom or machinery space) operations, when a casualty requires securing the boiler front fuel oil system, crack open the fuel oil recirculating valve after shutting the fuel oil quick closing valve.

079-46.7.1 HIGH WATER IN BOILER. This casualty is discussed in detail in the following paragraphs.

079-46.7.1.1 Symptoms. High water in the boiler can be recognized by the following symptoms:

1. Boiler is priming.
2. Water level is above maximum desired level (or out of sight in boiler water gauge glass).
3. Sudden decrease in automatic feedwater control signal.
4. Remote water level indicator alarm sounds.
5. Decrease in superheater outlet temperature indicated.

6. Rumbling sound and vibration occurs in steam piping.
7. Steam leak(s) at flanges, packing glands, and turbine control valves.
8. Intermittent slowing down of turbine-driven equipment occurs.

CAUTION

For this casualty, the Commanding Officer must establish ship's policy regarding the Engineering Officer of the Watch (EOOW) automatically shutting main engine throttle valve to reduce main engine damage from slugs of water. If the EOOW must request permission to stop the affected main engine, the delay could allow turbine damage. Ship's position could be critical, as when alongside another ship, and must be considered in establishing policy.

079-46.7.1.2 Causes. Causes of this casualty could be the following:

1. Failure of automatic feedwater control
2. Inattention of personnel

CAUTION

Following a high water casualty, astern throttle shall be opened first to drain water from the steam line before turbine is returned to service. Damage may have occurred by water carryover. Note any unusual noise when placing main engine back in operation. Priming results in slugs of water entering the turbine, and could cause failure of thrust bearings of main engine, turbogenerator(s), or feed pumps.

079-46.7.1.3 Remedial Actions. When casualty occurs perform the following:

1. Notify and keep Main Engine Control informed of situation. Main Engine Control will notify Bridge, giving maximum speed available, action being taken to correct situation, and estimated time necessary to make repairs.
2. Secure boiler as follows:
    a. Shut boiler feed control valve.
    b. Trip boiler fuel oil supply quick-closing valve.
    c. Shift combustion and feedwater control to remote manual.
    d. Shut boiler feed stop-check valve.
    e. Surface-blow affected boiler.
    f. Shut boiler main and auxiliary steam stop valves.
    g. Open and adjust superheater protection bleeder valve to maintain minimum flow through superheater (uncontrollable superheater boilers only) until steam drum pressure is 1380 to 2070 kPa (200 to 300 lb/in) below operating pressure.

h. Shut bleeder valve.

i. Shut applicable fuel oil system valves:

(1) Shut all burner safety shut-off devices or burner needle valves.

(2) Shut all burner supply and return root valves, including steam atomization root valves.

(3) Shut fuel oil quick-closing valve and manual shut off valves to all burner stages (pressure fired).

(4) Remove all atomizers from burners.

(5) Stop fuel oil service pump (when one boiler per space operating or pump only supplying affected boiler).

j. Shut condensate inlet valve to DFT when one boiler per group operating.

k. Shut all air registers.

l. Stop forced draft blowers(s).

m. Crack open superheater header drain valves to bilge.

n. Shut superheater header drain valves when all condensate is expelled.

o. Open main and auxiliary steam line drain valves.

3. Shut main engine throttle valves, trip turbogenerator and feed pumps (superheated steam only):

a. Open main engine turbogenerator, and feed pumps turbine casing drains.

b. Open auxiliary turbine casing drains.

c. Open main steam line drains.

4. Cross-connect auxiliary steam immediately, when boiler is reported off the line.

5. Cross-connect main steam after drains are reported clear.

6. Shift and inspect main engine lube oil strainers.

7. Shift and inspect ship's service turbogenerator lube oil strainers.

8. Observe and record main engine rotor thrust position.

9. Observe and record ship's service turbogenerator rotor thrust position.

10. Chemically test water for chloride content.

11. Light-off and bring boiler on the line using Engineering Operating Procedures.

079-46.7.1.4 Possible Additional Casualties. Possible additional casualties are as follows:

1. Water carryover into main steam lines resulting in stopping of main engine, affected turbogenerator(s), and main feed pumps
2. Loss of boiler
3. Damage to turbine thrust bearing or blading
4. Blown steam line gaskets, valves, seal rings, and packing
5. Loss of main feed pumps
6. Contamination of boiler superheater

079-46.7.2 LOW WATER IN BOILER. This casualty, its causes and symptoms, remedial actions to be taken, and possible additional casualties which may result from it are discussed in the following paragraphs.

079-46.7.2.1 Symptoms. Low water in boiler can be recognized by the symptoms listed:

1. Sudden increase shown in automatic feedwater control signal.
2. Sudden increase shown in automatic combustion control signal.
3. Remote water level indicator alarm sounds.
4. Unusual drop in steam pressure occurs.
5. Water drops out of sight in boiler water gauge glass(es).

079-46.7.2.2 Causes. Causes of low water are as follows:

1. Failure of automatic feedwater control
2. Loss of main feed pressure
3. Inattention of personnel
4. Failure of main feed booster, main feed pump, or both
5. Low water in DFT
6. Ruptured DFT or feed piping

CAUTION

In the event of low water, it is essential that no attempt be made to restore normal water level.

079-46.7.2.3 Remedial Actions. Actions to be taken to remedy casualty is as follows:

1. Notify and keep Main Engine Control informed of situation.

CAUTION

When boiler is secured due to low water, boiler shall be allowed to cool slowly (see NSTM Chapter 221, Boilers). When boiler is secured due to low water, do not open superheater protection bleeder.

2. Secure boiler:
   a. Trip boiler fuel oil supply quick-closing valve.
   b. Shift combustion and feedwater control to remote manual.
   c. Shut boiler main steam stop valve.
   d. Shut boiler auxiliary steam stop valve.
   e. Lift safety valve using hand easing gear until pressure is 1380 to 2070 kPa (200 to 300 lb/in) below operating pressure.
   f. Shut applicable fuel oil system valves.
      (1) Shut all burner safety shut-off devices or burner needle valves.

(2) Shut all burner supply and return root valves, including steam atomization root valves.
(3) Shut fuel oil quick-closing valve and manual shut-off valves to all burner stages (pressure fired).
(4) Remove all atomizers from burners.

g. Shut boiler feed control valve.
h. Shut boiler feed stop-check valve to fuel oil service pump when steaming one boiler per group.
i. Trip stream quick-closing valve to fuel oil service pump when steaming one boiler per group.
j. Shut condensate inlet valve to DFT when one boiler per group operating.
k. Shut all air registers.
l. Stop forced draft blower(s).
m. Shut feedwater line stop valve.
n. Stop auxiliary machinery as required (when one boiler per group operating).
   (1) Stop fuel oil service pump.
   (2) Stop main feed booster pump and main feed pump.

3. Secure DFT as required.

079-46.7.2.3.1 Main Engine Control will perform the following:

1. Notify Bridge of casualty.
2. Report maximum speed available.
3. Notify Bridge of casualty cause, action being taken, and estimated time needed to make repairs.
4. Order plant cross-connected as required.
5. Order turbogenerators tripped as required.

079-46.7.2.4 Possible Additional Casualties. Possible additional casualties which may result from low water in the boiler are as follows:

1. Loss of boiler:
   a. Distortion of boiler heating surface
   b. Serious steam or water leaks
   c. Ruptured boiler tube
   d. Destruction of brickwork
   e. Warping of boiler casings
   f. Loss of steam pressure

079-46.7.3 RUPTURED BOILER TUBE. This casualty is discussed in the following paragraphs.

079-46.7.3.1 Symptoms. A ruptured boiler tube produces the following symptoms:

1. Unusual drop in steam pressure occurs.
2. Firebox fills with steam.

3. Difficulty in maintaining water level occurs.
4. Sudden increase in automatic feedwater or combustion control signal.

079-46.7.3.2 Causes. Boiler tube rupture results from the following causes:

1. Low water in boiler
2. Excessive erosion of tubes
3. Fouled watersides
4. Fouled firesides/excessive corrosion
5. Excessive rate or steam generating/over-firing

079-46.7.3.3 Remedial Actions. Take the following remedial actions when a boiler tube ruptures:

1. Notify and keep Main Engine Control informed of situation.
2. Secure boiler.
   a. Shift feedwater control to remote manual.
   b. Trip boiler fuel oil supply quick-closing valve.
   c. Shut boiler main steam stop valve.
   d. Shut boiler auxiliary steam stop valve.
   e. Shut applicable fuel oil system valves:
      (1) Shut all burner safety shut-off devices or burner needle valves.
      (2) Shut all burner supply and return root valves, including steam atomization root valves.
      (3) Shut fuel quick-closing valve and manual shut-off valves to all burner stages (pressure fired).
      (4) (Remove all atomizers from burners, if conditions permit.
      (5) Lift safety valves using hand easing gear until all pressure is removed from the boiler.
   f. Continue to feed boiler, if possible, in order to maintain water level until boiler has cooled (except when failure was caused by low water or large leak).
   g. Trip steam quick-closing valve to fuel oil service pump (when one boiler per group operating).
   h. Shut condensate inlet valve to DFT (when one boiler per group operating).
   i. Open all air registers.
   j. Shut boiler feed control valve when boiler has cooled or steam drum water level has dropped below minimum level.
   k. Shut boiler feed stop-check valve.
   l. Shut boiler feedline stop valve.
   m. Shift combustion control to remote manual and decrease signal to minimum.
   n. Stop operating auxiliary machinery, as required:
      (1) Stop forced draft blower(s).
      (2) Stop fuel oil service pump.
      (3) Stop main feed and main feed booster pumps.
   o. Shut superheater header drain valves to high pressure drain main.

CAUTION

Secure all air to boiler as soon as pressure has decreased and steam does not escape into space. Allow boiler to cool slowly (see NSTM Chapter 221).

079-46.7.3.3.1 Main Engine Control will perform the following:

1. Notify Bridge and report maximum speed available.
2. Notify Bridge of casualty cause, action being taken, and estimated time required to make repairs.
3. Order plant cross-connected, as required.
4. Order turbogenerators tripped, as required.

079-46.7.3.4 Possible Additional Casualties. Other casualties resulting from ruptured boiler tubes are listed below:

1. Personnel injuries
2. Loss of steam pressure
3. Loss of boiler

079-46.7.4 FUEL OIL SUCTION LOSS. Fuel oil suction loss is discussed in detail in the following paragraphs.

079-46.7.4.1 Symptoms. Loss of fuel oil suction will be indicated by:

1. Fires are sputtering excessively.
2. Fuel oil pressure drops rapidly.
3. Fires die out.
4. Fuel oil service pump loses suction and increases in speed.
5. Unusual noise in fuel oil service pump.
6. Fuel oil pump discharge pressure is below normal.
7. Rapid drop in steam pressure occurs.
8. Sudden increase in automatic combustion control signal.

079-46.7.4.2 Causes. Fuel oil suction loss results from the following causes:

1. Low or empty fuel oil service tank
2. Clogged fuel oil service pump suction lines
3. Clogged fuel oil strainer
4. Loss of fuel oil service pump

5. Ruptured fuel oil service piping
6. Major fuel oil leak in burner supply line
7. Water in fuel oil

079-46.7.4.3 Remedial Actions. When suction is lost, the following actions shall be taken:

1. Trip fuel oil quick-closing valve.
2. Shut applicable fuel oil system valves.
   a. Shut all burner safety-shutoff devices or burner needle valves.
   b. Shut all burner supply and return root valves, including steam atomization root valves.
   c. Shut fuel oil quick closing valves and manual shut-off valves to all burner stages (pressure fired).
   d. Remove all atomizers from burners.
3. Shift combustion and feedwater control to remote manual (if installed).
4. Notify and keep Main Engine Control informed of situation.
5. Trip steam quick-closing valve to fuel oil service pump (when operating one boiler per group).
6. Shut all air registers.
7. Stop forced draft blowers.
8. Maintain water level.
9. Shut main and auxiliary steam valves.
10. Open and adjust superheater protection bleeder valve to maintain minimum flow through superheater (uncontrollable superheater boilers only) until steam drum pressure is 1380 to 2070 kPa (200 to 300 lb/in) below operating pressure, then shut bleeder valve.
11. Inspect furnace floor for accumulation of unburned fuel; report results to EOOW.

NOTE

If affected space is steaming only one boiler, upon shutting main and auxiliary steam stop valves, Main Engine Control may order plant cross-connected, as required.

12. Light off boiler using Engineering Operational Procedures when suction is regained, and cause of casualty determined and corrected.

079-46.7.4.3.1 After notification of casualty, Main Engine Control will perform the following:

1. Notify Bridge and report maximum speed available.
2. Notify Damage Control Central if oil leak is cause.
3. Notify Bridge of casualty cause, action being taken, and estimated time needed to make repairs.
4. Order plant cross-connected, as required.
5. Order turbogenerators tripped, as required.

079-46.7.4.4 Possible Additional Casualty. A class BRAVO fire may result from loss of fuel oil suction.

079-46.7.5 FUEL OIL SERVICE PUMP FAILURE. Casualty resulting from fuel oil service pump failure is discussed in detail in the following paragraphs.

079-46.7.5.1 Symptoms. Failure of fuel oil service pump produces the following symptoms:

1. Burner sputters, fires are extinguished.
2. Service pump discharge pressure indicates low.
3. Service pump discharge pressure indicates zero.
4. Loss of steam pressure

079-46.7.5.2 Causes. Fuel oil service pump failure is caused by the following:

1. Momentary or continued loss of suction
2. Improper pump priming
3. Mechanical failure in pump or piping systems
4. Loss of steam or electric power to prime mover

079-46.7.5.3 Remedial Actions. When fuel oil service pump fails, initiate the following procedures:

1. Trip boiler fuel oil quick-closing valve.
2. Shut applicable fuel oil system valves:
   a. Shut all burner safety-shutoff devices or burner needle valves.
   b. Shut all burner supply and return root valves, including steam atomization root valves.
   c. Shut fuel oil quick closing valves and manual shut-off valves to all burner stages (pressure-fired).
   d. Remove all atomizers from burners.
3. Shift combustion and feedwater control to remote manual (if installed).
4. Notify and keep Main Engine Control informed of situation.
5. Trip steam quick-closing valve to fuel oil service pump (when one boiler per group operating).
6. Shut all air registers.
7. Stop forced draft blowers.
8. Maintain water level.
9. Shut main and auxiliary steam stop valves.
10. Open and adjust superheater protection bleeder valve to maintain minimum flow through superheater (uncontrollable superheater boilers only) until steam drum pressure is 1380 to 2070 kPa (200 to 300 lb/in) below operating pressure, then shut bleeder valve.

NOTE

If affected space is steaming only one boiler, upon shutting main and auxiliary steam stop valves Main Engine Control may order plant cross-connected, as required.

11. Light off boiler using**Engineering Operational Procedures** when suction is regained, and cause of casualty determined and corrected.

079-46.7.5.3.1 After notification of casualty, Main Engine Control will perform the following:

1. Notify Bridge of casualty and report maximum speed available.
2. Notify Bridge of casualty cause, action being taken, and estimated time needed to make repairs.
3. Order plant cross-connected, as required.
4. Order turbogenerators tripped, as required.

079-46.7.5.4 Possible Additional Casualties. Possible additional casualties are as follows:

1. Loss of boiler fires
2. Loss of steam pressure

079-46.7.6 MAJOR FUEL OIL LEAK. This casualty, its symptoms and causes, remedial actions, and possible additional casualties which may result from it are discussed in the following paragraphs.

079-46.7.6.1 Symptoms. A major fuel oil leak produces the following symptoms:

1. Massive oil spillage on decks:
   a. Through bulkheads,
   b. From piping,
   c. From fittings, and
   d. From other components of fuel oil system.
2. Severe drop or total loss of fuel oil pressure is indicated.
3. Furnace fires are extinguished.
4. Fuel oil service pump races.
5. Sudden increase in combustion control signal occurs.

079-46.7.6.2 Causes. A major fuel leak results from the following causes:

1. Ruptured fuel oil burner supply line
2. Deteriorated piping or gaskets
3. Shock, vibration, or both

4. Excessive system pressure
5. Battle or standing damage
6. Collision

079-46.7.6.3 Remedial Actions. When a major fuel oil leak occurs, proceed as follows:

1. Report the leak to Space Supervisor or Main Engine Control.
2. Man the machinery space foam proportioning station.
3. Secure the oil source.
   a. Trip fuel oil supply quick-closing valves.
   b. Shut applicable fuel oil system valves.
      (1) Shut all burner safety shut-off devices or burner needle valves.
      (2) Shut all burner supply and return root valves including steam atomization root valves.
      (3) Shut fuel oil quick-closing valves and manual shut-off valves to all burner stages (pressure-fired).
      (4) Remove all atomizers from burners.
   c. Use any means available, such as a rag or bucket, to reduce the flow of oil and deflect it away from hot surfaces.
4. Keep Main Engine Control informed of situation.
5. Call away firefighting parties and break out firefighting equipment. Stand by to flush down gross spillage or combat fires as necessary.
6. Trip steam quick-closing valve to fuel oil service pump.
7. Shift combustion and feedwater controls to remote manual (if installed).
8. Shut boiler main and auxiliary steam stop valves.
9. Open and adjust superheater protection bleeder valve to maintain minimum flow through superheater (uncontrollable superheater boilers only) until steam drum pressure is 1380 to 2070 kPa (200 to 300 lb/in) below operating pressure, then shut bleeder valve.
10. Shut all air registers.
11. Shut condensate inlet valve to DFT.
12. Stop forced draft blowers.
13. Shut feed water stop check valve.
14. Stop main feed and main feed booster pumps.
15. Activate the Twin Agent Fire Extinguishing System (TAFES) and use Aqueous Film Forming Foam (AFFF) to remove oil accumulation on deckplates or bulkheads, and wash oil into the bilge. Water may also be used. Rags that have been used for cleanup shall be placed in a suitable container. Discharge AFFF into the bilge to cover liquid surfaces and prevent ignition of the oil.
16. As time and personnel permit, the following concurrent actions should be accomplished:
   a. Secure operating machinery as necessary in the vicinity of the leak to control the casualty. Start or maintain equipment in unaffected spaces to maintain propulsion, electric power and firemain pressure.
   b. Activate AFFF bilge sprinkling, if installed, for one minute to ensure all bilge surfaces are vapor secured.

17. Pump bilge to the oily waste holding tank or overboard as conditions permit, observing the latest environmental control directives.

079-46.7.6.3.1 When notified of casualty, Main Engine Control will perform the following:

1. Notify Bridge; report maximum speed available.
2. Notify Bridge of casualty cause, extent of damage, and estimated time needed to make repairs.
3. Order plant cross-connected, as required.
4. Order turbogenerators tripped, as required.

079-46.7.6.4 Possible Additional Casualties. The following possible additional casualties may result from fuel oil leakage:

1. Loss of boiler and steam pressure
2. Loss of fuel oil pressure
3. Class BRAVO fire

079-46.7.7 WATER IN FUEL OIL. Casualties resulting from water in fuel oil and their treatment are discussed in the following paragraphs.

079-46.7.7.1 Symptoms. Water in fuel oil will be readily recognized by:

1. Burners sputter or are extinguished.
2. Fuel oil service pump races or noise level rises.
3. Excessive accumulation of slag on firesides occurs.
4. Fuel oil service pump discharge pressure is below normal.
5. Minor explosions occur in firebox.
6. Excessive panting of boiler.

079-46.7.7.2 Causes. This casualty could be a result of the following:

1. Presence of water in delivered oil
2. Improper stripping or testing of oil prior to use
3. Underwater hull damage causing leak in fuel oil tank
4. Ruptured water line in fuel oil tank
5. Improperly installed manhole covers/plates
6. Missing fuel oil cover plugs
7. Adverse weather conditions, allowing water to enter through improperly mounted or missing flash screens and vents

079-46.7.7.3 Remedial Actions. The following procedures shall be initiated to remedy water in fuel oil.

1. Trip fuel oil supply quick-closing valves.
2. Notify and keep Main Engine Control informed of situation.
3. Shift combustion and feedwater control to remote manual (if installed).
4. Shut applicable fuel oil system valves:
   a. Shut all burner safety-shutoff devices or burner needle valves.
   b. Shut all burner supply and return root valves, including steam atomization root valves.
   c. Shut fuel oil quick closing valves and manual shut-off valves to all burner stages (pressure-fired).
   d. Remove all atomizers from burners.
   e. Stop fuel oil service pump.
5. Shut all air registers.
6. Maintain normal steam drum water level.
7. Shut boiler main and auxiliary steam stop valves.
8. Shut condensate inlet valve to affected DFT.
9. Open and adjust superheater protection bleeder valve, to maintain minimum flow through superheater (uncontrollable superheater boilers only) until steam drum pressure is 1380 to 2070 kPa (200 to 300 lb/in) below operating pressure, then shut bleeder valve.
10. Continue operation of blowers maintaining approximately 0.5 kPa (2 inches of water) of air pressure within the air casing.
11. Inspect furnace floor for any accumulation of unburned fuel, and report results to EOOW.
12. Position three-way valve to contaminated oil tank.
13. Start standby service pump with suction on standby service tank.
14. Make a thorough inspection to determine source of contamination.
15. Make necessary repairs.

079-46.7.7.3.1 After being notified of water in fuel oil casualty, Main Engine Control will perform the following:

1. Notify Bridge of casualty.
2. Report maximum speed available.
3. Notify Bridge of casualty cause, action being taken, and estimated time needed to make repairs.
4. Order plant cross-connected, as required.
5. Order turbogenerators tripped as required.

079-46.7.7.4 Possible Additional Casualties. Possible additional casualties are as follows:

1. Deterioration of boiler refractories

2. Excessive build-up slag on firesides
3. Loss of boiler

079-46.7.8 RESIDUAL FIRES. Residual fires are not casualties. They may occur when securing burners according to casualty control procedures or as a result of mechanical problems in the fuel oil service system, specifically leaking through of valves in the fuel oil service system, specifically leaking through of valves in the burner supply system. A residual fire is defined as the presence of fire at the burner tips or on the firebox deck that is caused by fuel leaking into the boiler after burner safety shutoff devices and manifold valves have been secured. When residual fires are present take the following action:

1. Ensure that burner safety shut-off devices and manifold valves have been secured and the recirculating valve is open.
2. Leave a lower air register open to allow fires to burn out.
3. Remove the atomizers from the boiler. Snuff out any flame at the burner tip before draining oil from atomizers.
4. Visually verify when the residual fire goes out.
5. Inspect the furnace using the BID for any accumulation of unburned fuel.
6. If residual fires are not the result of the securing procedures, effect repairs before relighting fires.

079-46.7.9 FUEL ACCUMULATION IN FURNACE. Apply the following procedures when fuel has accumulated in the furnace of a hot or cold boiler.

1. When the fuel accumulated in the furnace burns while the burners are lighted, the following procedures apply:
   a. Reduce the boiler firing rate.
   b. Secure all but one lower burner and allow the accumulated fuel to burn out.
   c. Determine the cause of fuel accumulation, correct, and fire the boiler as necessary.
2. When accumulated fuel continues to burn after burners have been secured, the following procedures apply:
   a. Open 1 lower air register to admit combustion air. (Open all air registers on CE V2M-8 top-fired boilers).
   b. Stop forced-draft blowers.
   c. Allow the fire to burn itself out.
   d. Inspect the furnace for evidence of unburned fuel.
3. When an accumulation of fuel does not continue to burn in the furnace of a hot boiler after the burners are secured, the following procedures apply:
   a. Do not admit air to the furnace.
   b. Stop forced-draft blowers.
   c. Close all air registers tightly.
   d. Activate the boiler air casing steam smothering system. For V2M-8 (top-fired) boilers the steam smothering system will not effectively fill the furnace and uptakes. On these boilers secure fuel to the burners, but do not secure atomizing steam to the burners. Continue to admit atomizing steam for 30 minutes. After 30 minutes secure atomizing steam and purge the furnace.

079-46.7.10 BOILER FURNACE EXPLOSIONS. Boiler furnace explosion, its description, causes, and remedial actions are discussed in the following paragraphs.

079-46.7.10.1 Description. A boiler furnace explosion is the uncontrolled ignition of fuel/air combustible mixtures within the boiler furnace. This type of ignition is different from the ignition of proper the fuel/air mixture which takes place at the burner atomizer tip. An explosion in the boiler furnace consists of a detonation caused by an accelerating flame propagation front that reaches sonic velocities. The detonation exceeds the yield strength of the boiler furnace, casing, and uptake, and the boiler is structurally damaged. The following symptoms are indications of a possible boiler furnace explosion:

1. Unusual noise while attempting to light fires
2. Sudden increase in fire room pressure
3. Sudden expansion and contraction of boiler outer casing

079-46.7.10.2 Causes. Causes of boiler furnace explosions are listed as follows:

1. Improper balance of fuel and air at atomizer
2. Accumulation of unburned fuel in boiler furnace caused by the following:
   a. Failure to promptly secure fuel supply to atomizers when fires are extinguished
   b. Improperly assembled atomizer
   c. Wet atomizing steam
   d. Leakage of burner valves
   e. Failure to establish burner light off correctly including proper use of torch or ignitor
   f. Repeated unsuccessful burner light off attempts
   g. Failure to open air register after burner ignition
   h. Water in fuel
3. Failure to purge furnace properly
   a. Accumulation of combustible gases in furnace, boiler, and uptake area
   b. Inadequate capacity of or total lack of light off blower
4. Economizer gas side restrictions due to inadequate soot blowing

079-46.7.10.3 Remedial Actions. Proceed as follows after a furnace explosion.

1. Trip boiler fuel oil system quick-closing valve (if equipped, trip the steam quick-closing valve to the fuel oil service pump).
2. Secure applicable burner fuel oil system valves:
   a. Shut all burner atomizer safety-shut-off devices of atomizer connection needle valves.
   b. Shut all burner supply and return root valves and steam atomization root valves.
   c. Shut fuel oil quick closing valves and manual shut-off valves to all burner atomizer stages (pressure fired).
   d. Remove all atomizers from burners.
3. Stop fuel oil service pump.

4. Shift combustion and feedwater controls to remote manual (if installed).
5. Notify and keep Main Engine Control informed of situation.
6. Maintain normal steam drum water level (not always possible).
7. Open all air registers, unless casing fire is present.
8. If casing fire is present, shut all air registers and open steam smothering valve to boiler casing. Do not open steam smothering valve if casing is ruptured.
9. Secure boiler:
   a. Shut main and auxiliary steam stops.
   b. Open superheater bleeder.
10. Cool air casing by using a low velocity fog.
11. Secure main feed and booster pumps.
12. Employ firefighting procedures as necessary (see **NSTM Chapter 555, Volume 1, Surface Ship Firefighting** , Section 6).

079-46.7.10.3.1 After being notified of boiler furnace explosion Main Engine Control will perform the following:

1. Notify Bridge of casualty.
2. Report maximum speed available.
3. Keep Bridge informed of action being taken, and estimated time to make repairs.
4. Order plant cross-connected, as required.
5. Order turbogenerators tripped, as required.

079-46.7.11 BOILER AIR CASING EXPLOSION. An air casing explosion is to be considered and treated in the same manner as a boiler furnace explosion. A casing explosion can be caused by fuel dribbling back from the atomizer tip along atomizer barrel into the area between casings at the burner front.

079-46.7.12 BOILER UPTAKE EXPLOSION. An uptake explosion is to be considered and treated in the same manner as a boiler furnace explosion.

079-46.7.13 FLAREBACK. Flareback, its description, causes, and recommended follow-up procedure are discussed in the following paragraphs. Flareback, as compared to boiler furnace explosion, for casualty purposes, is considered as occurring only during boiler initial burner light-off.

079-46.7.13.1 Description. Flareback is the extremely rapid, volatile ignition or detonation of fuel and air mixture at the burner atomizer tip. This is followed by the rapid extinguishing of the atomizer fire and a rush of furnace gas and flame back through the burner air register and light-off port (if in use). Physical damage to the boiler and associated equipment does not occur. However, a careful inspection by experienced personnel should be conducted to determine boiler integrity and whether there was a flareback or a boiler furnace explosion. With any noted damage to the boiler, it should be considered that a furnace explosion has taken place and the casualty should be treated as such.

079-46.7.13.2 Causes. Flarebacks are caused by the following:

1. Improper balance of fuel and air at atomizer
2. Accumulation of unburned fuel in furnace
3. Failure to purge furnace properly

079-46.7.13.3 Follow-up Procedure. Following flareback in the boiler burner light-off procedure, proceed as follows:

1. Remove light-off torch or secure igniter.
2. Trip boiler fuel oil system quick-closing valve.
3. Secure burner atomizer safety-shut-off device or atomizer connection needle valve and simultaneously secure burner lead root valve(s).
4. Stop fuel oil service pump.
5. Notify and keep Main Engine Control informed of situation.
6. Remove atomizer from light-off burner.
7. Open registers of all burners.
8. Ascertain that furnace has not accumulated any unburned fuel oil. Presence of visible oil vapors and either white or black smoke is a sign of unburned fuel. Burner atomizer light-off shall not be conducted with accumulated fuel oil in furnace.

CAUTION

If a significant accumulation of fuel burning on the furnace floor is noted, no attempt should be made to extinguish the fire by using steam atomization or increasing the wind box draft. If accumulated fuel has spilled over into the air, casing steam smothering should be employed. Forced draft blowers should be adjusted to minimum until all accumulated fuel has burned off the firebox floor. The possibility of excessive soot formations on the generating bank and economizer tubes exists. Use of soot blowers prior to complete combustion of accumulated fuel could result in secondary combustion or an explosion in the economizer or uptake area.

9. Purge furnace at maximum available draft for 10 minutes. This time duration is based on the assumption that no emergency time factor exists for lighting off the boiler and that some ships have limited capacity or no lighting-off blower. For emergency situations, consult boiler front Furnace Purge Time plates and **NSTM Chapter 221.**
10. During purge procedure, reexamine boiler for integrity and note casing air leakage. Check light-off atomizer for proper assembly.
11. Prepare boiler for light-off.
12. Light off burner atomizer in accordance with applicable boiler technical manual detail instructions.

079-46.7.13.4 Possible Additional Casualties. Possible additional casualties due to flareback include:

1. Personnel burn injuries
2. Class BRAVO fire outside of boiler

NOTE

The following procedures do not apply to pressure-fired boilers.

079-46.7.14 WHITE SMOKE. A potentially explosive situation exists when white smoke occurs. White smoke is actually unburned fuel in the form of a mist. Therefore, correct a white smoke condition as soon as possible, particularly under cold boiler conditions. Adjust forced draft blower speed/vane position. Take care to ensure that water vapor is not mistaken for white smoke. Symptoms, causes, remedial actions, immediate actions, and possible additional casualties are discussed in the following paragraphs.

WARNING

Do not adjust the fuel oil header pressure in an attempt to correct a white smoke condition.

079-46.7.14.1 Symptoms. White smoke can be recognized by the following indications:

1. Periscope is indicating white smoke; for example, red/orange color or completely dark.
2. Photoelectric smoke indicators (if installed) indicate white smoke.
3. Sputtering, unusual, or erratic flame pattern occurs.
4. Topside observer reports white smoke.

079-46.7.14.2 Causes. This casualty could result from one or more of the following:

1. Excess air
2. Misadjusted fuel/air ratio relay
3. Malfunctioning fuel oil control valve
4. Malfunctioning Automatic Combustion Control (ACC) system
5. Improper atomization

WARNING

If unable to correct the white smoke condition within one minute of its detection, or if unsure of when white smoke started, proceed to immediate actions.

NOTE

This presupposes that the commencement time of white smoke is known. The one minute maximum is based on limited data from previous explosion accounts and the necessity to avoid overreaction to false white smoke reports. Good judgment, however, calls for securing the boiler immediately vice continuing attempts to correct the condition if any of the following conditions exist: (A) commencement time of white smoke is unknown; (B) white smoke is extremely heavy; (C) initial corrective action is not effective. Additionally, commanding officers might consider establishing a policy of immediate securing when white smoke is detected during inport steaming.

079-46.7.14.3 Remedial Actions. Proceed as follows to remedy white smoke casualty:

1. Shift fuel oil and forced draft blowers to remote manual control and reduce air flow to obtain a clear stack.
2. Check burner flame patterns. Secure burners showing evidence of improper combustion.

079-46.7.14.4 Immediate Actions. In addition, take the following steps:

1. Trip fuel oil quick-closing valve.
2. Notify and keep Main Engine Control informed of situation.
3. Stop main feed pump(s), turbine-driven main feed booster pump(s) and turbine-driven main condensate pump(s).
4. Stop fuel oil service pump(s).
5. Increase forced draft blower speed to remove smoke and vapor.
6. Shut burner fuel oil safety shutoff devices.
7. Crack open fuel oil supply manifold recirculating valve.
8. Shut burner fuel oil supply manifold and steam atomizing valves.
9. Visually verify that fires are secured.
10. Ensure all air registers are open.
11. Open and adjust superheater protection bleeder valve to maintain minimum flow through superheater (uncontrollable superheater boilers only) until steam drum pressure is 1380 to 2070 kPa (200 to 300 lb/in) below operating pressure, then shut bleeder valve.
12. Shut boiler main and auxiliary steam stop valves.
13. Remove atomizers from burners.

079-46.7.14.5 Possible Additional Casualties. The following possible additional casualties may result from white smoke:

1. Boiler furnace explosion
2. Boiler uptake explosion

3. Brickwork failure
4. Loss of boiler
5. Injury to operating personnel
6. Class Bravo fire

079-46.7.15 BRICKWORK FAILURE. Brickwork failure casualties, their symptoms, causes, and remedial actions are discussed in the following paragraphs.

079-46.7.15.1 Symptoms. Brickwork failure can be diagnosed by the following:

1. Hot spots found on boiler casing.
2. Visual inspection into boiler reveals damage.
3. Rumbling sound issues from firebox.

079-46.7.15.2 Causes. Brickwork failure may result from the following:

1. Flareback
2. Heavy shock
3. Improper installation
4. Deterioration of brickwork
5. Warped casing(s)
6. Firing rate too high during boiler light-off, causing thermal shock
7. Boiler cooling down too rapidly during securing, causing thermal shock
8. Improper boiler baking out or drying out after water washing

NOTE

Major brickwork failure is defined as defects in an area large enough to prevent noticeable cooling of the inner casing when burner or burners adjacent to the damaged area are secured.

CAUTION

In any brickwork failure, regardless of how minor, another boiler should be lit off immediately and the damaged boiler secured as soon as possible. When damage is major, secure the boiler immediately.

079-46.7.15.3 Remedial Actions. When brickwork failure occurs, proceed as follows:

1. Notify and keep Main Engine Control informed of the situation.
2. Secure burner(s) adjacent to damaged area.

3. Adjust firing rate to prevent overfiring boiler.
4. Secure boiler immediately in event of major brickwork failure.
5. Secure the boiler as soon as possible in the event of minor brickwork failure.

079-46.7.15.3.1 After being notified of the failure, Main Engine Control will perform the following:

1. Notify Bridge, report maximum speed available, and estimated time required to make adjustments or repairs.
2. Order plant cross-connected, as required.
3. Order turbogenerators tripped, as required.

079-46.7.15.4 Possible Additional Casualty. Loss of boiler while major repairs are made can occur with brickwork failure.

079-46.7.16 FORCED DRAFT BLOWER FAILURE. Forced draft blower failure is discussed in detail in the following paragraphs.

079-46.7.16.1 Symptoms. Forced draft blower failure is recognized by the following symptoms:

1. Excessive vibration of blower occurs.
2. Blower slows down or speeds up.
3. Smoke is indicated by smoke periscope/smoke indicator needle.
4. Drop in air casing pressure occurs.
5. Bearing is hot.
6. High lube oil temperature is indicated.

079-46.7.16.2 Causes. Forced draft blower failure results from:

1. Loose, broken, or missing foundation bolts
2. Speed-limiting governor failure
3. Damage to turbine, propeller, or bearings
4. Low or no lubricating oil
5. Dirty fan blades
6. Prime mover failure
7. Blocked or closed damper, shutter, or flaps
8. Ruptured lube oil line
9. Insufficient cooling water
10. Improper valve alignment
11. Bearing problems

079-46.7.16.3 Remedial Action. When forced draft blower failure occurs, the following actions shall be taken:

1. Notify and keep Main Engine Control informed of situation.
2. Increase speed on unaffected blower when two blowers are in use.
3. Secure burners at once to prevent flareback when only one blower is in use.
4. Start standby blower.
5. Secure affected blower and lock air shutters.
6. Tag blower which is out of commission, and investigate failure.

079-46.7.16.3.1 After being notified of failure, Main Engine Control will perform the following:

1. Notify Bridge and report maximum speed available.
2. Notify Damage Control Central if oil leak exists.
3. Order plant cross-connected, as required.

079-46.7.16.4 Possible Additional Casualties. Possible additional casualties are listed as follows:

1. Loss of boiler
2. Flareback
3. Fire due to ruptured lube oil line

079-46.7.17 BOILER AIR CASING FIRE. Fire in boiler air casing, along with causes and actions to be taken is discussed in the following paragraphs.

079-46.7.17.1 Symptoms. Fire in boiler air casing produces the following symptoms:

1. Presence of flame, smoke, or excessive heat noted on casing or deck.
2. Blistering of paint on outer casing occurs.
3. Visual inspection through burner and furnace sight glasses reveals fire in casing.

079-46.7.17.2 Causes. Fire in air casing may result from:

1. Accumulation of oil in air casing double front caused by the following:
    a. Partially plugged atomizers
    b. Leaking atomizers (when secured and not removed from furnace)
    c. Excessive deposits of carbon in registers or furnace throat rings
    d. Plugged drain holes or improperly adjusted atomizers
2. Flareback

079-46.7.17.3 Remedial Actions. When fire is discovered, proceed with the following:

1. Trip boiler fuel oil quick-closing valve.
2. Notify and keep Main Engine Control informed of situation.
3. Shut applicable fuel oil system valves:
   a. Shut all burner safety-shutoff devices or burner needle valves.
   b. Shut all burner supply and return root valves, including steam atomization root valves.
   c. Shut fuel oil quick closing valves and manual shut-off valves to all burner stages (pressure fired).
4. Stop fuel oil service pump.
5. Stop forced draft blower(s).
6. Shut all air registers.
7. Open casing steam smothering valve to affected boiler.
8. Staff firefighting equipment.
9. Maintain normal water level.
10. Close boiler main and auxiliary steam stops and open superheater bleeder.
11. When fire is out inspect for extent of damage and make necessary repairs.

WARNING

Ensure fire in boiler air casing is out before removing atomizers from burners.

12. Remove atomizers from burners.

079-46.7.17.3.1 After being notified of fire, Main Engine Control will proceed as follows:

1. Notify Bridge and report maximum speed available.
2. Notify Bridge of casualty cause, extent of damage, and estimated time needed to make repairs.
3. Order plant cross-connected, as required.
4. Order turbogenerators tripped, as required.

079-46.7.17.4 Possible Additional Casualties. Other casualties which may result from boiler air casing fire are as follows:

1. Personnel injury
2. Warped or burned casings
3. Distortion of air registers
4. Class BRAVO fire in space

5. Loss of steam pressure
6. Loss of boiler
7. Loss of space

079-46.7.18 CONTROL AIR PRESSURE LOSS. The ship's control air system is automatically augmented by a low pressure (LP) air compressor in the event that the control air system compressors fail. Ships without control air systems use LP air compressors to supply the control air. The LP air compressors are augmented by high pressure (HP) air compressors that supply control air via pressure reducing valves. On some ships, the amount of this reduction is automatic; on others it must be set manually. Symptoms, causes, remedial actions, and restoration of casualty are discussed in the following paragraphs.

NOTE

Training in the emergency procedure for shifting boiler combustion and feedwater control shall be conducted frequently.

079-46.7.18.1 Symptoms. Loss of air pressure will be recognized when following conditions occur:

1. Control air pressure alarm sounds.
2. Control air pressure drops below required pressure.
3. Auxiliary exhaust pressure rises as air-operated unloading valve to condenser closes (if installed).
4. Main feed pump(s) speeds up to governor setting; or main feed pump controls air lock as is (if installed).
5. Combustion and feedwater controls air lock as is (if installed).

079-46.7.18.2 Causes. Loss of control air pressure results from:

1. Low pressure/control air compressor or drive motor failure
2. Controller malfunction
3. Improper valve alignment
4. Fluctuation in electric power
5. Ruptured air lines

079-46.7.18.3 Remedial Actions. Remedial actions are discussed in the following paragraphs.

1. The EOOW shall make every effort to maintain present speed authorizing judicious throttle changes in order to maintain present steam drum pressure until boiler control has been regained or control air supply has been restored. Notify the Bridge of the casualty, reporting maximum speed available and speed change restrictions.

WARNING

The use of the throttle to maintain control of the boiler while shifting from an air lock condition to a manual control condition should be minimized, and the dynamic state of the engineering plant should be taken into account. Once manual control has been established, speed changes should be minimized until full automatic control has been reestablished.

2. When loss of control air alarm sounds and time permits:
   a. Inspect air compressor(s) and air augmenting station(s) for proper operation and alignment.
   b. Ensure vital air systems cross-connected.
   c. Ensure additional air compressor started.

CAUTION

When loss of control air is a result of ruptured air piping, isolate rupture.

3. The EOOW shall order Propulsion Plant placed in local manual control if it is determined that control air pressure cannot immediately be restored. Notify Bridge.
4. Shift main feed pump(s) to local manual.
5. Shift feedwater control valve to local manual.
6. Shift forced draft blower(s) to local manual control if applicable.
7. Shift fuel oil control valve to local manual.
8. Shift main condenser auxiliary exhaust unloading valve to manual.
9. Shift main condensate recirculating control valve to manual (if applicable).
10. Shift lube oil unloading valve to manual.
11. Shift main and Ship's Service Turbine Generator gland seal regulators to manual.
12. Shift excess feed dump valve to manual.
13. Shift makeup feed control valve to manual.
14. Maintain DFT water level normal.
15. Shift distilling plant regulating valve to manual.
16. Investigate cause of failure and make necessary repairs. The EOOW shall notify Bridge of estimated time to repair.

079-46.7.18.4 Repair Casualty. When it has been determined the casualty has not affected the plant equipment and it can be immediately repaired, restore air controlled components to automatic operation. When the casualty cannot be immediately repaired, continue to operate the plant in local manual control, or secure the plant in accordance with normal securing procedures.

079-46.7.19 WATER GAUGE GLASS CARRIED AWAY ON BOILER. This casualty is discussed in detail in the following paragraphs.

079-46.7.19.1 Symptoms. When the water gauge glass is carried away on the boiler, the following symptoms will be observed:

1. Gauge glass cracks or disintegrates.
2. Steam escapes into space.

079-46.7.19.2 Causes. The water gauge glass being carried away on the boiler results from:

1. Shock or vibration
2. Improper installation
3. Material fatigue
4. Glass deterioration

079-46.7.19.3 Remedial Actions. Remedial actions are contained in the following procedures:

1. Shut bottom and top water column valves to damaged glass.
2. Notify and keep Main Engine Control informed of situation.
3. Open water column drain valve to damaged glass.
4. Replace glass.

NOTE

Warm up gauge glass using top cutout valve before opening bottom valve. Retorque after warmup prior to placing in service.

5. Open bottom column valve.
6. Open top column valve slowly.
7. Inspect for leaks.
8. Shut drain.
9. Compare water level with other glass (if installed).

079-46.7.19.4 Possible Additional Casualties. Possible additional casualties are as follows:

1. Personnel injury
2. Loss of direct boiler water level indications

079-46.7.20 BOILER ECONOMIZER FIRE. Fire in the boiler economizer is discussed in the following paragraphs, along with its symptoms, causes, remedial action, and possible additional casualties.

079-46.7.20.1 Symptoms. This fire will be obvious from the following symptoms:

1. Abnormally high economizer outlet is indicated.
2. Sparks and heavy smoke emitting from stack.
3. Smoke and flames in smoke periscope.

079-46.7.20.2 Causes. Causes of fire in boiler economizer are as follows:

1. Ineffective use of boiler soot blowers, causing soot to accumulate in economizer area
2. Accumulation of soot in economizer area, due to steaming rate and improper control of fuel and air ratio
3. Excessive boiler air pressure, causing sparks to ignite soot in economizer area

NOTE

Fire in economizer shall be treated as a boiler wrap-up (see NSTM Chapter 221).

079-46.7.20.3 Remedial Actions. The following remedial actions shall be taken when boiler economizer fire is discovered:

1. Trip fuel oil quick-closing valve.
2. Notify and keep Main Engine Control informed of situation.
3. Shut applicable fuel oil system valves:
   a. Shut all burner safety-shutoff devices or burner needle valves.
   b. Shut all burner supply and return root valves, including steam atomization root valves.
   c. Shut fuel oil quick-closing valves and manual shut-off valves to all burner stages (pressure fired).
   d. Remove all atomizers from burners.
4. Stop forced draft blower(s).

CAUTION

When two or more boilers are connected to a common stack, secure all boilers affected.

5. When steaming only one boiler, stop fuel oil service pump(s).
6. Shut all air registers.

CAUTION

Ensure electric power to periscope lights is secured before water is applied.

7. Staff firefighting equipment.
8. Maintain normal water level.
9. Inspect for extent of damage and make necessary repairs when fire is out.

079-46.7.20.3.1 After being notified of fire, Main Engine Control will perform the following:

1. Notify Bridge.
2. Report maximum speed available.
3. Notify Bridge of casualty cause, extent of damage, and estimated time needed to make repairs.
4. Notify Damage Control Central to stand by.
5. Order plant cross-connected, as required.
6. Order turbogenerators tripped, as required.

079-46.7.20.4 Possible Additional Casualties. Loss of boiler may result due to the following:

1. Distortion of economizer tubes and extended surfaces
2. Distortion of uptake area
3. Warped boiler air casing in economizer area

079-46.7.21 SUPERCHARGER FAILURE. Failure of supercharger is discussed in detail in the following paragraphs.

079-46.7.21.1 Symptoms. Supercharger failure produces the following symptoms:

1. Excessive vibration of supercharger occurs.
2. Supercharger slows or overspeeds.
3. Fluctuating automatic signals occur.
4. Drop in air pressure is indicated.

079-46.7.21.2 Causes. Supercharger failure results from:

1. Internal damage or material failure of turbine
2. Internal damage or material failure of bearings
3. Loss of lubrication
4. Loose or broken foundation bolts

079-46.7.21.3 Remedial Actions. In the event of supercharger failure, use the following procedures to correct condition:

1. Notify and keep Main Engine Control informed of situation.
2. Shift to remote manual control.
3. Slow supercharger.
4. Check lube oil level in sump tank.

5. Secure affected boiler (if supercharger problems cannot be resolved).

079-46.7.21.3.1 When notified of failure, Main Engine Control will perform the following:

1. Notify Bridge of casualty.
2. Report maximum speed available.
3. Notify Bridge of casualty cause, action being taken, and estimated time required to make repairs.

079-46.7.21.4 Possible Additional Casualties. Possible additional casualties resulting from supercharger failure are as follows:

1. Flareback
2. Loss of steam pressure
3. Loss of boiler

079-46.8 MAIN ENGINE (TURBINE-DRIVE) CASUALTIES.

079-46.8.1 JAMMED THROTTLE (AHEAD AND ASTERN). Primary casualty to the throttle occurs when throttle is jammed (ahead and astern) and cannot be moved.

CAUTION

Do not use the opposite throttle to control engine speed, except when it is necessary to stop the shaft in an emergency (see NSTM Chapter 231, Propulsion and SSTG Steam Turbines).

079-46.8.1.1 Causes. The jammed throttle could be caused by the following:

1. Foreign matter caught between nozzle valve seat and disk
2. Damaged throttle valve shafting
3. Defective linkage:
   a. Pins
   b. Gears
   c. Cams
   d. Springs
4. Failure of throttle valve control air or hydraulic assist unit
5. Nozzle control valve stems:
   a. Bent
   b. Seized
   c. Loose

079-46.8.1.2 Remedial Actions. Actions to remedy casualty are as follows:

1. Notify Main Engine Control by stating, **“Main engine throttle ahead/astern valve in jammed at _______ r/min.”**
2. Take control of the main engine with guarding valve.
3. Inspect throttle valve mechanism for:
   a. Binding
   b. Jamming
   c. Damage
   d. Misalignment
4. Test throttle when cause of casualty has been corrected.

079-46.8.1.2.1 Main Engine Control shall take the following steps:

1. Transmit report to Bridge.
2. Notify Bridge of casualty cause and estimated time to make repairs.
3. Notify Bridge when repairs are complete.
4. Request permission to test throttle.

079-46.8.2 LOSS OF OR LOW LUBE OIL PRESSURE TO MAIN ENGINE. This casualty is discussed in the following paragraphs, including symptoms, causes, remedial action, and possible additional casualties.

079-46.8.2.1 Symptoms. Symptoms of this casualty are as follows:

1. Low lube oil pressure alarm sounds.
2. Low lube oil pressure warning light is illuminated.
3. Low lube oil pressure alarm flag registers.
4. Lube oil pressure gauge indicates a below normal pressure.
5. No oil flow is observed in bearing oil sight flow glass.
6. Excessive bearing temperature is observed on bearing thermometer.

079-46.8.2.2 Causes. Causes are as follows:

1. Clogged lube oil piping:
   a. Strainer
   b. Filter
2. Failure of operating pump, coupled with failure of standby pump to start
3. Low oil level in reduction gear sump
4. Malfunction or improper setting of:

a. Unloading valve
b. Relief valve

5. Major lube oil piping leak

6. Failure of lube oil pump steam or electric power supply due to an operational casualty or damage to pump power supply source

079-46.8.2.3 Remedial Actions. Actions to be taken to remedy the casualty are as follows:

1. Notify Main Engine Control of casualty and that shaft is being stopped and locked. Main Engine control shall control ship's speed.

CAUTION

Multiple shaft ships shall reduce ship's speed to 15 knots or less before an affected shaft is locked. On ships with multiple shafts which lose lube oil pressure and steam pressure simultaneously in one engine room during split-plant operation, and the plant cannot be cross-connected immediately, the way should be taken off the ship by backing down on the unaffected shaft(s) until shaft is stopped.

2. Stop and lock affected main engine shaft (see paragraph 079-46.8.26).

3. Attempt to regain lubricating oil pressure.

4. Investigate system alignment and operating and standby pump.

5. Shift main lube oil strainers.

6. Monitor main engine sump lube oil level.

7. Replenish from storage tank, if necessary, to restore sump to normal operating level.

8. Monitor all turbine and reduction gear bearings thermometers to ascertain which bearings have been overheated.

9. Inspect lube oil piping for leakage.

NOTE

See NSTM Chapter 231, Propulsion and SSTG Steam Turbines.

10. Secure turbine gland seal steam and air ejector, and break vacuum if shaft is to be locked for 5 minutes or more.

NOTE

Breaking vacuum through the turbine glands can cause the shaft to bow and damage labyrinth packing.

11. Draw sample from water side of lube oil cooler; observe for presence of oil. Take lube oil sample, examine for the presence of water or sediment.

12. Inspect the lube oil strainer that was in operation at time of casualty.

13. Determine if any bearing metal is present.
14. Align and, if necessary, start the lube oil purifier for main engine sump-to-sump operation.
15. Make necessary repairs when cause has been determined.
16. Restore lube oil pressure.
17. Shift and inspect lube oil strainers to determine if any bearing metal is present.

CAUTION

An ″IN SPECIFICATION″ bearing wear reading of "good" is not an accurate indication that the bearing is not damaged. A buildup of wiped bearing metal may be holding the shaft in a position which will give a false indication of actual bearing condition.

18. Take axial and radial clearances of all bearings where means to do so are provided.
19. Inspect all turbine and reduction gear bearings (see**NSTM Chapter 231, and NSTM Chapter 9420, Propulsion Reduction Gears, Couplings, and Associated Components**) if required, since bearing inspection is required for loss of lube oil but not for low lube oil pressure.
20. Report extent of bearing repairs required, and estimated time needed to make repairs.
21. Complete bearing repairs.
22. Request permission to place main engine in operation.
23. Unlock shaft to test main engine (see paragraph 079-46.8.26).

079-46.8.2.3.1 Main Engine Control will perform the following:

1. Notify Bridge of maximum speed available.
2. Notify Bridge of casualty cause, and estimated time needed to make bearing inspection and repairs.
3. Notify Bridge when repairs are completed.
4. Request permission to test main engine.

079-46.8.2.4 Possible Additional Casualties. Additional casualties that may occur are as follows:

1. Unusual noise or vibration in main engine
2. Hot bearing
3. Damage to turbines, bearings, or reduction gears

079-46.8.3 EXCESSIVE LUBRICATING OIL PUMP DISCHARGE PRESSURE TO MAIN ENGINE. Symptoms, causes, remedial actions, and possible additional casualties resulting from this casualty are discussed in the following paragraphs.

079-46.8.3.1 Symptoms. Symptoms are as follows:

1. Increase in pressure is indicated on lube oil pump discharge pressure gauge.
2. Increase in pressure is indicated on bearing oil pressure gauge.
3. Increase in differential pressure through lube oil strainers.
4. Oil leakage observed at turbine bearing oil seals.

079-46.8.3.2 Causes. Causes of the casualty could be the following:

1. Defective or improperly operating constant pressure pump governor
2. Defective or improperly operating unloading valve
3. Restriction in lube oil piping
4. Plugged strainer
5. Defective or improperly operating relief valve

079-46.8.3.3 Remedial Actions. Actions to take to remedy casualty are as follows:

1. Notify and keep Main Engine Control informed of situation.
2. Maintain engine speed.
3. Monitor bearing oil flow sight glasses for normal flow.
4. Monitor bearings for normal temperatures.
5. Ensure lube oil pump is operating at proper speed.
6. Ensure oil unloading valve, relief valves, and constant pressure pump governor valve are functioning properly.
7. Ensure lube oil strainer differential pressure is within tolerance, if greater than specification shift.
8. Inspect lube oil strainers.
9. Inspect lube oil system piping for restrictions.

NOTE

High lubricating oil discharge pressure, resulting from restriction in the strainer or piping, may be accompanied by low bearing oil pressure, and must be handled as a loss of lubricating pressure (see paragraphs 079-46.8.2 through 079-46.8.2.4).

079-46.8.3.3.1 Main Engine Control will perform the following:

1. Notify Bridge of casualty and report maximum speed available.
2. Notify Bridge of casualty cause, action being taken, and estimated time to make repairs.

079-46.8.3.4 Possible Additional Casualties. Possible additional casualties that can occur are as follows:

1. Loss or low main engine lube oil pressure
2. Damage to main engine bearings or gears.

079-46.8.4 LEAK IN MAIN ENGINE LUBE OIL SYSTEM. Symptoms, causes, actions to be taken and possible additional casualties are discussed in the following paragraphs.

079-46.8.4.1 Symptoms. Symptoms are as follows:

1. Smell of hot lube oil is noted.
2. Oil is observed spraying or flowing from vicinity of leak.
3. Low oil level is indicated on sump oil level indicator.
4. Excessive amount of lube oil found in bilges.

079-46.8.4.2 Causes. Causes are as follows:

1. Damage resulting in ruptured or sheared fittings
2. Defective piping, fitting or gasket
3. Improper reassembly of piping or bearing cover and oil seal
4. Improper testing of lube oil strainer after cleaning

079-46.8.4.3 Remedial Actions. Actions to be taken to remedy casualty are as follows:

1. Report the leak to Main Engine Control. Keep Main Engine Control informed of situation.
2. Determine nature of oil leak and secure the oil source. Use any means available, such as a rag or bucket, to reduce the flow of oil and deflect it away from hot surfaces.

NOTE

> A main engine lube oil system leak can be of a mild nature and permit continued operation of the main engine or it can be of a serious nature and require stopping and locking the main engine shaft.

3. When oil leak is of a serious nature, notify Main Engine Control that main engine shaft is being stopped and locked.
4. Staff firefighting equipment.
5. Activate the Twin Agent Fire Extinguishing System and use Aqueous Film Forming Foam to remove oil accumulation on deckplates or bulkheads, and wash oil into the bilge. Water may also be used. Rags that have been used for cleanup shall be placed in a suitable container. Discharge Aqueous Film Forming Foam into the bilge to cover liquid surface and prevent ignition of the oil.
6. As time and personnel permit, the following concurrent actions should be accomplished:
   a. Secure operating machinery as necessary in the vicinity of the leak to control the casualty. Start or maintain equipment in unaffected spaces to maintain propulsion, electric power and firemain pressure.

b. Activate Aqueous Film Forming Foam bilge sprinkling, if installed, for one minute to ensure all bilge surfaces are vapor secured.

7. Pump bilge to the oily waste holding tank or overboard as conditions permit, observing the latest environmental control directives.
8. Monitor sump oil level indicator.
9. Monitor all main engine bearings for proper oil flow and temperature.
10. Shift and inspect lube oil strainer.
11. Determine if any bearing metal is present on magnets or inside strainer.
12. Determine cause of leakage and perform necessary repairs.
13. Replenish sump oil level from storage tank.
14. Subject repair to pressure test.
15. Request permission to unlock main engine shaft and test main engine.

079-46.8.4.3.1 Main Engine Control will perform the following:

1. Notify Bridge of casualty.
2. Control speed of ship (see paragraph 079-46.8.26).
3. Notify Bridge of casualty cause, and estimated time needed for repairs.
4. Notify Bridge when repairs have been made.
5. Request permission to unlock shaft and test main engine.

079-46.8.4.3.2 When oil leak is of a minor nature, notify and keep main Engine Control informed of the situation.

1. Attempt to stop oil leak.
2. Staff firefighting equipment.
3. Remove all fire hazards and spilled oil.
4. Pump bilges as necessary, observing latest environmental control directives.
5. Monitor sump level oil indicator and replenish sump from storage tank to maintain sump normal operating level.
6. Shift and inspect lube oil strainers.
7. Determine if any bearing metal is present.
8. Determine cause of leak.
9. Perform necessary repairs.

079-46.8.4.3.3 Main engine control will perform the following:

1. Notify Bridge of casualty.

2. Request adjustments in shaft speed as necessary.
3. Notify Bridge of casualty cause and estimated time of repairs.
4. Notify Bridge when repairs have been made and main engine is ready to answer all bells.

079-46.8.4.4 Possible Additional Casualties. Possible additional casualties that can occur are as follows:

1. Low main engine lube oil pressure
2. Loss of main engine lube oil pressure
3. Hot main engine bearings
4. Class BRAVO fire

079-46.8.5 HIGH OIL LEVEL IN MAIN ENGINE SUMP. Symptoms, causes, actions to be taken, and possible additional casualties that can occur are discussed in the following paragraphs.

079-46.8.5.1 Symptoms. Symptoms are as follows:

1. Increase in oil level is indicated on main engine sump oil level gauge.
2. Rapid increase in oil temperature in main engine sump and to main engine bearings is indicated.
3. Overflow of foaming oil through gear casing vent occurs.
4. Oil leakage appears at gear casing joint flashing.

079-46.8.5.2 Causes. Causes of the casualty could be the following:

1. Leaking or improperly aligned valves in purifying or lube oil transfer system
2. Water in main engine lube oil system
3. Defective gear case vent

079-46.8.5.3 Remedial Actions. Actions to be taken to remedy casualty are as follows:

1. Notify and keep Main Engine Control informed of situation.
2. Slow main engine to one-third speed, or stop if necessary.
3. Ensure sump vents are clear.
4. Draw sample of lube oil from cooler.
5. Test for water.
6. Observe oil flow sight glasses for normal flow and color.
7. Start lube oil purifier on sump to-sump operation.
8. Observe sludge discharge from amount of water removed.
9. Monitor bearing temperatures.

10. Ensure gland sealing steam is at proper pressure and bearing slop drain pocket hole is clear and free to drain.
11. Shift purifier discharge to settling tanks, when no water is present in oil and oil level remains high.
12. Ensure gland steam vent exhauster is operating properly.
13. Replenish oil level from storage tank if oil level is low after removal of water.
14. Ensure lube oil system is properly aligned.
15. Shift and inspect lube oil strainer.
16. Determine if any bearing metal is present.
17. Inspect sump tank and piping located in bilges for source of water contamination.
18. Resume speed as required, when cause has been determined and repairs made.
19. Observe oil flow sight glasses for normal flow.
20. Monitor bearing temperatures.

079-46.8.5.3.1 Main Engine Control will perform the following:

1. Notify Bridge of casualty, of speed changes on affected engine, and maximum speed available.
2. Notify Bridge of casualty cause, action being taken, and estimated time to make repairs.
3. Notify Bridge when repairs have been made.
4. Request permission to test main engine.

079-46.8.5.4 Possible Additional Casualties. Possible additional casualties that could occur are as follows:

1. Hot main engine bearing
2. Emulsified main engine lube oil, resulting in increase in frictional resistance, causing oil film breakdown in bearings
3. Class BRAVO fire

079-46.8.6 LOW LUBE OIL LEVEL IN MAIN ENGINE SUMP. Symptoms, causes, actions to be taken and possible additional casualties that can occur are described in the following paragraphs.

079-46.8.6.1 Symptoms. Symptoms of this casualty are as follows:

1. Main engine sump oil level gauge indicates below normal level.
2. Excessive lube oil appears in bilges.
3. Lube oil cooler waterside test sample indicates oil in water.
4. Oil slick reported trailing from ship.

079-46.8.6.2 Causes. Causes of the casualty could be the following:

1. Lube oil purifier in sump-to-sump operation loses seal
2. Leaking tube or tube sheet in lube oil cooler
3. Leaking sump casing or lube oil piping
4. Improperly aligned valves in purifier or lube oil transfer system

079-46.8.6.3 Remedial Actions. Actions to be taken to remedy casualty are as follows:

1. Notify and keep Main Engine Control informed of the situation.

NOTE

The nature of the cause for the low lube oil level may necessitate stopping and locking the shaft.

2. Replenish oil level in main engine sump from storage tank.
3. Investigate lube oil purifier for proper seal and alignment.
4. Shut suction valve and stop purifier if seal is lost.
5. Ensure lube oil transfer system valves are properly aligned.
6. Monitor amount of oil in storage and settling tanks.
7. Determine if amount has increased.
8. Investigate for leaks in reduction gear casing and lube oil system piping.
9. Check bilges for excessive lube oil.
10. Draw sample from water side of lube oil cooler.
11. Test for indications of oil.

CAUTION

When cause is found to be a lube oil cooler tube failure, request permission to isolate cooler and reduce main engine speed, as necessary, below critical bearing temperature. Cool lube oil by placing rags on cooler shell and directing a spray of water on rags.

12. Notify Bridge of casualty and request adjustments in ship’s speed as required.
13. Notify Bridge of casualty cause, action being taken, and estimated time to make repairs.

079-46.8.6.4 Possible Additional Casualties. Possible additional casualties that can occur are as follows:

1. Large loss of lube oil, causing excessive loss of lube oil from stowage
2. Loss of lube oil pressure in main engine
3. Class BRAVO fire

079-46.8.7 WATER IN MAIN ENGINE LUBE OIL SYSTEM. This casualty is discussed in detail in the following paragraphs.

079-46.8.7.1 Symptoms. Symptoms of this casualty are as follows:

1. High oil level in lube oil sump is indicated.
2. Fluctuating, or loss of, lube oil pressure occurs.
3. Hot bearings found.
4. Discoloration of lube oil found.
5. Emulsified oil foaming from gear case vent occurs.
6. Leak occurs at reduction gear case manhole covers in bilges.

079-46.8.7.2 Causes. Causes of this casualty could be the following:

1. Improper operation of lube oil purifier
2. Excessive gland sealing steam pressure
3. Plugged slop drain holes
4. Ruptured tube or tube sheet in lube oil cooler
5. Leakage into lube oil sump suction piping in bilges

079-46.8.7.3 Remedial Actions. Actions to be taken to remedy casualty are as follows:

1. Notify and keep Main Engine Control informed of situation.

NOTE

Small amounts of water in main engine lube oil system normally will not require slowing or stopping main engine. Large amounts of water in main engine lube oil system, however, must be treated as a major casualty and remedied immediately. This may require slowing or stopping affected engine if bearing temperature rises abnormally or water content in oil continues to increase (see paragraphs 079-46.8.11 through 079-46.8.11.5).

2. Place lube oil purifier on sump-to-sump operation.
3. Inspect waste drain for amount of water removed.
4. Monitor main engine bearing temperature.
5. Observe oil flow sight gauges for normal oil flow and appearance.
6. Monitor main engine lube oil sump level.
7. Shift and inspect lube oil strainers.
8. Determine if any bearing metal is present.
9. Inspect for leaks in lube oil suction piping in bilges.

10. Draw sample from oil side of oil cooler and inspect for water.
11. Make necessary repairs when cause has been determined.
12. Replenish sump oil level from storage tank, if required.

079-46.8.7.3.1 Main Engine Control will perform the following:

1. Notify Bridge of casualty.
2. Request adjustments in ship's speed as necessary.
3. Report maximum speed available.
4. Notify Bridge of casualty cause, action being taken, and estimated time to make repairs.

079-46.8.7.4 Possible Additional Casualties. Possible additional casualties that can occur are as follows:

1. Hot main engine bearings
2. Unusual noise in main engine reduction gears

079-46.8.8 MAIN ENGINE LUBRICATING OIL COOLER TUBE FAILURE. Failure of lubricating oil cooler tube being carried away is discussed in detail in the following paragraphs.

079-46.8.8.1 Symptoms. Symptoms of this casualty are as follows:

1. Water found in lube oil.
2. Low/high lube oil sump level is indicated.
3. Oil slick reported trailing from ship.

079-46.8.8.2 Causes. Causes of the casualty are as follows:

1. Heavy shock
2. Tube or tube sheet metal deterioration

NOTE

Not all ships are provided with a means of by-passing a lube oil cooler. Some ships, however, have more than one cooler that can be placed in service.

079-46.8.8.3 Remedial Actions. Transmit casualty report to Main Engine Control. Keep Main Engine Control informed of situation. Reduce speed when permissible.

1. By-pass cooler (when applicable).
2. Place standby lube oil cooler in operation (where applicable).
3. Operate at speeds below critical bearing temperature.

4. Replenish oil from storage tank to main engine sump, to restore proper sump operating level.

079-46.8.8.3.1 Main Engine Control will perform the following:

1. Notify Bridge of casualty.
2. Report maximum speed available.
3. Notify Bridge of casualty cause, action being taken, and estimated time to make repairs.

079-46.8.8.3.2 When it is not permissible to reduce speed sufficiently, the oil leak is minor, and ship has adequate supply of oil on board, Main Engine Control will perform the following:

1. Increase lubricating oil pressure if necessary, so oil will leak in water side of cooler.
2. Pump makeup oil into main engine sump.
3. Direct water from firemain to outside of oil line to provide some cooling.
4. Continuously monitor main engine sump lube oil level.

079-46.8.8.3.3 When it is not permissible to reduce speed and oil leak is major, Main Engine Control will perform the following:

1. Secure cooling water inlet and outlet valves and drain seawater side of lube oil cooler.
2. Apply artificial cooling to shell of lube oil cooler.
3. Continuously monitor main engine sump oil level.

079-46.8.9 MAIN LUBE OIL PUMP (MOTOR-DRIVEN) CASUALTIES. Several types of casualties can occur to this equipment, each with varied causes and varied actions to be taken for each cause. These types of casualties, causes, and courses of corrective action are described in the following paragraphs.

079-46.8.9.1 Pump Fails to Deliver Normal Discharge Pressure. Causes and remedies for this casualty are as follows:

1. Cause
   a. Air leakage in stuffing box
   b. Air leakage in suction piping
   c. Unloading valve malfunction
   d. Pump loses suction
   e. Internal pump problems
   f. Lube oil system not properly aligned
2. Actions to be taken
   a. Provide sealing oil and adjust packing gland for slight leakoff.
   b. Investigate and eliminate air leakage in suction piping by plugging or patching holes. Tighten loose bolts and nuts on flanges.

c. Adjust unloading valve to proper setting.
d. Ensure sump oil level is adequate and suction check valve (when installed) is operating properly.
e. Start standby pump; stop and investigate affected pump.
f. Properly align lube oil system.

079-46.8.9.2 Pump Stops Rotating. Causes and remedies for this casualty are as follows:

1. Causes
   a. Electrical failure
   b. Internal pump/motor problems
2. Actions to be taken
   a. Start standby pump.
   b. Investigate affected pump.

079-46.8.9.3 Pump Fails to Start from Standby Status. Causes and remedies for this casualty are as follows:

1. Causes
   a. Cut-in switch failure
   b. Cut-in switch actuating line valve not opened
2. Actions to be taken
   a. Manually start pump.
   b. Open actuating line valve.

079-46.8.9.4 Unusual Noise or Vibration. Causes and remedies for this casualty are as follows:

1. Causes
   a. Internal pump/motor problems
   b. Misalignment of unit
   c. Packing gland
2. Respective action to be taken for each cause
   a. Start standby pump.
   b. Stop and investigate affected pump.
   c. Adjust packing gland.

NOTE

Main lube oil pump deficiencies can cause a loss of lube oil pressure to main engine. If there is any doubt concerning operation of main lube oil pump, place standby pump in service, and take affected pump out of service for investigation.

079-46.8.10 MAIN LUBE OIL PUMP (TURBINE-DRIVEN) CASUALTIES. This equipment can also experience several different casualties with differing causes and courses of remedial action for each. These are described in the following paragraphs.

079-46.8.10.1 Pump Fails to Deliver Normal Discharge Pressure. Causes and actions to be taken are as follows:

1. Causes
   a. Turbine not up to speed
   b. Insufficient steam pressure
   c. Speed-limiting governor malfunction
   d. Constant pressure governor malfunction
   e. Air leakage in stuffing box
   f. Air leakage in suction piping
   g. Unloading valve malfunction
   h. Pump loses suction
   i. Internal pump problems
   j. Lube oil system not properly aligned
2. Actions to be taken
   a. Open steam supply and throttle valves.
   b. Adjust constant pressure governor to restore normal speed.
   c. Restore steam pressure or open turbine manual nozzle valve if low steam pressure conditions exist.
   d. Start standby pump.
   e. Stop and investigate affected pump.
   f. Put governor on manual bypass.
   g. Start standby pump.
   h. Stop and investigate affected pump.
   i. Provide sealing oil and adjust packing gland for slight leakoff.
   j. Investigate and eliminate air leakage in suction piping by plugging or patching holes.
   k. Tighten loose bolts and nuts on flanges.
   l. Adjust unloading valve to proper setting.
   m. Ensure sump oil level is adequate and suction check valve is operating properly.
   n. Start standby pump.
   o. Stop and investigate affected pump.
   p. Align lube oil system properly.

079-46.8.10.2 Pump Stops Rotating. Causes and remedial actions to be taken are as follows:

1. Causes
   a. Loss of steam pressure
   b. Constant pressure governor malfunction
   c. Internal pump/turbine problems

2. Actions to be taken
   a. Start standby pump.
   b. Restore steam pressure.
   c. Investigate affected pump.

079-46.8.10.3 Unusual Noise or Vibrations. Causes and actions to be taken are as follows:

1. Causes
   a. Internal pump/turbine problems
   b. Misalignment of unit
   c. Packing gland too tight
2. Actions to be taken
   a. Start standby pump.
   b. Stop affected pump and investigate.
   c. Adjust packing gland.

079-46.8.10.4 Water in Lube Oil. Causes and respective actions to be taken for each cause are as follows:

1. Causes
   a. Plugged turbine/bearing housing drain hole
   b. Leaking tube or tube sheet of lube oil cooler
   c. Excessive condensation in gear case
   d. Excessive carbon packing clearance
2. Respective actions to be taken for each cause
   a. Start standby pump. Stop affected pump, clean drain hole, and change oil.
   b. Start standby pump. Stop and investigate affected pump, change oil.
   c. Start standby pump. Stop affected pump, change oil.
   d. Start standby pump. Stop affected pump, change oil.

079-46.8.10.5 Loss of Lube Oil Pressure. Causes and respective actions to be taken for each cause are as follows:

1. Causes
   a. Low oil level in sump
   b. Leaking seals, gaskets, or piping
   c. Attached lube oil pump malfunction
2. Respective actions to be taken for each cause
   a. Restore oil level to high mark on dipstick.
   b. Start standby pump. Stop and investigate affected pump.
   c. Start standby pump. Stop and investigate affected pump.

CAUTION

Main lube oil service pump deficiencies can cause loss of lube oil pressure to main engine. If there is doubt concerning the operation of main lube oil pump, place emergency pump in service and take affected pump out of service for investigation.

079-46.8.10.6 Excessive Lube Oil Temperature. Causes and respective actions to be taken for each cause are as follows:

1. Causes
   a. Insufficient cooling water to cooler
   b. Obstructed cooler tubes
   c. Bearing problems
2. Respective actions to be taken for each cause
   a. Inspect cooling water system for proper pressure and alignment. Vent cooler; increase water flow.
   b. Start standby pump. Shift to standby cooler. Investigate and repair affected cooler.
   c. Start standby pump. Slow affected pump until bearing temperature returns to normal. Stop and investigate affected pump.

079-46.8.11 HOT BEARING IN MAIN ENGINE. Symptoms, causes, actions to be taken to remedy casualty, and possible additional casualties, are listed in the following paragraphs.

079-46.8.11.1 Symptoms. Symptoms of this casualty are as follows:

1. Bearing temperature is above the normal operating temperature but less than 82°C (180°F) and the oil temperature differential between inlet and outlet is less than 28°C (50°F).
2. Bearing cover is excessively hot to the touch.
3. Rapid increase in bearing temperature over usual operating temperature of the bearing is indicated.
4. Babbitt or foreign matter is discovered in lube oil strainer.
5. High bearing remote temperature alarm sounds.
6. Unusual noise or vibration is detected in main engine.
7. Bearing is emitting smoke.

079-46.8.11.2 Cause. This casualty could be caused by the following:

1. Insufficient lube oil pressure to bearing
2. Obstructed bearing oil supply or return line
3. Grit or dirt in lube oil
4. Improperly fitted or aligned bearing

5. Poor condition of journal, or bearing surface
6. Bearing oil film lost due to water in lube oil
7. Improper lube oil temperature from cooler
8. Misalignment of rotors, gears, or shafting
9. High main engine lube oil sump level
10. Excessive gland seal leakoff
11. Excessive lube oil pressure

079-46.8.11.3 Remedial Actions. When a main engine bearing is above the normal operating temperature but less than 82°C (180°F) or the oil temperature differential between inlet and outlet is less than 28°C (50°F), proceed as follows:

CAUTION

If bearing temperature becomes uncontrollable 82°C (180°F) maximum, or there is a 28°C (50°F) difference between oil inlet and outlet temperature, stop and lock shaft (see paragraph 079-46.8.26).

1. Notify and keep Main Engine Control informed of situation.
2. Set bearing watch.
3. Ensure that the main engine lube oil cooler outlet temperature is between 49°C (120°F) and 54°C (130°F).
4. Monitor the main engine lube oil sump level.
5. Monitor main engine bearing temperatures and oil sight flow indicators for normal oil flow.

CAUTION

Do not lower lube oil temperature below 49°C (120°F).

6. Lower lube oil temperature 3°C (5°F) but not less than 49°C (120°F).
7. Raise lube oil pressure 35 kPa (5 psi).
8. Observe and record rotor position clearances on main engine.
9. If bearing temperature continues to rise, proceed to immediate actions.

079-46.8.11.4 Immediate Actions. Proceed as follows to remedy casualty:

CAUTION

Any interruption of lube oil flow to bearings must be treated as a loss of lube oil pressure.

1. Slow main engine in standard speed increments. Indicate speed changes on the engine order telegraph.
2. Slow unaffected shafts to match affected shaft's speed.

NOTE

Continue to slow main engine in relation to bearing temperature reports.

3. Monitor main engine bearing temperatures and oil sight flow indicators for normal oil flow at each change of speed.
4. Observe and record turbine rotor position clearances on main engine at each change of speed.

NOTE

When ship's speed is slowed below 8 knots, start main condenser circulating water pump.

5. When main engine is slowed below one-third speed, align main engine turbine drains for maneuvering.

CAUTION

The main engine shaft will be stopped and locked only to prevent damage. Maintain low speed operation of engine. This will decrease load on bearing and permit bearing temperatures to be lowered to a safe temperature limit before stopping the engine in order to prevent bearing metal from seizing onto the shaft.

6. Deflect gland sealing steam away from bearing cover.

CAUTION

Rapid cooling of bearing cover and shell will cause bearing metal to contract and decrease bearing clearance.

7. Direct cool air from ventilation duct or portable blower over top of bearing cover.

CAUTION

Prevent water from contaminating lube oil.

8. Only as a last resort, apply wet rags to bearing cover and oil inlet piping.
9. If temperature continues to rise, stop and lock shaft (see paragraph 079-46.8.26).
10. Shift and inspect lube oil strainers.
11. Place lube oil purifier in operation, aligned for sump-to-sump purification.
12. Draw lube oil sample from suction side of lube oil purifier.
13. Determine if bearing metal is present.

079-46.8.11.4.1 When bearing temperature is controllable and has been reduced to a safe temperature range:

1. Remove artificial means of cooling.
2. Restore lube oil system pressure to normal operating limits.
3. Reduce excess cooling water flow through lube oil cooler, maintaining normal operating parameters.
4. Proceed at an engine speed which will maintain bearing temperatures within a satisfactory range.
5. Indicate speed changes on engine order telegraph.
6. Monitor bearing oil flow and temperature continuously as engine speed increases.
7. Shift and inspect lube oil strainers.
8. Determine if bearing metal is present.
9. Shut turbine drains when main engine is approaching one-third speed.
10. Place main circulating water pump in standby status when main engine speed is approaching two-thirds speed and scoop injection is installed.
11. Inform Main Engine Control of maximum speed engine is capable of making.

079-46.8.11.4.2 Main Engine Control will:

1. Notify Bridge of casualty.
2. Request permission to adjust ship’s speed as required.
3. Report maximum speed available.
4. Notify Bridge when stopping and locking main shaft (see paragraph 079-46.8.26).
5. Notify Bridge of estimated time needed for inspection and repair.
6. Notify Bridge when casualty repair has been made.

7. Request permission to increase ship's speed as necessary.

079-46.8.11.5 Possible Additional Casualties. Possible additional casualties that can occur are as follows:

1. Unusual noise in main engine
2. Unusual vibration in main engine
3. Wiped bearings
4. Damage to turbines or reduction gear

079-46.8.12 HOT THRUST BLOCK BEARING. Symptoms, causes, remedial actions, and possible additional casualties are listed in the following paragraphs.

079-46.8.12.1 Symptoms. Symptoms of this casualty are as follows:

1. Bearing lube oil outlet temperature exceeds 82°C (180°F) or oil temperature differential between inlet and outlet exceeds 28°C (50°F)
2. Bearing cover is excessively hot to touch
3. Rapid rise in bearing temperature
4. Babbitt or foreign matter discovered in lube oil strainers
5. High bearing remote temperature alarm
6. Unusual noise or vibration detected in main engine or thrust block
7. Bearing emitting smoke

079-46.8.12.2 Causes. This casualty could be caused by the following:

1. Insufficient lube oil pressure to bearings
2. Obstructed bearing oil supply or return line
3. Grit or dirt in lube oil
4. Improperly fitted or aligned bearing
5. Poor condition of bearing surface
6. Bearing oil film lost due to water in lube oil
7. Improper lube oil temperature from cooler
8. Misalignment of bearing or shafting
9. Excessive lube oil pressure

079-46.8.12.3 Remedial Actions. When a thrust block bearing is above the normal operating temperature but less than 82°C (180°F) or the oil temperature differential between inlet and outlet is less than 28°C (50°F), proceed as follows:

CAUTION

If bearing temperature becomes uncontrollable 82°C (180°F) maximum, or there is a 28°C (50°F) difference between oil inlet and outlet temperature, proceed to immediate actions.

1. Notify and keep Main Engine Control informed of situation.
2. Set bearing watch.
3. Ensure that the lube oil cooler outlet temperature is between 49°C (120°F) and 54°C (130°F).
4. Monitor the lube oil sump level.
5. Monitor thrust block bearing temperature and oil sight flow indicators for normal oil flow.

CAUTION

Do not lower lube oil temperature below 49°C (120°F).

6. If bearing temperature continues to rise, proceed to immediate actions.

079-46.8.12.4 Immediate Actions. Proceed as follows with immediate actions:

CAUTION

Any interruption of lube oil flow to bearing must be treated as a loss of lube oil pressure.

1. Slow main engine in standard speed increments. Indicate speed changes on engine order telegraph.
2. Slow unaffected shafts to match affected shaft's speed.

NOTE

Continue to slow main engine in relation to bearing temperature reports.

3. Monitor thrust block bearing temperatures and oil sight flow indicators for normal oil flow at each change of speed.

NOTE

When ship's speed is slowed below 8 knots, start main condenser circulating water pump.

4. When main engine is slowed below one-third speed, align main engine turbine drains for maneuvering.

CAUTION

The main engine shaft will be stopped and locked only to prevent damage. Maintain low speed operation of the engine. This will decrease load on bearing and permit bearing temperatures to be lowered to a safe temperature limit before stopping the engine.

CAUTION

Rapid cooling of bearing cover and shell will cause bearing metal to contract and decrease bearing clearance.

5. Direct cool air from ventilation duct or portable blower over top of bearing cover.

CAUTION

Prevent water from contaminating lube oil.

6. Apply wet rags to bearing cover and oil inlet piping.
7. Only as a last resort, spray water on rags placed on thrust block oil inlet piping.
8. If temperature continues to rise, stop and lock shaft (see paragraph 079-46.8.26).
9. Shift and inspect lube oil strainers at varying intervals.
10. Place lube oil purifier in operation, aligned for sump-to-sump purification.
11. Draw lube oil sample from lube oil system.
12. Determine if bearing metal is present.

079-46.8.12.4.1 When bearing temperature is controllable and has been reduced to a safe temperature range:

1. Remove artificial means of cooling.
2. Restore lube oil system pressure to normal operating limits.

3. Reduce excess cooling water flow through lube oil cooler while maintaining normal operating parameters.
4. Proceed at an engine speed which will maintain bearing temperatures within a satisfactory range.
5. Indicate speed changes on engine order telegraph.
6. Monitor continuously bearing oil flow and temperature as engine speed increases.
7. Shift and inspect lube oil strainers.
8. Determine if bearing metal is present.
9. Shut turbine drains when main engine is approaching one-third speed.
10. Place main circulating water pump in standby status when main engine speed is approaching two-thirds speed and scoop injection is installed.
11. Inform Main Engine Control of maximum speed engine is capable of making.

079-46.8.12.4.2 When the bearing temperature is uncontrollable, take the following steps:

1. Inform Main Engine Control of estimated time to make inspection and repairs.
2. Continue to purify lube oil in sump.

079-46.8.12.4.3 Main Engine Control will perform the following:

1. Notify Bridge of casualty.
2. Request permission to adjust ship’s speed as required.
3. Report maximum speed available.
4. Notify Bridge when stopping and locking main shaft (see paragraph 079-46.8.26).
5. Notify Bridge of estimated time needed for inspection and repair.
6. Notify Bridge when casualty repair has been made.
7. Request permission to increase ship’s speed as necessary.

079-46.8.12.5 Possible Additional Casualties. Possible additional casualties that can occur are as follows:

1. Unusual noise in main engine
2. Unusual vibration in main engine
3. Wiped bearing
4. Damaged reduction gear

079-46.8.13 HOT LINE SHAFT SPRING BEARING. Symptoms, causes, actions to be taken, and possible additional casualties that can occur are listed in the following paragraphs.

079-46.8.13.1 Symptoms. Symptoms of this casualty are as follows:

1. Bearing lube oil sump or system operating temperature is above normal or exceeds 82°C (180°F).
2. Bearing cover is excessively hot to touch.
3. Unusual rise in bearing lube oil sump temperature shown.
4. Babbitt or foreign matter is discovered in lube oil sample or lube oil strainers.
5. Unusual noise or vibration is detected in main engine.
6. Bearing is emitting smoke.

079-46.8.13.2 Causes. This casualty could be caused by the following:

1. Insufficient lube oil in bearing sump
2. Grit or dirt in lube oil
3. Improperly fitted or aligned bearing
4. Poor condition of journal or bearing surface
5. Bearing oil film lost due to water in lube oil
6. Defective lubricating oil ring
7. Insufficient cooling water flow (submarines)

079-46.8.13.3 Remedial Actions. Actions to be taken to remedy casualty are as follows:

1. Notify and keep Main Engine Control informed of situation.

CAUTION

If lube oil sump temperature is above normal operating temperature and continues to rise in spite of remedial actions, proceed to immediate actions.

2. Set bearing watch.
3. Inspect lube oil sump for normal oil level and check oil lubricating rings for proper operation.
4. Monitor line shaft bearing lube oil sump temperature.
5. Direct cool air from ventilation duct or portable blower over top of bearing cover.
6. Increase cooling water flow (submarines).

CAUTION

Prevent water from contaminating lube oil.

7. Apply wet rags to lube oil sump exterior.
8. If bearing temperature continues to rise, proceed to immediate actions.

079-46.8.13.4 Immediate Actions. Proceed as follows with immediate action:

1. Slow main engine in standard speed increments. Indicate speed changes on engine order telegraph.
2. Slow unaffected shafts to match affected shaft's speed.

NOTE

If required, continue to slow main engine in relation to bearing temperature reports.

CAUTION

The main engine line shaft will be stopped and locked only to prevent damage. Maintain low speed operation of the engine. This will decrease load on bearing and permit bearing temperatures to be lowered to a safe temperature limit before stopping the engine in order to prevent bearing metal from seizing onto the shaft.

3. Monitor and report line shaft bearing lube oil sump temperature at each change of speed.

NOTE

When ship's speed is slowed below 8 knots, start main condenser circulating water pump.

4. When main engine is slowed below one-third speed, align main engine turbine drains for maneuvering.

CAUTION

Rapid cooling of line shaft bearing cover and shell will cause bearing metal to contract and decrease bearing clearance.

5. Direct cool air from ventilation duct or portable blower over top of bearing cover.

CAUTION

Prevent water from contaminating lube oil. Only as a last resort apply wet rags to bearing cover.

6. Only as a last resort apply wet rags to bearing cover.
7. Spray water on rags placed on line shaft bearing cover.
8. If temperature continues to rise, stop and lock shaft (see paragraph 079-46.8.26).

NOTE

Apply clean oil directly to journal surface by pouring oil slowly through inspection cover, if cause of hot bearing was loss of, or insufficient lube oil to bearing.

079-46.8.13.4.1 When bearing temperature is controllable and has been reduced to a safe temperature range, take the following steps:

1. Remove artificial means of cooling.
2. Proceed at an engine speed which will maintain bearing temperature within a satisfactory range.
3. Indicate speed change on engine order telegraph.
4. Monitor bearing temperature continuously as engine speed increases.
5. Inform Main Engine Control of maximum speed engine is capable of making.

079-46.8.13.4.2 Main Engine Control will perform the following:

1. Notify Bridge of casualty and, when bearing temperature is uncontrollable, request permission to adjust ship's speed as required.
2. Report maximum speed available.
3. Notify Bridge when stopping and locking main shaft.
4. Notify Bridge of estimated time for inspection and repairs.
5. Notify Bridge when casualty has been corrected.
6. Request permission to increase ship's speed as necessary.

079-46.8.13.5 Possible Additional Casualties Possible additional casualties that can occur are as follows:

1. Unusual noise in main engine reduction gear
2. Unusual vibration in main engine
3. Wiped bearing
4. Damage to turbines or reduction gear

079-46.8.14 UNUSUAL NOISE IN MAIN ENGINE TURBINE OR REDUCTION GEARS. Although an unusual noise usually is a symptom, in this case the symptom is the casualty. Causes, actions to be taken, and possible additional casualties that can occur are given in the following paragraphs.

079-46.8.14.1 Causes. Causes could be the following:

1. Water carry over from boiler into turbine
2. Broken turbine blade or blades
3. Loose or detached shrouding
4. Turbine blading rubbing
5. Turbine shaft riding on carbon or labyrinth packing and bearing oil seal
6. Main engine operating at its critical speed
7. Ship operating or maneuvering in shallow water
8. Foreign object in turbine or reduction gear
9. Thrust, journal, or line shaft bearing problems

10. Loose fitting of inspection plates
11. Back lash in reduction gears
12. Damage to attached lube oil pump
13. Debris riding against line shaft
14. Line shaft binding in bulkhead shaft seal
15. Stern tube or strut bearing gripping main shaft
16. Excessive condensate level in main condenser
17. Turbine or reduction gear foundation bolts loose, causing misalignment
18. Broken teeth in reduction gears or quill shafts

079-46.8.14.2 Remedial Action. If unusual noises are heard, notify and keep Main Engine Control informed of situation.

079-46.8.14.2.1 A rumbling noise in main engine turbine indicates water carryover from boiler into turbine. If such a noise is detected in the turbine, take the following steps:

1. Shut turbine throttle valve.
2. Open turbine casing and steam supply line drains.
3. When drains are clear of water, slowly return engine to speed as ordered.
4. Shut turbine casing and steam supply line drains.

079-46.8.14.2.2 For other unusual noises, slow main engine until noise stops. Indicate speed changes on Engine Order Telegraph. Determine and record speed at which noise stops. Then take the following steps:

NOTE

When ship's speed is below two-thirds speed and scoop injection is installed, start main circulating water pump. When main engine speed is below one-third speed, open turbine drains.

1. Shift and inspect lube oil strainers.
2. Determine if metal is present.
3. Monitor all main engine and line shaft bearings for proper temperature and lube oil flow.
4. Inspect main engine for loose fittings of inspection plates.
5. Inspect attached lube oil pump for abnormal operation.
6. Take turbine rotor position clearance and record it.
7. Inspect exposed turbine shafts and glands for indications of overheating.
8. Inspect line shaft bulkhead seals for indications of misalignment or improper adjustment.

9. Report when cause has been determined and estimated time required for repairs.
10. Ensure main condenser vacuum and hot well level are normal.

079-46.8.14.2.3 Main Engine Control will perform the following:

1. Notify Bridge of casualty.
2. Request permission to adjust speed as necessary.
3. Report casualty cause and estimated time required to make repairs.

079-46.8.14.2.4 If the unusual noise is a metallic sound inside a turbine or a loud roaring noise in the reduction gears, stop and lock main engine shaft immediately. Inform Main Engine Control of estimated time for inspection and repairs.

079-46.8.14.2.5 Main Engine Control will perform the following:

1. Inform Bridge of casualty.
2. Report that main engine shaft is being stopped and locked (see paragraph 079-46.8.26).
3. Report maximum speed available.
4. Inform Bridge of estimated time for inspection and required time to make repairs.

079-46.8.14.3 Possible Additional Casualties. Possible additional casualties that can occur are as follows:

1. Unusual vibration in main engine turbine, reduction gear, or line shaft
2. Hot main engine bearing
3. Loss of main condenser vacuum

079-46.8.15 UNUSUAL VIBRATION IN MAIN ENGINE TURBINE, REDUCTION GEARS, OR LINE SHAFT. As with noises, unusual vibrations are both symptom and casualty, and possible additional casualties are given in the following paragraphs.

079-46.8.15.1 Causes. Causes for this casualty could be the following:

1. Water carry over from boiler into turbine
2. Thrust, journal, or line shaft bearing problems
3. Broken turbine blade(s)
4. Loose or detached shrouding
5. Bowed turbine rotor
6. Propeller excitation
7. Main engine operating at its critical speed

8. Ship operating or maneuvering in shallow water
9. Line shaft binding in bulkhead seal
10. Bent or damaged shaft or propeller
11. Improper propeller balance
12. Fouled propeller, fair water, or shaft
13. Improper shaft alignment
14. Turbine reduction gear:
    a. Loose
    b. Broken
    c. Missing
15. Line shaft bearing foundation bolts:
    a. Loose
    b. Broken
    c. Missing
16. Excessive condensate level in main condenser
17. Stick-slip in stern tube or strut bearing

079-46.8.15.2 Remedial Actions. Actions to be taken to remedy casualty are as follows:

1. Notify and keep Main Engine Control informed of situation.

NOTE

A bowed turbine rotor can be experienced any time a warmed-up rotor is allowed to sit idle.

2. Slow main engine until vibration stops, when vibration is of a moderate nature.
3. Indicate speed changes on Engine Order Telegraph.

NOTE

Ships with more than one main engine line shaft may require that the unaffected shafts may require increase speed to compensate for the speed lost by the affected shaft.

4. Determine and record speed at which vibration stops.

NOTE

When ship's speed is below two-thirds speed and scoop injection is installed, start main circulating water pump. When main engine speed is below one-third speed, open turbine drains. When vibration persists on ships with more than one shaft, unaffected shafts should be slowed to assist in detecting cause of affected shaft vibration.

5. Shift and inspect lube oil strainers.
6. Determine if bearing metal is present.
7. Monitor all main engine and line shaft bearings for proper temperature and lube oil flow.
8. Inspect main engine turbine, reduction gears and line shaft bearings for loose, broken, or missing foundation bolts.
9. Take turbine rotor position clearances and record them.
10. Inspect line shaft bulkhead seals for indications of misalignment or improper adjustments.
11. Inspect propeller, fair water, and shaft for fouling or damage, when practicable.
12. Report when cause has been determined and give estimated time for repairs.
13. Ensure main condenser vacuum and hot well level are normal.

079-46.8.15.2.1 Main Engine Control will perform the following:

1. Notify Bridge of casualty and request permission to adjust speed as necessary.
2. Report casualty cause and estimated time required to make repairs.

079-46.8.15.2.2 When vibration is heavy, stop and lock main engine shaft immediately (see paragraph 079-46.8.26). Inform Main Engine Control of estimated time required for inspection and repairs.

079-46.8.15.2.3 Main Engine Control will take the following steps:

1. Inform Bridge of casualty and that main engine shaft is being stopped and locked and maximum speed available.
2. Inform Bridge of estimated time for inspection and required time to make repairs.

079-46.8.15.3 Possible Additional Casualties Other possible casualties that can occur are as follows:

1. Loss of main engine lube oil pressure
2. Hot main engine bearing
3. Loss of main condenser vacuum

079-46.8.16 LOSS OF VACUUM IN MAIN CONDENSER. This section does not apply to submarines; however, some of the causes listed in subsection 079-46.8.16.2 can be useful for troubleshooting any steam propulsion system loss of vacuum. Symptoms, causes, and actions to be taken to remedy the casualty and possible additional casualties that can occur are given in the following paragraphs.

079-46.8.16.1 Symptoms. Symptoms of this casualty are as follows:

1. Main condenser vacuum gauge indicates a decrease in vacuum.
2. Main engine speed decreases.

079-46.8.16.2 Causes. Six primary conditions cause this casualty; four have numerous contributing factors to consider. Causes are given in the following paragraphs.

079-46.8.16.2.1 Excessive air leakage into vacuum system. Contributing factors are as follows:

1. Freshwater drain tank vacuum drag float control valve sticks in open position
2. Condenser vacuum drag aligned to an empty makeup feed tank
3. Insufficient turbine gland seal steam pressure
4. Broken, cracked or leaking hot well level sight glass
5. Standby condensate pump vent valve to main condenser open
6. Idle set of air ejectors has a valve open
7. Loose valve stem packing gland
8. Loose or damaged pipe or tubing fittings
9. Leaking turbine casing sentinel valve

079-46.8.16.2.2 Air removal equipment malfunction. Contributing factors are as follows:

1. Insufficient steam pressure to air ejector
2. Insufficient flow of condensate for cooling air ejector condenser
3. Loss of loop seal
4. Flooded air ejector condenser
5. Clogged, dirty, or eroded nozzles
6. Cracked or broken nozzle diffuser
7. Misalignment of operating unit valves
8. Improper assembly of air ejector nozzles
9. Dirty steam side of air ejector condenser
10. Dirty condensate side of air ejector condenser

079-46.8.16.2.3 Excessive amount of condensate in condenser. Contributing factors are as follows:

1. Operating condensate pump malfunction
2. Misalignment of pump suction, discharge valves, or both
3. Improper adjustment or malfunction of condensate recirculating valve
4. Improper adjustment or malfunction of hot well level controls
5. Improper adjustment or malfunction of makeup feed valve
6. Insufficient number of pumps in operation for condensate loads
7. DFT run down valve to condenser open

8. Flooded DFT

079-46.8.16.2.4 Insufficient flow of circulating seawater. Contributing factors are as follows:

1. Failure or malfunction of circulating water pump
2. Misalignment of condenser seawater injection, overboard valves, or both.
3. Inadvertent shutting of motor-operated injection or overboard valves
4. Plugged or restricted condenser tubes
5. Plugged or restricted pump sea suction or scoop injection
6. Air-bound condenser

079-46.8.16.2.5 Three additional causes of reduced condenser vacuum are:

1. Dirty condenser steam side
2. High seawater injection temperature
3. Fouled seawater side of condenser

079-46.8.16.3 Remedial Actions The first action to be taken to remedy this casualty is to notify and keep Main Engine Control informed of situation.

079-46.8.16.3.1 A reduced but steady condenser vacuum which is due to a high seawater injection temperature, reduced flow of circulating water, or fouled condenser tubes, is not a casualty condition and in itself should not restrict propulsion plant operation. Refer to the authorized operating procedures and main turbine technical manual to allow continued operation without overpressurizing the main condenser.

079-46.8.16.3.2 When a partial loss of vacuum occurs on a propulsion turbine during normal underway steaming conditions, including full power, and the situation permits (other than alongside replenishment or combat), immediately slow main engine to compensate for the loss of vacuum as follows:

NOTE

This section is not applicable to submarine propulsion.

1. Vacuum at 53 cm (21 inches) of mercury, make two-thirds speed
2. Vacuum at 46 cm (18 inches) of mercury, make one-third speed
3. Vacuum at 38 cm (15 inches) of mercury, stop main engine

079-46.8.16.3.3 Additional steps to be taken are as follows:

1. Monitor vacuum gauge.

2. Control main engine speed based on indicated vacuum.
3. Monitor pressure gauge to turbine gland seal steam, air ejector steam supply, condensate and circulating pump discharge pressure.
4. Determine that all pressures are normal.
5. Investigate vacuum system for air leakage.
   a. Shut condenser vacuum drag valve to fresh water drain tank.
   b. Ascertain drain tank water level and ensure float control valve and mechanism are functioning properly.
   c. Open condenser vacuum drag valve when investigation indicates conditions are normal.
   d. Shut condenser vacuum drag valve to makeup feed tank.
   e. Determine water level in tank.
   f. Shift manifold suction valve to standby tank, if necessary.
   g. Open vacuum drag valve when conditions are normal.
   h. Ensure standby condensate pump vent valve is shut.
   i. Shut hot well level sight glass cutout valves.
   j. Inspect glass for cracks or breakage.
   k. Ensure sight glass packing glands are sealing properly.
   l. Open cutout valves when conditions are normal.
   m. Inspect all piping, gauge lines, and gauge line connections for breaks, cracks, and tightness.
   n. Inspect all valve packing glands for tightness.
   o. Inspect all sentinel valves to ensure proper seating.
6. Investigate air removal equipment for proper operation.
   a. Observe inter-condenser vacuum gauge
   b. Compare inter-condenser vacuum gauge reading with condenser vacuum gauge reading.
   c. Charge the loop seal if they are equal.
   d. Ensure inter- and after-condenser drain valves are open.
   e. Monitor condensate outlet temperature.
   f. Ensure outlet temperature is not in excess of 71°C (160°F).
   g. Open air ejector condenser vent valves and expel all air.
   h. Ensure all valves for unit in operation are open.
7. Determine amount of condensate in condenser.

CAUTION

When standby pump is placed in operation, control amount of condensate to DFT with pump discharge valve. Rapid transfer of large volumes of condensate into DFT can cause depressurization and collapse of tank.

a. Start standby condensate pump.
b. Investigate valve alignment of original operating pump
c. Ensure proper operation and adjustment of condensate recirculating valve.

d. Ensure proper operating and adjustment of hot well controls.
e. Ensure proper operation and adjustment of makeup feed valve.
f. Start additional pumps as required.
g. Ensure DFT run down valve to condenser is shut.
h. Ensure DFT is not flooded.

8. Monitor flow of circulating seawater.
   a. Monitor operation of circulating water pump.
   b. Ensure proper alignment of seawater valves.
   c. Monitor for circulating water system restrictions in:
      (1) Condenser tube
      (2) Pump
      (3) Valves
   d. Monitor for air load condenser tubes.
9. Monitor seawater injection temperature.

NOTE

When main engine is slowed below one-third, open main engine turbine drain valve.

10. Shut main engine throttles when vacuum continues to drop to 35 cm (15 inches) of mercury.
11. Indicate stop on Engine Order Telegraph.
12. Trail shaft.
13. Secure auxiliary exhaust to main condenser.

079-46.8.16.3.4 Main Engine Control will perform the following:

1. Notify Bridge of casualty.
2. Request permission to adjust ship's speed as required.
3. Notify Bridge of casualty cause, action being taken, and estimated time to make repairs.
4. Order auxiliary exhaust cross-connection as required.

079-46.8.16.4 Possible Additional Casualties. Possible additional casualties that may occur are as follows:

1. Reduced efficiency of engineering plant
2. Damaged turbine blades due to overheating
3. Turbine damage, if vacuum loss is accompanied with flooded condenser on steam side and shaft is not locked

079-46.8.17 LEAK IN MAIN CONDENSER. Symptoms, causes, and actions to be taken to remedy casualty are given in the following paragraphs.

079-46.8.17.1 Symptoms Leak will be recognized by excessive or sudden release of steam or water spray, or flowing water from condenser.

079-46.8.17.2 Causes Causes of this casualty are as follows:

1. Corrosion or erosion of condenser tubes
2. Damage from shock or excessive vibration
3. Excessive pressure

079-46.8.17.3 Remedial Actions Two conditions can occur with this casualty. They require differing actions to remedy the situation.

079-46.8.17.3.1 When leaks occur which are not of sufficient magnitude to prevent continued operation or when estimated time of arrival in port is less than 24 hours, take following steps:

1. Notify and keep Main Engine Control informed of situation.
2. Isolate condensate system.
3. Limit number of boilers on engine involved.
4. Blow-down the boiler(s) as necessary to keep feedwater salinity within specified limit.

079-46.8.17.3.2 When leaks occur which are of sufficient magnitude to require immediate shutdown in operation, take the following steps:

1. Notify and keep Main Engine Control informed of situation.
2. Request permission to stop engine and secure affected plant.
3. Stop engine and secure affected plant.
4. Shift drains, auxiliary exhaust, and turbogenerator exhaust to auxiliary condenser.
5. Continue main lubrication oil system in operation.
6. Proceed using other engine.
7. Inspect and test condenser and plug leaking tube(s) (see **NSTM Chapter 254 Condensers, Heat Exchangers, and Air Ejectors**).

079-46.8.17.3.3 Main Engine Control will perform the following:

1. Notify Bridge of casualty.
2. Request permission to adjust speed as necessary.
3. Notify Bridge of casualty cause, action being taken, and estimated time needed to make repairs.

079-46.8.18 HOT CONDENSER. Symptoms, causes, actions to be taken to remedy casualty, and possible additional casualties that can occur are given in the following paragraphs.

079-46.8.18.1 Symptoms. Symptoms of this casualty are as follows:

1. Main condenser inlet and overboard temperature are at or above 60°C (140°F).
2. Main condenser is hot to the touch.
3. Loss of all vacuum in main condenser occurs.

079-46.8.18.2 Causes. Causes of this casualty are as follows:

1. Improperly securing main condenser when securing main engine
2. Failure or inability to secure all steam sourced to main condenser after a major casualty
3. Steam valves leaking through to an idle condenser
4. Main condenser circulating water inlet or overboard valve shut while condenser is in operation
5. Failure or malfunction of main circulating water pump with the ship moored/anchored and main condenser receiving exhaust steam

079-46.8.18.3 Remedial Action. When a hot condenser results in steam being generated on the seawater side, a steam bubble will form in waterboxes and tubes. Initiation of normal circulating water flow with the circulating pump will result in collapse of the steam bubble, creation of a vacuum in the waterboxes and an inrush of water from the sea chest, with resultant severe water hammer (shock). Depending upon the degree of overheating and shock, condenser tube joints may loosen and leak, or rubber expansion joints in the piping may rupture and cause flooding of the space.

WARNING

Do not attempt to restore normal circulating water flow through hot condenser with main circulating water pump before condenser temperature is decreased below 60°C (140°F).

079-46.8.18.3.1 Notify and keep Main Engine Control informed of situation. Then take the following steps:

1. Ensure all sources of steam are secured to main condenser.
   a. Ensure main engine throttle and guarding valves are shut.
   b. Ensure auxiliary exhaust is secured to main condenser.
2. Open main condenser inlet valve.
3. Shut overboard valve.
4. Open condenser overboard header vent valve.

NOTE

Continue to cool condenser by allowing seawater to flow through vent until outlet temperature of seawater is below 60°C (140°F).

079-46.8.18.3.2 Main Engine Control will notify Bridge of casualty cause, action being taken, and estimated time required to make repairs.

079-46.8.18.4 Possible Additional Casualties Possible additional casualties that can occur are as follows:

1. Severe water hammer, resulting in damage to condenser and circulating water piping
2. Rupture of expansion joints
3. Flooding of main machinery spaces.

079-46.8.19 MAIN CONDENSER CASUALTY. Casualty to the main condenser can occur during operation when condenser hot well becomes flooded, when condensate is in a high salinity condition, or when a vacuum leak occurs. Each of these conditions have differing causes and differing courses of action to be taken to correct the casualty. The conditions, causes, and actions to be taken are described in the following paragraphs.

079-46.8.19.1 During Operation. Causes of casualty during operation are as follows:

1. Insufficient circulating water
2. Obstructed inlet header or tubes
3. Overloading condenser
4. Dirty steam sides

079-46.8.19.1.1 Actions to be taken for casualty during operation are as follows:

1. Increase circulating water flow; vent header.
2. Inspect condenser for proper operation and alignment.
3. Secure condenser.
4. Remove obstruction.
5. Decrease exhaust load to main condenser.
6. Secure condenser.
7. Clean condenser.

079-46.8.19.2 Condenser Hot Well Flooded. Causes of casualty are as follows:

1. Inadequate condensate removal
2. Overloading condenser

3. Hot well thermostatic control malfunction (recirculating system)

079-46.8.19.2.1 Actions to be taken for casualty under this condition are as follows:

1. Start standby condensate pump.
2. Shut vacuum drag valve.
3. Shut recirculating valve.
4. Secure auxiliary exhaust to condenser.
5. Inspect hot well thermostatic control for proper operation and alignment.

079-46.8.19.3 High Salinity in Condensate. Causes of casualty are as follows:

1. Leaking condenser tube or tube sheet
2. Contaminated make-up feed
3. High water level in bilges

079-46.8.19.3.1 Actions to be taken for casualty under this condition are as follows:

1. Secure condenser.
2. Hydrostatically test and repair leaks.
3. Shift make-up feed suction to standby tank.
4. Pump bilges.
5. Inspect piping for air leaks.

079-46.8.19.4 Vacuum Leak. Vacuum leak occurs when condenser shell or shell fittings are open to atmosphere. In this situation, test for leaks and make repairs.

079-46.8.20 FAILURE OF MAIN CONDENSER CIRCULATING WATER PUMP (TURBINE-DRIVEN). Six different conditions can bring about this casualty. Each condition has varying causes and courses of remedial action. These are described in the following paragraphs.

079-46.8.20.1 Pump Fails to Deliver Normal Discharge Pressure. Causes of this conditions are as follows:

1. Turbine not up to speed
2. Insufficient supply steam pressure
3. Speed-limiting governor malfunction
4. Obstructed sea chest
5. Swing check valve fails to function properly
6. Internal pump problems

7. Injection or overboard valves or both, not fully open

079-46.8.20.1.1 Respective actions to be taken for each cause are as follows:

1. Open steam supply and throttle valve.
2. Restore steam pressure.
3. Investigate speed-limiting governor.
4. Stop pump, shut suction valve, and blow out sea chest.
5. Inspect swing check valve for proper operation.
6. Stop pump and investigate.
7. Ensure injection and overboard valves are fully open.

079-46.8.20.2 Pump Stops Rotating. Causes of this condition are as follows:

1. Loss of steam pressure
2. Internal pump problems

079-46.8.20.2.1 Actions to be taken to correct this condition are as follows:

1. Restore steam pressure.
2. Secure and investigate.

079-46.8.20.3 Unusual Noise or Vibration. Causes of this condition are as follows:

1. Misalignment of unit
2. Internal pump/turbine problems
3. Obstructed sea chest

079-46.8.20.3.1 When pump stops rotating, shut it down and investigate to determine cause; correct condition.

079-46.8.20.4 Water in Lube Oil. Causes of this condition are as follows:

1. Plugged housing drain hole
2. Leaking tube or tube sheet of lube oil cooler
3. Excessive condensation in gear case
4. Excessive packing clearance

079-46.8.20.4.1 To correct these casualty causes, stop pump, clean drain hole, investigate pump functioning, and change the oil.

079-46.8.20.5 Loss of Lube Oil Pressure. Causes of this condition are as follows:

1. Low oil level in sump
2. Leaking seals, gasket, or piping

079-46.8.20.5.1 To remove causes of this condition, stop and investigate pump and restore oil level to high mark on dipstick.

079-46.8.20.6 High Lube Oil Temperature. Causes of this condition are as follows:

1. Insufficient cooling water to cooler
2. Obstructed cooler tubes
3. Bearing problems

079-46.8.20.6.1 Respective action to be taken for each cause to correct condition:

1. Inspect cooling water system for proper alignment. Vent cooler, increase cooling water flow.
2. Stop and investigate pump.
3. Slow pump until temperature returns to normal. Stop pump and investigate.

NOTE

Main circulating pump deficiencies can cause a loss of vacuum in main condenser.

079-46.8.21 FAILURE OF MAIN CONDENSATE PUMP (MOTOR-DRIVEN). Three different conditions can bring about this casualty. Each condition has varying causes and courses of remedial action. These are described in the following paragraphs.

079-46.8.21.1 Pump Fails to Deliver Normal Pressure. Causes of this condition are as follows:

1. Air leakage in stuffing box
2. Pump vent line valve shut
3. Pump loses suction
4. Internal pump problems

079-46.8.21.1.1 Respective actions to be taken for each cause to remedy the condition are as follows:

1. Provide sealing water and adjust packing gland for slight leakoff.
2. Open vent line valve.
3. Adjust condensate recirculating valve to provide proper water level in condenser hot well.

4. Start standby pump. Stop and investigate affected pump.

079-46.8.21.2 Pump Stops Rotating. Causes of this condition are as follows:

1. Insufficient hot well water level
2. Internal pump/motor problems
3. Misalignment of unit
4. Packing gland too tight

079-46.8.21.2.1 To remedy this condition, start standby pump. Stop and investigate affected pump.

079-46.8.21.3 Unusual Noise or Vibration. Causes of this condition are as follows:

1. Insufficient hot well water level
2. Internal pump/motor problems
3. Misalignment of unit
4. Packing gland too tight

079-46.8.21.3.1 To remedy the condition, adjust packing gland for slight leakoff.

NOTE

Main condenser condensate pump deficiencies can cause flooded main condenser, hot air ejector condenser, and low water level in DFT.

079-46.8.22 FAILURE OF MAIN CONDENSATE PUMP (TURBINE-DRIVEN). Six different conditions can bring about this casualty. Each condition has varying causes and courses of remedial action. These are described in the following paragraphs.

079-46.8.22.1 Pump Fails to Deliver Normal Discharge Pressure. Causes of this condition are as follows:

1. Turbine not up to speed
2. Insufficient supply steam pressure
3. Speed-limiting governor malfunction
4. Air leakage in stuffing box
5. Pump vent line valve shut
6. Pump loses suction
7. Internal pump problems

079-46.8.22.1.1 Respective actions to be taken for each cause to remedy the condition are as follows:

1. Open steam supply and throttle valve.
2. Restore steam pressure.
3. Start standby pump. Stop and investigate affected pump.
4. Provide sealing water and adjust packing gland for slight leakoff.
5. Open vent line valve.
6. Adjust hot well level control valves/condensate recirculating valves to provide proper water level in condenser hot well.
7. Start standby pump. Stop and investigate affected pump.

079-46.8.22.2 Pump Stops Rotating. Causes of this condition are as follows:

1. Loss of steam pressure
2. Internal pump/turbine problems

079-46.8.22.2.1 Respective actions to be taken for each cause to remedy this condition are as follows:

1. Start standby pump. Restore steam pressure.
2. Start standby pump. Stop and investigate affected pump.

079-46.8.22.3 Unusual Noise or Vibration. Causes of this condition are as follows:

1. Insufficient water level in condenser hot well
2. Internal pump/turbine problems
3. Misalignment of unit
4. Packing gland too tight

079-46.8.22.3.1 Actions to be taken to remedy this condition are as follows:

1. Adjust condensate recirculating valve to provide proper water level in condenser hot well; ensure pump vent valve is open.
2. Start standby pump. Stop and investigate affected pump.
3. Adjust packing gland for slight leakoff.

079-46.8.22.4 Water in Lube Oil. Causes of this condition are as follows:

1. Leaking tube or tube sheet of lube oil cooler
2. Excessive packing clearance
3. Excessive condensation in gear casing
4. Plugged housing drain hole

079-46.8.22.4.1 Actions to be taken to remedy condition are as follows:

1. Start standby pump. Stop and investigate affected pump. Change oil.
2. Clean drain hole.

079-46.8.22.5 Loss of Lube Oil Pressure. Causes of this condition are as follows:

1. Leaking seals, gaskets, or piping
2. Shaft driven lube oil pump malfunction
3. Low oil level in sump

079-46.8.22.5.1 Actions to be taken to remedy condition are as follows:

1. Start standby pump. Stop and investigate affected pump.
2. Restore oil level to high mark on dipstick.

079-46.8.22.6 Excessive Lube Oil Temperature. Causes of this condition are as follows:

1. Insufficient cooling water
2. Obstructed cooler tubes
3. Bearing problems

079-46.8.22.6.1 Actions to be taken for each cause to correct this condition are as follows:

1. Increase cooling water through cooler. Vent cooler header. Ensure proper alignment of cooling water system.
2. Start standby pump. Stop and investigate affected pump.
3. Start standby pump. Slow affected pump until temperature drops, then stop pump and investigate.

NOTE

Main condenser condensate pump deficiencies can cause flooded main condenser, hot air ejector condenser and low water level in DFT.

079-46.8.23 MAIN AIR EJECTOR MALFUNCTION. Four different conditions can bring about this casualty. Each condition has varying causes and courses for remedial action. These are described in the following paragraphs.

079-46.8.23.1 Condenser Vacuum Slowly Drops and Holds. Causes of this condition are as follows:

1. Overheated air ejector condenser
2. Air bound air ejector condenser

3. Decrease in steam pressure

079-46.8.23.1.1 Respective action to be taken for each cause to remedy condition is as follows:

1. Adjust recirculating valves to provide sufficient circulation.
2. Vent air ejector condenser header.
3. Adjust steam pressure to normal operating pressure.

079-46.8.23.2 Vacuum Fluctuating. Causes of this condition are as follows:

1. Plugged or obstructed nozzle
2. Fluctuating steam pressure

079-46.8.23.2.1 Action to be taken for each cause to remedy condition is as follows:

1. Shift units.
2. Stabilize steam pressure.

079-46.8.23.3 Respective Air Ejector Inner Condenser and Condenser Vacuum Equalize. Cause of this condition is loss of loop seal. To remedy this, recharge loop seal.

079-46.8.23.4 Vacuum Slowly Drops and Continues to Drop. This is caused by loss of steam pressure, which must be restored to correct the condition.

NOTE

Air ejector condenser deficiencies can cause loss of vacuum in condenser.

079-46.8.24 FAILURE OF ENGINE ORDER TELEGRAPH. Symptoms, causes, actions to be taken to remedy this casualty, and a possible additional casualty that can occur are described in the following paragraphs.

079-46.8.24.1 Symptoms. Symptoms are as follows:

1. Pointer is locked; remains in one position; unit hums excessively.
2. Pointer oscillates or spins.
3. Pointer indicates 180 degrees away from desired position.
4. Pointer has jerky erratic movements.
5. Pointer moves opposite desired direction.
6. Signal bell does not operate.
7. Signal bell rings continuously.

8. Entire engine order system is operating erratically.
9. Entire engine order system is not operating.

079-46.8.24.2 Causes. Causes are as follows:

1. Power failure
2. Fault in interconnecting wiring
3. Faulty synchro
4. Mechanical misalignment

079-46.8.24.3 Remedial Actions. Actions to be taken to correct the casualty are as follows:

1. Notify and keep Main Engine Control informed of situation.
2. Transmit all engine orders via IJV/XIJV sound-powered phone circuit.
3. Isolate and locate fault.
4. Test Engine Order Telegraph using standard Engineering Operational Procedures when repairs have been made.

079-46.8.24.4 Possible Additional Casualty. Improper maneuvering of the ship can result from this casualty.

079-46.8.25 LOSS OF STEAM PRESSURE TO MAIN ENGINE AND TURBOGENERATOR. Symptoms, causes, and actions to be taken to remedy this casualty are discussed in the following paragraphs.

079-46.8.25.1 Symptoms. Symptoms are as follows:

1. Steam pressure gauge registers below normal operational pressure.
2. Gradual or immediate slow down of engines occurs.

079-46.8.25.2 Causes. Causes of this casualty are as follows:

1. Boiler room casualty
2. Damage or malfunction of steam supply system

079-46.8.25.3 Remedial Actions. Actions to be taken to correct the casualty are as follows:

1. Notify and keep Main Engine Control informed of situation.
2. Close main throttle to prevent auxiliary steam pressure from dropping below 85 percent of rated pressure and possible loss of boiler(s) from the line.
3. Trip the turbogenerator(s) from the line.

079-46.8.25.3.1 If electric load is split, bus-tie between the two main switchboards must be closed immediately until a supply of steam is available to the turbogenerator from the other plant. Then take additional steps:

1. Open both auxiliary cross-connection valves.
2. Open main and turbogenerator steam cross-connections.
3. Secure boiler stop-valves.
4. Shift to electric auxiliaries, as required.

079-46.8.25.3.2 Main Engine Control shall perform the following:

1. Notify Bridge of casualty, action being taken, and estimated time required to correct the condition.
2. Request permission to alter speed as necessary.

079-46.8.26 LOCKING AND UNLOCKING OF SHAFT WHILE UNDERWAY. This operation may be considered as a deliberate maneuver rather than a casualty.

079-46.8.26.1 Surface Ships - Locking Shaft. To lock shaft while underway, proceed as follows:

1. Slow ship's speed to approximately one-half full power speed or less, or the maximum designated locking speed.
2. Close the ahead throttle and open the astern throttle sufficiently to stop and hold shaft.
3. Throttleman take note of astern steam pressure required to stop and hold shaft. Observe and record rpm of unaffected shaft and the rudder position.

CAUTION

Shaft must remain stationary while being locked.

4. When affected shaft is stopped and unaffected shaft is at ordered rpm, engage the jacking gear and locking device.

WARNING

Ensure jacking gear area is cleared of personnel prior to closing the astern throttle to prevent injury should the shaft break free and cause the jacking gear to come apart.

5. When shaft is locked, slowly shut astern throttle.
6. Notify Bridge that shaft is locked and of the maximum speed available on unaffected shaft.

CAUTION

If the shaft is locked for more than 5 minutes, the turbine rotor may become bowed. Vacuum should be broken and gland seal secured to prevent distortion of the rotor.

079-46.8.26.1.1 Throttleman staffing unaffected engine is to maintain and log required revolutions as directed by Main Engine Control.

CAUTION

Do not secure lubrication oil to an engine whose shaft is locked while the ship is underway.

079-46.8.26.2 Surface Ships - Unlocking Shaft. To unlock shaft while ship is underway, proceed as follows:

NOTE

If operationally feasible, it is preferred to unlock the shaft with no way on the ship. Under these circumstances, the engine should be restored to service in accordance with normal operating procedures.

CAUTION

Ensure lube oil system is aligned and in operation prior to unlocking main shaft.

CAUTION

Speed of unaffected shaft should be at same rpm and the rudder should be in the same position as when affected shaft was locked.

1. Remove lockpin from jacking gear engaging lever.
2. When signaled, slowly increase astern steam pressure to 50 lb/in below pressure required to lock shaft.
3. Apply steady pressure to jacking gear engaging lever toward the disengage position.
4. If excessive pressure is required to disengage jacking gear, signal throttleman to increase steam pressure. If excessive pressure is still required, signal throttleman to decrease steam pressure.

CAUTION

Maintain control of shaft speed with astern throttle if necessary on multiple screw ships to prevent shaft from exceeding ordered speed increments. Investigate carefully for evidence of overheating of bearings or unusual noises or vibrations while bringing the engine back up to speed.

5. When jacking gear engaging lever is in the disengaged position, disengage the locking device (shaft brake) and signal the throttleman to slowly shut the astern throttle.
6. Insert lockpin in jacking gear engaging lever in disengaged position.
7. EOOW shall report to Bridge, **"Shaft is unlocked and trailing."**

079-46.8.26.3 **Submarines** . To lock or unlock shaft on submarines on surface or submerged, proceed as follows:

1. Single Shaft Submarines.
   a. Locking Shaft When on Surface. To lock shaft, proceed as follows:
      (1) Close ahead throttle and open astern throttle to stop the shaft and adjust throttle opening to hold shaft stationary, assuming shaft was rotating in the ahead direction.
      (2) With shaft stopped, the ship speed will continue to drop, with resulting reduction in torque required to hold shaft stationary. Throttleman must allow for this and reduce throttle opening to ensure that shaft does not rotate and possibly damage turning gear.
      (3) When ship speed has dropped to 50 percent of full power speed or less, engage turning gear by operation of the engagement lever, as outlined in NAVSEA technical manuals. Shaft turns must be zero (shaft stationary) when engaging turning gear. Immediately engage shaft lock or brake in accordance with NAVSEA technical manuals.
      (4) Close astern throttle.
         (a) Ascertain that there is no tendency for motor shaft to turn in either direction at any time.
         (b) Notify Main Engine Control when shaft is locked.
         (c) Maintain lube oil pressure and temperature on the locked unit. Lube oil will have to be secured when bearing replacement or patching of a lube oil line is necessary.
         (d) If it is likely that the shaft will be put back in operation before the turbines can be completely cooled down, proceed as follows in order to reduce rotor bowing. Secure the first-stage air ejector steam and allow vacuum to drop; maintain a condenser vacuum of about 10 inches Hg by throttling the air ejector suction valve. The low vacuum will retard rotor cooling and thus reduce the probability of bowing the rotor. Open turbine drains, recirculate condensate, and slow main circulating pump. See **NSTM Chapter 231** and **NSTM Chapter 241** .
         (e) If the turbine will not be back in operation before it has completely cooled down, the above action to reduce bowing of rotors is not necessary. The condenser may be secured or continued in normal operation as desired.
   b. Locking Shaft When Submerged. To accomplish this, follow the same procedure as specified in step a., above.
   c. Unlocking Shaft When on Surface. To unlock shaft, proceed as follows:
      (1) Reduce temperature of main steam as much as practicable.
      (2) Apply gland steam to turbines, following manufacturer's recommended procedures and settings.

(3) Establish normal condenser vacuum.

(4) Unlatch turning gear disengaging lever (do not release turning gear brake or lock) and apply a firm steady pull on the lever for disengagement.

(5) With low ship speed, the turning gear may disengage when a firm, steady pull is applied. In this case, skip steps 6 and 7 and proceed directly to 8.

(6) Open astern throttle slowly. As the astern turbine bowl pressure builds up, the astern turbine torque will increase. When the astern torque is approximately equal to the torque caused by the trailing propeller, the turning gear will come out of engagement. Disengagement must be accomplished quickly with one continuous movement of the disengaging lever.

(7) When the turning gear is disengaged, close the astern throttle.

(8) Disengage turning gear lock or brake.

(9) Roll turbine with steam, following normal start-up procedures.

CAUTION

Do not roll turbine while turning gear is engaged.

(10) Notify Main Engine Control when shaft is unlocked and turbine plant is available to get under way.

d. Unlocking Shaft When Submerged. To accomplish this, follow the same procedure as specified in step c., above.

CAUTION

A stopped shaft, when submerged submarine has way on, will affect the stability and controllability of the submarine. For training drill, it is recommended that the submarine be trimmed to positive buoyancy so that it will tend to rise rather than sink when way is lost. If necessary, control can be maintained by use of secondary propulsion motor when shaft is stopped.

2. Twin-Shaft Submarines.

a. Locking Shaft When on Surface. To lock shaft, proceed as follows:

(1) Make sure the submarine speed is less than one-half full-power speed. If speed is too great, slow the ship.

(2) Close the ahead throttle control valve and open the astern throttle until the propeller shaft to be locked has stopped. This applies when shaft is rotating for any reason in the ahead direction.

(3) Record astern turbine chest pressure on stopped shaft at the moment it has just stopped. Record ship speed and turns of other shaft.

(4) While holding the shaft stopped with astern steam, engage turning gear and immediately clamp or engage the turning gear lock or brake. (The motor shaft may have to be turned by hand or jogged by power to line up the splines for engagement.) Shaft turns **must be zero** (shaft stationary) when engaging turning gear.

(5) Close astern throttle.

(a) Ascertain that there is no tendency for the shaft to turn at any time.

(b) Notify Main Engine Control when shaft is locked.

(c) Maintain lube oil pressure and temperature on the locked unit. Lube oil will have to be secured when bearing replacement or patching of a lube oil line is necessary.

(d) If it is likely that the shaft will be put back in operation before the turbines can be completely cooled down, proceed as follows in order to reduce rotor bowing. Secure the first-stage air ejector steam and allow vacuum to drop; maintain a condenser vacuum of about 10 inches Hg by throttling the air ejector suction valve. The low vacuum will retard rotor cooling and thus reduce the probability of bowing the rotor. Open turbine drains, crack throttle drains open, recirculate condensate, and slow main circulating pump. See **NSTM Chapter 231** and **NSTM Chapter 241** .

(e) If the turbine will not be put back in operation before it has completely cooled down, the above action to reduce bowing of rotors is not necessary. The condenser may be secured or continued in normal operation as desired.

(f) When one shaft is locked, the throttleman on the unaffected shaft can restore ship speed and revolution, as directed by Main Engine Control, within 50 percent of full power speed or less.

b. Locking Shaft When Submerged. To accomplish this, follow the same procedure as specified in step a., above.

CAUTION

Stopping the shaft when submerged submarine has way on will affect the stability and control of the submarine. For training drill, it is recommended that the submarine be trimmed to positive buoyancy so that it will tend to rise rather than sink when shaft is stopped and way is lost. If necessary, control can be maintained by use of secondary propulsion motor while shaft is stopped.

c. Unlocking Shaft When on Surface. To unlock shaft, proceed as follows:

(1) Reduce temperature of main steam as much as practicable.

(2) Apply gland steam to turbines, following manufacturer's recommended procedures and settings.

(3) Establish normal condenser vacuum.

(4) Bring speed on operating shaft to value recorded at time turning gear was engaged.

(5) Unlatch turning gear engaging lever (**do not** disengage turning gear lock) and apply a firm steady pull on the lever for disengagement. With low ship speed, the turning gear may disengage when the firm steady pull is applied. In this case, skip steps 6 and 7 and proceed directly to 8.

(6) Open astern throttle slowly. As the astern turbine's bowl pressure builds up, the astern turbine torque will increase. When the bowl pressure is approximately equal to that recorded when the shaft was locked, the torque will be equal to the torque caused by the trailing propeller and the turning gear will come out of engagement. Disengagement must be accomplished quickly with one continuous movement of the disengaging lever.

(7) When turning gear is disengaged, close the astern throttle.

(8) Disengage turning gear lock by releasing brake or disengaging locking device.

(9) Notify Main Engine Control when shaft is unlocked and turbine is available to produce power.

CAUTION

Do not roll turbine while turning gear is engaged.

d. Unlocking Shaft When Submerged. To accomplish this, follow same procedure as specified in step c., above.

CAUTION

A stopped shaft, when submerged submarine has way on, will affect the stability and control of the submarine. For training drill, it is recommended that the submarine be trimmed to positive buoyancy so that it will tend to rise rather than sink when way is lost. If necessary, control can be maintained by use of secondary propulsion motor when shaft is stopped.

079-46.9 MAIN ENGINE (DIESEL-DRIVE) CASUALTIES

079-46.9.1 ENGINE SUDDENLY STOPS. The following paragraphs discuss actions to be taken when engine stops, as well as symptoms, causes, remedial actions to be taken, and some additional casualties which may occur.

079-46.9.1.1 Symptoms. Engine suddenly stops and:

1. Engine does not respond to throttle.
2. Engine will not restart.

079-46.9.1.2 Causes. Each of the following may cause sudden engine stoppage:

1. Obstructed fuel oil supply system
2. Governor or controls not properly functioning
3. Air bound in fuel oil system
4. Frozen or seized bearing and shafting
5. Overspeed trip stops engine
6. Air intake system obstructed
7. Overheated engine
8. Hydraulic lock
9. Fuel pump failure

079-46.9.1.3 Remedial Actions. When engine stops perform the following:

1. Notify and keep Main Engine Control informed of situation.

CAUTION

Do not remove engine crankcase covers or access covers until 30 minutes after shutdown of an engine when it is known or suspected that there has been an explosion, fire, or an overheated part in the crankcase.

2. Investigate fuel oil system for obstructions.

3. Investigate fuel oil systems for air binding.
4. Investigate governor and controls for proper operation.
5. Investigate overspeed trip for proper setting and operation.
6. Investigate air intake system for obstructions.
7. Investigate fuel pump for proper operation.
8. Jack over engine to check for freedom of movement.
9. Investigate cooling system for proper temperature and water level.
10. Investigate cylinders for water leak into cylinders.
11. Make repairs as necessary.
12. Restart engine when casualty has been corrected.
13. Test engine.

079-46.9.1.3.1 Main Engine Control will perform the following:

1. Notify Bridge of casualty.
2. Report maximum speed available.
3. Take control of engines from Bridge (if remote unit installed and engine is controlled by Bridge).

CAUTION

Do not overload engine.

4. Reduce speed on unaffected engine if twin screw.
5. Notify Bridge of casualty cause, action being taken, and estimated time needed to make repairs.

079-46.9.1.4 Possible Additional Casualties. Possible additional casualties are as follows:

1. Loss of power unit
2. Reduced maneuverability
3. Loss of maneuverability

079-46.9.2 LOSS OF AIR CLUTCH AIR PRESSURE. Loss of air pressure to air clutch is discussed in the following paragraphs, including symptoms and causes, remedial actions, and possible additional problems that could occur.

079-46.9.2.1 Symptoms. When air clutch loses air pressure:

1. Engine overspeeds and trips out.
2. Low air pressure alarm rings.

3. Loss of air supply will be indicated on gauge.
4. Odor arises from clutch slipping (burning).

079-46.9.2.2 Causes. Air pressure loss in air clutch is caused by the following:

1. Interruption in air supply line to clutch and clutch assembly
2. Ruptured air line or clutch tire
3. Air compressor failure

079-46.9.2.3 Remedial Actions. Air pressure loss shall be corrected by the following procedure:

1. Notify and keep Main Engine Control informed of situation.
2. Bring throttle and clutch control to stop position.
3. Investigate air compressor for proper operation.
4. Investigate for rupture in air supply system.
5. Investigate for obstruction in air supply piping.

CAUTION

If clutch is on fire, extinguish with CO_2 .

6. Break out firefighting equipment.
7. Make repairs as necessary.
8. Restart engine when casualty has been corrected.
9. Test engine.

079-46.9.2.3.1 Main Engine Control will perform the following:

1. Notify Bridge of casualty.
2. Report maximum speed available.
3. Take control of engines from Bridge (if remote unit installed and engine is controlled by Bridge).

CAUTION

Do not overload engine.

4. Reduce speed on unaffected engine, if twin screw.
5. Notify Bridge of casualty cause, action being taken, and estimated time needed to make repairs.

079-46.9.2.4 Possible Additional Casualties. Other casualties subsequent to air clutch air pressure loss may be as follows:

1. Reduced maneuverability
2. Loss of maneuverability
3. Fire in space

079-46.9.3 ELECTRIC POWER FAILURE TO GOVERNOR CONTROL MOTOR AND AIR CLUTCH. This casualty is discussed in the following paragraphs.

079-46.9.3.1 Symptoms. When power failure to governor control motor and air clutch occurs the following symptoms may be present:

1. Engine will slow to idling speed.
2. Clutch control will return to neutral position.
3. Engine will not respond to governor clutch controller.

079-46.9.3.2 Causes. Loss of power results from the following:

1. Blown fuses in controller circuit
2. Power failure to controller circuit
3. Open circuit in system
4. Dirty or broken contacts in controller

079-46.9.3.3 Remedial Actions. Proceed as follows to restore power:

1. Notify and keep Main Engine Control informed of situation.
2. Check power to controller.
3. Check fuses to controller.
4. Check for open circuit in system.
5. Check controller for open or dirty contacts.

NOTE

Use manual throttle control and manual clutch control until casualty to unit is corrected.

079-46.9.3.3.1 Main Engine Control will perform the following:

1. Notify Bridge of casualty.
2. Report maximum speed available.
3. Take control of engines from Bridge (if remote unit installed and engine is controlled by Bridge).

CAUTION

Do not overload engine.

4. Reduce speed on unaffected engine, if twin screw.
5. Notify Bridge of casualty cause, action being taken, and estimated time required to make repairs.

079-46.9.3.4 Possible Additional Casualties. Possible additional casualties are momentarily reduced or lost maneuverability.

079-46.9.4 UNABLE TO START ENGINE (ELECTRIC START). Inability to start engine using electric starter motor is discussed in the following paragraphs.

079-46.9.4.1 Symptoms. With failure to start engine, casualty and symptom are the same; engine will not turn over when start button is pressed.

079-46.9.4.2 Causes. Failure to start may be caused by any of the following:

1. Batteries low or dead
2. Poor connection in starter button or batteries
3. Open circuit in system
4. Starter motor open
5. Badly worn starter motor brushes
6. Engine frozen
7. Water in cylinders
8. Improper operation of starter engagement
9. Worn or broken pinion gear
10. Broken tooth on ring gear

079-46.9.4.3 Remedial Actions. To locate casualty cause and restore starting:

1. Notify and keep Main Engine Control informed of situation.
2. Replace or charge batteries.
3. Check starter electrical system for open or poor condition.
4. Check condition of starting motor.
5. Check engaging mechanism of starter motor for proper operation.
6. Jack over engine to check for freedom of movement.
7. Inspect pinion and ring gear for wear and broken teeth.
8. Use air motor to start engine.

9. Make repairs to electrical starting system.

079-46.9.4.3.1 Main Engine Control will notify Bridge of casualty, action being taken, and estimated time needed to make repairs.

079-46.9.5 LOW LUBE OIL PRESSURE. The following paragraphs discuss low lube oil pressure, symptoms, causes, remedial action, and possible additional casualties resulting from this condition.

079-46.9.5.1 Symptoms. Low lube oil pressure can be recognized by the following:

1. Pressure gauge indicates low lube oil pressure.
2. Low lube oil pressure alarm sounds.
3. Engine noise increases.

079-46.9.5.2 Causes. Low oil pressure can be caused by:

1. Low oil level in sump
2. Restricted lube oil strainers:
   a. Filters
   b. Pump suction screen
   c. Lines
3. Lube oil pump failure
4. Leak in lube oil system
5. Faulty pressure regulator

079-46.9.5.3 Remedial Actions. To restore lube oil pressure to normal level, proceed as follows:

1. Secure engine immediately. Notify and keep Main Engine Control informed of situation.

CAUTION

Do not remove engine crankcase covers or access covers until 30 minutes after shutdown of an engine when it is known or suspected that there has been an explosion, fire, or an overheated part in the crankcase.

2. Investigate lube oil sump level for proper level.
3. Investigate lube oil strainers, filters, screws and lines for obstruction.
4. Investigate lube oil pump for proper operations.
5. Check lube oil pressure regulator for proper operation.
6. Make repairs as necessary.
7. Restart and test engine when casualty is corrected.

079-46.9.5.3.1 Main Engine Control will perform the following:

1. Notify Bridge of casualty while securing engine.
2. Request adjustments in ship's speed as necessary.
3. Notify Damage Control Central if oil leak exists.
4. Take control of engines from Bridge (if remote unit installed and engine is controlled by Bridge).

CAUTION

Do not overload engine.

5. Reduce speed on unaffected engine, if twin screw.
6. Notify Bridge of casualty cause, action being taken, and estimated time required to make repairs.

079-46.9.5.4 Possible Additional Casualties. Possible additional casualties may include:

1. Overheated engine
2. Burned out bearings, shafts, pistons, and other movable parts
3. Seizing of bearing, shafts, pistons, and other movable parts
4. Loss of engine
5. Crankcase explosion
6. Class BRAVO fire

079-46.9.6 ENGINE OVERSPEEDS. Overspeeding of engine is discussed in the following paragraphs, including symptoms and causes of casualty, actions to be taken to correct problem, and additional casualties which may result.

079-46.9.6.1 Symptoms. Engine overspeeding will cause the following:

1. Engine operating speed rapidly increases.
2. Over-speed trips stop engine.

079-46.9.6.2 Causes. Overspeeding can be caused by the following:

1. Improper governor adjustment
2. Governor failure
3. Fuel pump sticking
4. Injector rack sticking
5. Throttle linkage loose or binding
6. Removing load from engine too rapidly

079-46.9.6.3 Remedial Actions. To correct engine overspeeding, use the following procedures:

1. Notify and keep Main Engine Control informed of situation.

CAUTION

Do not remove engine crankcase covers or access covers until 30 minutes after shutdown of an engine when it is known or suspected that there has been an explosion, fire, or an overheated part in the crankcase.

2. Bring engine controller to stop, or slow speed as necessary.
3. Investigate governor for failure.
4. Investigate governor for low oil level.
5. Investigate throttle linkage and injector racks for proper operation.
6. Make necessary repairs.
7. Restart engine if tripped.
8. Test engine.

079-46.9.6.3.1 Main Engine Control will perform the following:

1. Notify Bridge of casualty.
2. Report maximum speed available.
3. Take control of engines from Bridge (if remote unit is installed and engine is controlled by Bridge).

CAUTION

Do not overload engine.

4. Reduce speed on unaffected engine, if twin screw.
5. Notify Bridge of casualty cause, action being taken, and estimated time needed to make repairs.

079-46.9.6.4 Possible Additional Casualty. Loss of the power unit is an additional casualty of engine overspeeding.

079-46.9.7 LUBE OIL COOLER LEAK. Leakage in the lube oil cooler is discussed in the following paragraphs. Symptoms and causes of the casualty are listed, as well as actions to correct the condition and a possible additional casualty that can occur.

079-46.9.7.1 Symptoms. A leak in the lube oil cooler can be detected by the following:

1. Low oil level in engine sump
2. Lube oil in cooling water

3. Low lube oil pressure

079-46.9.7.2 Causes. This casualty is caused by a ruptured tube, or inner gaskets leaking in lube oil cooler.

079-46.9.7.3 Remedial Actions. Proceed as follows to repair leak in oil cooler.

1. Notify and keep Main Engine Control informed of situation.
2. Secure engine.

CAUTION

Do not remove engine crankcase covers or access covers until 30 minutes after shutdown of an engine when it is known or suspected that there has been an explosion, fire, or an overheated part in the crankcase.

3. Pressure-test cooler:
   a. Plug tube.
   b. Renew gaskets.
   c. Replace cooler as required.
4. Restart and test engine when cause of casualty has been removed.

079-46.9.7.3.1 Main Engine Control will perform the following:

1. Notify Bridge of casualty.
2. Report maximum speed available.
3. Take control of engines from Bridge (if remote unit installed and engine is controlled by the Bridge).

CAUTION

Do not overload engine.

4. Reduce speed on unaffected engine, if twin screw.
5. Notify Bridge of casualty cause, action being taken, and estimated time required to make repairs.

079-46.9.7.4 Possible Additional Casualty. Loss of the power unit is possible if casualty is not corrected promptly.

079-46.9.8 HIGH FRESHWATER COOLING TEMPERATURE. This condition is discussed in the following paragraphs.

079-46.9.8.1 Symptoms. Freshwater cooling temperature that is too high will cause the following symptoms:

1. Freshwater thermometers read high.

2. High temperature alarm sounds.
3. Low freshwater pressure is indicated.
4. Low seawater pressure is indicated.
5. High freshwater level in expansion tank.
6. Gas bubbles escape from tank.

079-46.9.8.2 Causes. Water temperature rising too high can result from the following:

1. Freshwater or seawater pump failure
2. Low water level in freshwater system
3. Air entrainment in either freshwater or seawater system (caused by air leak in suction side of pumps)
4. Plugged or restricted freshwater or seawater system
5. High compression leak into freshwater system from cylinders
6. Engine overload
7. Temperature regulator failure
8. Low lube oil level

079-46.9.8.3 Remedial Actions. To restore water temperature to lower level:

1. Notify and keep Main Engine Control informed of situation.
2. Reduce load or speed of engine, or both.
3. Check freshwater level.
4. Check freshwater pump operation.
5. Check:
   a. Temperature regulator
   b. Valve
   c. By-pass regulator.
6. Check seawater and freshwater systems for obstructions in suction and discharge sides.

CAUTION

Do not remove engine crankcase covers or access covers until 30 minutes after shutdown of an engine when it is known or suspected that there has been an explosion, fire, or an overheated part in the crankcase.

7. Check cylinders for cracks or gasket leaks between freshwater side and compression side.
8. Make necessary repairs.
9. Restart and test engine, if shut down.

079-46.9.8.3.1 Main Engine Control will perform the following:

1. Notify Bridge of casualty.
2. Report maximum speed available.
3. Take control of engine from Bridge (if remote unit is installed and engine is controlled by Bridge).

CAUTION

Do not overload engine.

4. Reduce speed on unaffected engine, if twin screw.
5. Notify Bridge of casualty cause, action being taken, and estimated time required to make repairs.

079-46.9.8.4 Possible Additional Casualties. Possible additional casualties are as follows:

1. Reduced power
2. Loss of power unit
3. Overheating of engine

079-46.9.9 LOW SEAWATER COOLING PRESSURE. This casualty is discussed in the following paragraphs. Symptoms and causes of casualty are listed as well as actions to correct the condition.

079-46.9.9.1 Symptoms. Low seawater cooling pressure will produce the following symptoms:

1. Low seawater pressure indicated on pressure gauge.
2. Freshwater cooling water and lube oil temperature rises above normal.

079-46.9.9.2 Causes. Low seawater cooling pressure is caused by:

1. Seawater pump failure
2. Sea chest or strainer obstruction, or both
3. Seawater pump air bound

079-46.9.9.3 Remedial Actions. To restore seawater pressure, proceed as follows:

1. Notify and keep Main Engine Control informed of situation.
2. Reduce load or speed of engine, as required, or both, to prevent overheating.
3. Cut in emergency seawater cooling from firemain.
4. Check and clean seawater strainer.
5. Steam out sea chest if obstructed.

079-46.9.9.3.1 Main Engine Control will perform the following:

1. Notify Bridge of casualty.
2. Report maximum speed available.
3. Take control of engines from Bridge (if remote unit installed and engine is controlled by Bridge).

CAUTION

Do not overload engine.

4. Reduce speed on unaffected engine, if twin screw.
5. Notify Bridge of casualty cause, action being taken, and estimated time needed to make repairs.

079-46.9.9.4 Possible Additional Casualty. Overheating of engine is a possible additional casualty of low seawater cooling pressure.

079-46.9.10 FAILURE OF REDUCTION GEAR LUBRICATING OIL PUMP (LST-TYPE). Reduction gear lubricating oil pump failure is discussed in the following paragraphs. Discussion includes symptoms and causes of the casualty, remedial actions to be taken, and possible additional casualties.

079-46.9.10.1 Symptoms. When reduction gear lubricating oil pumps fails, the following symptoms will be produced:

1. Lubricating oil pressure gauges indicate low or loss of pressure.
2. Low pressure lubricating oil alarm sounds.
3. Low pressure lubricating oil red marker appears.
4. No oil flow observed in bearing oil sight flow glass (if applicable).
5. Excessive bearing temperature observed on bearing thermometers.

079-46.9.10.2 Causes. Failure of reduction gear lubricating oil pump is caused by the following:

1. Failure of attached pump, coupled with failure of electric standby pump to start (standby pump starts automatically when oil pressure drops)
2. Low oil level in reduction gear sump
3. Major oil piping leak
4. Malfunction or improper setting or unloading valve or relief valve (if applicable)

079-46.9.10.3 Remedial Actions. To correct lubricating oil pump failure perform the following:

1. Notify Main Engine Control by stating,**“ Shaft is being stopped and locked.”**

2. Reduce load or speed of engine, or both.

079-46.9.10.3.1 Main Engine Control will then:

1. Notify Bridge of casualty.
2. Report maximum speed available.
3. Take control of engines from Bridge (if remote unit installed and engines are controlled by Bridge).

CAUTION

Do not overload engines.

4. Slow or stop unaffected engines, if twin screw.
5. Notify Bridge of cause of casualty, action being taken, and estimated time needed to make repairs.

079-46.9.10.3.2 Proceed with the following:

1. Stop and lock affected shaft.

NOTE

Ships equipped with variable pitch propellers should stop the affected rotating shaft by reversing the pitch of the propeller blades and reduce the amount of pitch as the shaft approaches zero r/min. The shaft should be locked as soon as the shaft approaches zero r/min.

CAUTION

A bearing wear reading of good is not an accurate indication that the bearing is not damaged. A build up of wiped bearing metal may be holding the shaft in position, which will give a false indication of the actual condition of bearing.

2. Inspect lubricating oil strainer in operation at time of casualty, determine if any bearing metal is present.
3. Take axial and radial clearances of all bearings, where means to do so are provided.
4. Inspect reduction gear bearings.
5. Report extent of damage (if any) and estimated time needed to make repairs when bearings have been inspected.
6. Determine and correct cause of oil pump failure.
7. Shift and inspect oil strainer, to determine if any bearing metal is present when damage has been corrected and oil pressure restored.
8. Request permission to unlock shaft to test reduction gear when repairs have been completed.
9. Align lubricating oil purifier to take suction on reduction gear sump.

079-46.9.10.3.3 Main Engine Control will also perform the following:

1. Notify Bridge of unaffected shaft speed requirement.
2. Notify Bridge of casualty cause and estimate time needed to make bearing inspection and repairs.
3. Notify Bridge when repairs are completed.
4. Request permission to test reduction gears.

079-46.9.10.4 Possible Additional Casualties. Possible additional casualties resulting from reduction gear lubricating oil pump failure are as follows:

1. Hot bearings
2. Damage to reduction gears

079-46.9.11 FAILURE OF REDUCTION GEAR COOLING WATER AND LUBRICATING OIL PUMP. The following paragraphs discuss failure of the reduction gear cooling water and lubricating oil pump, including casualty symptoms and causes, remedial actions, and possible additional casualties.

079-46.9.11.1 Symptoms. When reduction gear cooling water and lubricating oil pump fails, symptoms are as follows:

1. Lubricating oil and seawater cooling pressure gauges indicate low or loss of pressure.
2. Lubricating oil and seawater reduction gear pump alarm sounds.
3. Loss of excitation to propulsion motors of reduction gears affected (if applicable).
4. Excessive bearing temperatures observed on bearing thermometers.

079-46.9.11.2 Causes. This failure can be caused by the following:

1. Power failure to pump motor
2. Blown fuses
3. Open circuit in motor contoller or motor
4. Overload of motor (causing overload protection device to drop motor circuit off line)
5. Seizing of motor or pumps, or both
6. Major oil piping leak
7. Low oil level in reduction gear sump

079-46.9.11.3 Remedial Actions. Proceed as follows to correct the pump failure:

1. Notify and keep Main Engine Control informed of situation.
2. Start standby reduction gear cooling water and lubricating oil pump.

079-46.9.11.3.1 Main Engine Control will perform the following:

1. Notify Bridge of casualty.
2. Report maximum speed available.
3. Take control of engines from Bridge (if remote unit installed and engine is controlled by Bridge).

CAUTION

Do not overload engine.

4. Reduce speed on unaffected engine, if twin screw.
5. Notify Bridge of casualty cause, action being taken, and estimated time needed to make repairs.

079-46.9.11.3.2 When the oil pressure is not restored immediately perform the following:

1. Stop and lock shaft.
   a. Slow or stop unaffected engine if ship has way on.
   b. Lock shaft when affected shaft approaches zero r/min.

CAUTION

A bearing wear reading of “good” is not an accurate indication that bearing is not damaged. A build up of wiped bearing metal may be holding the shaft in position, giving a false indication of bearing condition.

2. Inspect lubricating oil filter that was in operation at the time casualty occurred.
3. Determine if any bearing metal is present.
4. Take axial and radial clearances of all bearings, where means to do so are provided.
5. Inspect reduction gear bearings.
6. Report extent of damage (if any) and estimated time needed to make repairs when bearings have been inspected.
7. Determine and correct cause of oil pump failure.
   a. Check power to controller of affected unit.
   b. Push reset button and restart pumps.
   c. Check pump and motor for freedom of movement.
   d. Check for open circuits.
   e. Check for major piping leaks.
8. Shift and inspect oil strainer to determine if any bearing metal is present when damage has been corrected and oil pressure restored.
9. Request permission to unlock shaft to test reduction gear when repairs have been completed.

079-46.9.11.3.3 Main Engine Control will then perform the following:

1. Notify Bridge of unaffected shaft speed requirements.
2. Notify Bridge of casualty cause and estimated time needed to make bearing inspection and repairs.
3. Notify Bridge when repairs are completed.
4. Request permission to test reduction gears.

079-46.9.11.4 Possible Additional Casualties. Possible additional casualties are as follows:

1. Reduced power and maneuverability
2. Hot bearings
3. Unusual noise in reduction gear, shafting or main engines
4. Unusual vibration in reduction gear, shafting, or main engine

079-46.9.12 FAILURE OF SPEED-LIMITING GOVERNOR. Speed-limiting governor failure is discussed in the following paragraphs.

079-46.9.12.1 Symptoms. Failure of speed-limiting governor results in the following symptoms:

1. Engine is racing.
2. Engine is running at excessive rate of speed.
3. Engine stops suddenly.
4. Excessive hunting of governor.
5. Governor fails to respond to load changes.

079-46.9.12.2 Causes. This casualty can be caused by the following:

1. Low oil level in speed-limiting governor
2. Pilot valve stuck or leaking
3. Improper adjustment of needle valve
4. Speed-limiting governor actuating arms binding
5. Speed-limiting governor activating arms loose
6. Separated linkage on speed-limiting governor actuating arms
7. Dirty lube oil in speed-limiting governor

079-46.9.12.3 Remedial Actions. To correct speed-limiting governor failure perform the following:

1. Notify and keep Main Engine Control informed of situation.
2. Secure engine by emergency stop control if engine starts to overspeed.
3. Check speed-limiting governor oil level.

4. Check adjustment of needle valve.
5. Check pilot valve and actuating valve.
6. Flush out speed-limiting governor and refill with clean oil.
7. Check speed drop settings and correct as necessary.

079-46.9.12.3.1 Main Engine Control will perform the following:

1. Notify Bridge of casualty.
2. Report maximum speed available.
3. Take control of engines from Bridge (if remote unit installed and engine is controlled by Bridge).

CAUTION

Do not overload engine.

4. Reduce speed on unaffected engine, if twin screw.
5. Notify Bridge of casualty cause, action being taken, and estimated time required to make repairs.

079-46.9.12.4 Possible Additional Casualty. Loss of power unit may result from failure of speed-limiting governor.

079-46.9.13 LOSS OF FUEL OIL PRESSURE. Fuel oil pressure loss is discussed in the following paragraphs, including symptoms and causes of casualty, remedial actions, and possible additional casualties which may result.

079-46.9.13.1 Symptoms. Loss of fuel oil pressure will produce the following symptoms:

1. Engine slows down.
2. Engine stops.
3. Low pressure indicated on fuel oil gauge.
4. Total loss of pressure indicated on fuel oil gauge.
5. Irregular operation of engine, unable to carry load.

079-46.9.13.2 Causes. The following list includes causes of pressure loss:

1. Low fuel oil in service tanks
2. Restriction in fuel oil piping
3. Fuel oil pump failure
4. Water in fuel oil
5. Fuel oil filters clogged
6. Fuel oil strainers clogged

7. Air entrainment in fuel oil system

079-46.9.13.3 Remedial Actions. To locate cause and correct casualty, proceed as follows:

1. Notify and keep Main Engine Control informed of situation.
2. Check fuel oil level in service tanks.
3. Investigate service pumps for proper operation.
4. Investigate valves and piping from engine to tanks for leaks.
5. Investigate fuel oil filters and strainers for restrictions.
6. Check for water in fuel oil.
7. Bleed off air in fuel oil system.

CAUTION

Avoid excessive fuel oil pressure in system.

8. Start auxiliary fuel oil booster pump.

079-46.9.13.3.1 Main Engine Control will perform the following:

1. Notify Bridge of casualty.
2. Report maximum speed available.
3. Take control of engines from Bridge (if remote unit installed and engine is controlled by Bridge).

CAUTION

Do not overload engine.

4. Reduce speed on unaffected engine, if twin screw.
5. Notify Bridge of casualty cause, action being taken, and estimated time needed to make repairs.

079-46.9.13.4 Possible Additional Casualties. Possible additional casualties are as follows:

1. Reduced power
2. Loss of power
3. Class BRAVO fire

079-46.9.14 WATER IN ENGINE CYLINDERS/CRANKCASE, OR AIR INTAKE PORTS (AIR BOX). This casualty is discussed in the following paragraphs. Discussion covers symptoms and causes of water leakage into cylinder, crankcase, or air intake ports, corrective action to be taken, and possible additional casualty.

079-46.9.14.1 Symptoms. Presence of water will be detected by the following symptoms:

1. Water ejects from test cocks when engine is blown down or jacked over.
2. Water detected in lube oil.
3. Loss of cooling water is indicated.
4. Lower level of cooling water indicated in expansion tank when engine is stopped.
5. Lower level of cooling water indicated in surge tank when engine is stopped.
6. Freshwater level increases when engine is running:
   a. Gas bubbles escape from freshwater expansion tank vent.
   b. Vapor escapes from freshwater expansion tank vent.
7. Lower firing and cylinder temperatures.
8. Engine cylinder knock detected.

079-46.9.14.2 Causes. Causes of water presence in engine cylinders, crankcase, or air intake ports are as follows:

1. Crack in cylinder head or liner
2. Leaking or blown out gaskets or seal between combustion chamber and cooling water jacket
3. Leaking or blown out gaskets or seal between combustion chamber and exhaust system

079-46.9.14.3 Remedial Actions. Proceed as follows to correct this condition:

1. Notify and keep Main Engine Control informed of situation.

CAUTION

A bearing wear reading of good is not an accurate indication that bearing is not damaged. A build up of wiped bearing metal may be holding the shaft in position, giving a false indication of bearing condition.

2. Stop engine immediately, if running.
3. Check cylinders by jacking over with test cocks open.
4. Pressure test freshwater cooling system.
5. Investigate and make repairs, as necessary.
6. Start lube oil purifier.
7. Remove water from lube oil in engine sumps.

079-46.9.14.3.1 Main Engine Control will perform the following:

1. Notify Bridge of casualty.

2. Report maximum speed available.
3. Take control of engines from Bridge (if remote unit installed and engine is controlled by Bridge).

CAUTION

Do not overload engine.

4. Reduce speed on unaffected engine, if twin screw.
5. Notify Bridge of casualty cause, action being taken, and estimated time required to make repairs.

079-46.9.14.4 Possible Additional Casualty. Loss of power unit is a possible additional casualty resulting from the presence of water in cylinders, crankcase, or air intake ports.

079-46.10 MAIN ENGINE (GAS TURBINE DRIVE) CASUALTIES

079-46.10.1 LOSS OF LUBE OIL PRESSURE TO REDUCTION GEARS. This casualty is discussed in the following paragraphs. Discussion includes symptoms and causes of loss of lube oil pressure, remedial action to be taken, and possible additional casualties.

079-46.10.1.1 Symptoms. Pressure loss may be detected by the following symptoms:

1. Lube oil header pressure high/low alarm illuminated.
2. Lube oil remote bearing pressure lube oil alarm illuminated.
3. Lube oil strainer differential pressure alarm illuminated.
4. Sump level low alarm is energized.
5. On-line (and standby) lube oil pump high speed light is illuminated.
6. High journal (or thrust bearing) temperature alarm illuminated.
7. No oil flow observed in bearing oil flow sight glasses.

079-46.10.1.2 Causes. Loss of lube oil pressure to reduction gears results from the following:

1. Major leak in reduction gear lube oil system
2. Obstruction in lube oil piping or strainer
3. Failure of attached, lead and standby lube oil pumps
4. Defective pressure transducer
5. Misalignment of lube oil purifier

079-46.10.1.3 Remedial Actions. To restore oil pressure to reduction gears, use the following procedures:

1. Notify and keep Main Engine Control informed of situation.

2. Stop affected engines, verify pitch is zero.
3. Lock affected shaft.
4. Disconnect attached lube oil pump when it has failed.
5. Inspect standby lube oil pump for possible binding.
6. Monitor lube oil alarm and status indicators for possible failure.
7. Obtain a group printout.
8. Monitor propulsion turbine synthetic lube oil system for overheating.
9. Ensure lube oil pump mode selector switch is in proper position.
10. Monitor lube oil strainers for differential pressure.
11. Inspect lube oil system for leaks.
12. Attempt to start standby lube oil pump in LOCAL if pump fails to start in REMOTE.
13. Shut down affected propulsion turbine as required.
14. Replenish oil in sump tank when tank is low.
15. Restart and test in accordance with **Engineering Operational Procedures** when cause has been determined and casualty is eliminated.

079-46.10.1.3.1 Main Engine Control will perform the following:

1. Notify Bridge of casualty.
2. Report stopping and locking shaft.
3. Notify Damage Control Central if oil leak exists.
4. Take control of turbine when remoted to Bridge.
5. Reduce speed on unaffected shaft as required.
6. Notify Bridge of casualty cause, action being taken, and estimated time needed to make repairs.

079-46.10.1.4 Possible Additional Casualties. Possible additional casualties resulting from loss of oil pressure to reduction gears are as follows:

1. Damage to main reduction gear bearings
2. Damage to main reduction gears
3. Reduced maneuverability
4. Loss of maneuverability
5. Class BRAVO fire

079-46.10.2 HIGH LUBE OIL TEMPERATURE IN REDUCTION GEARS. High lube oil temperature in reduction gears is discussed in the following paragraphs. Symptoms and causes of the casualty are listed, as well as remedial actions to correct the condition and possible additional casualties that can occur.

079-46.10.2.1 Symptoms. Temperature increase in lube oil will be indicated by the following symptoms:

1. Lube oil header temperature high/low alarm sounds and light is illuminated.
2. Reduction gear journal (or thrust) bearing high temperature alarm sounds and light illuminates.
3. Lube oil header temperature gauge shows increase in temperature.

079-46.10.2.2 Causes. High lube oil temperature in reduction gears is caused by the following:

1. Cooling water system failure
2. Lube oil system misaligned
3. High oil level in reduction gear sump
4. Lube oil cooler improperly vented

079-46.10.2.3 Remedial Actions. Proceed as follows to correct conditions:

1. Notify and keep Main Engine Control informed of situation.
2. Monitor cooling water system for proper operation.
3. Check lube oil system alignment.
4. Monitor oil level in reduction gear sump.
5. Vent lube oil cooler.
6. Test reduction gears in accordance with **Engineering Operational Procedures** when casualty is eliminated.

079-46.10.2.3.1 Main Engine Control will perform the following:

1. Notify Bridge of casualty.
2. Report maximum speed available.
3. Take local control of turbines when turbines are remoted to Bridge.
4. Reduce speed on unaffected turbine as required.
5. Notify Bridge of casualty cause, action being taken, and estimated time required to make repairs.

079-46.10.2.4 Possible Additional Casualties. Casualties resulting from overheated lube oil are as follows:

1. Hot bearing
2. Reduced maneuverability
3. Loss of maneuverability

079-46.10.3 HOT BEARING IN REDUCTION GEAR. This casualty is discussed in detail in the following paragraphs. Discussion includes causes and symptoms of hot bearing in reduction gear, remedial actions that shall be taken, and possible additional casualties.

079-46.10.3.1 Symptoms. Hot bearings will be recognized by the following symptoms:

1. High journal (or thrust) bearing temperature alarm sounds and light illuminates.
2. Lube oil header pressure indicates low.
3. Lube oil pressure to remote bearing indicates low.
4. Metal or other foreign matter in lube oil strainer.

NOTE

Bearings which have indicated temporary signs of distress (hot bearings) and return to normal temperatures, shall be inspected thoroughly at the earliest opportunity.

079-46.10.3.2 Causes. Hot bearing in reduction gear casualty is caused by the following:

1. Emulsified oil
2. High oil temperature
3. Improper warmup of reduction gears
4. Low lube oil pressure
5. Plugged or clogged oil system
6. Material deficiencies

079-46.10.3.3 Remedial Actions. The following procedures shall be used to correct hot bearing casualty:

1. Notify and keep Main Engine Control informed of situation.
2. Slow affected shaft.
3. Increase lube oil pressure.
4. Increase cooling water flow to lube oil cooler.
5. Apply artificial cooling to bearing cover.
6. Stop and lock shaft when bearing temperature cannot be controlled.
7. Shift and inspect lube oil strainers.
8. Monitor reduction gear sump level.
9. Monitor oil flow sight glasses for normal oil flow.
10. Place lube oil purifier in operation sump to sump.
11. Take lube oil sample for test.
12. Test in accordance with **Engineering Operational Procedures** when casualty is corrected.

079-46.10.3.3.1 Main Engine Control will perform the following:

1. Notify Bridge of casualty.
2. Report maximum speed available.
3. Take local control of turbines when turbines are remoted to Bridge.
4. Reduce speed of unaffected turbines as required.
5. Notify Bridge of casualty cause, remedial action being taken, and estimated time required to make repairs.

079-46.10.3.4 Possible Additional Casualties. Possible additional casualties are as follows:

1. Wiped bearing
2. Reduced maneuverability
3. Loss of maneuverability

079-46.10.4 UNUSUAL NOISE/VIBRATION IN MAIN REDUCTION GEAR OR SHAFT. The causes and symptoms, remedial action, and possible additional casualties arising from unusual noise or vibration in the main reduction gear or shaft are discussed in the following paragraphs.

079-46.10.4.1 Symptoms. When these conditions occur, it can be considered that the symptoms are themselves casualties. They would appear as follows:

1. Unusual noise in main reduction gear or shaft.
2. Unusual vibration in main reduction gear or shaft.

079-46.10.4.2 Causes. Noises and vibrations in reduction gear or shaft can be caused by the following:

1. Bulkhead shaft seal misaligned or damaged
2. Fouled propeller, fairwater, or shaft
3. Damaged propeller or shaft
4. Wiped reduction gear bearing
5. Defective attached lube oil pump
6. Defective attached controllable reversible propeller hydraulic pump
7. Snubbers worn or misaligned
8. Wiped line shaft bearing
9. Loose, broken, or missing line shaft bearing hold-down bolts
10. Debris riding against shaft
11. Broken reduction gear teeth
12. Stern tube or strut bearing stickslip

079-46.10.4.3 Remedial Actions. The following procedures should aid in locating and correcting noises and vibrations in reduction gear or shaft:

1. Notify and keep Main Engine Control informed of situation.
2. Slow main engines as required.

CAUTION

If unusual noise is detected within main reduction gears, stop and lock shaft.

3. Investigate main reduction gear casings, main shaft, and seals for abnormalities.
4. Ensure line shaft bearings have adequate lubrication.
5. Ensure reduction gear (and shaft bearing) hold-downs bolts are in place and tight.
6. Ensure stern tube seal and shaft bulkhead seals are properly functioning.
7. Inspect attached lube oil pump.
8. Inspect controllable reversible propeller hydraulic pump.
9. Test in accordance with **Engineering Operational Procedures** when noise or vibration has been corrected.

079-46.10.4.3.1 Main Engine Control will perform the following:

1. Notify Bridge of casualty.
2. Report maximum speed available.
3. Take local control of turbines when turbines are remoted to Bridge.
4. Reduce speed of unaffected turbines as required.
5. Notify Bridge of casualty cause, action being taken, and estimated time needed to make repairs.

079-46.10.4.4 Possible Additional Casualties. Possible additional casualties are as follows:

1. Damaged clutch
2. Damaged reduction gear
3. Damaged shaft bearings
4. Reduced maneuverability
5. Loss of maneuverability

079-46.10.5 BRAKE FAILS TO ENGAGE/DISENGAGE. Symptoms and causes of this casualty, remedial actions for it, and possible additional casualties are discussed in the following paragraphs.

079-46.10.5.1 Symptoms. When brake fails to engage or disengage, the following symptoms will appear:

1. Brake-on light fails to illuminate on command.
2. Power turbine r/min fails to decrease.
3. Brake-off light fails to illuminate on command.

4. Power turbine r/min remains at zero.

079-46.10.5.2 Causes. This casualty is caused by the following:

1. Controls system failure
2. Insufficient air pressure (engage only)
3. Defective brake pack
4. Insufficient lube oil pressure (engage only)
5. High lube oil temperature (engage only)
6. Clutch brake mode selector switch in wrong position
7. Defective clutch brake assembly

079-46.10.5.3 Remedial Actions. To restore braking, proceed as follows:

1. Notify and keep Main Engine Control informed of situation.
2. Monitor air pressure for normal pressure.
3. Monitor lube oil pressure for normal pressure.
4. Monitor lube oil temperature for normal temperatures.
5. Ensure clutch mode selector switch properly positioned.
6. Investigate brake pack.
7. Investigate clutch brake assembly.
8. Investigate controls system.

079-46.10.5.3.1 Main Engine Control will perform the following:

1. Notify Bridge of casualty.
2. Report maximum speed available.
3. Reduce speed of unaffected turbines, as required.
4. Notify Bridge of casualty cause, action being taken, and estimated time needed to make repairs.

079-46.10.5.4 Possible Additional Casualties. Affected braking capabilities may result in the following:

1. Windmilling of power turbine
2. Loss of affected gas turbine main engine
3. Contaminated reduction gear lube oil system
4. Reduced maneuverability
5. Loss of maneuverability

079-46.10.6 CLUTCH FAILS TO ENGAGE/DISENGAGE. The following paragraphs discuss symptoms, causes, remedial actions, and possible additional casualties arising from clutch failure.

079-46.10.6.1 Symptoms. When clutch failure occurs, the following will arise:

1. Clutch fails to engage/ disengage, alarm sounds, and warning light illuminates.
2. Clutch engage/disengage pushbutton light extinguishes.
3. Gas turbine module on-line status light remains illuminated/extinguished.
4. Shaft continues to rotate when disengage command given.

079-46.10.6.2 Causes. Clutch failure can be caused by the following:

1. Insufficient air pressure
2. Insufficient oil pressure (engage only)
3. Low oil temperature (engage only)
4. Controls system malfunction
5. Defective clutch assembly
6. Clutch brake mode selector switch in wrong position.

079-46.10.6.3 Remedial Actions. To remedy clutch failure to engage/disengage, proceed as follows:

1. Notify and keep Main Engine Control informed of situation.
2. Monitor air pressure for normal pressure.
3. Monitor oil pressure for normal pressure.
4. Monitor oil temperature for normal temperature.
5. Ensure clutch brake selector switch positioned properly.
6. Investigate clutch assembly.
7. Investigate controls system.

079-46.10.6.3.1 Main Engine Control will perform the following:

1. Notify Bridge of casualty.
2. Report maximum speed available.
3. Reduce speed of unaffected turbine as required.
4. Notify Bridge of casualty cause, action being taken, and estimated time required to make repairs.

079-46.10.6.4 Possible Additional Casualties. Possible additional casualties are as follows:

1. Damage to clutch assembly
2. Loss of gas turbine module
3. Reduced maneuverability
4. Loss of maneuverability.

079-46.10.7 HIGH LUBE OIL LEVEL IN REDUCTION GEAR SUMP. Symptoms, causes, remedial actions to be taken, and possible additional casualties resulting from high lube oil level in reduction gear sump are discussed in the following paragraphs.

079-46.10.7.1 Symptoms. High lube oil level in reduction gear sump will produce the following symptoms:

1. Erratic oil temperature readings indicated.
2. Erratic oil pressure readings indicated.
3. High oil level indicated on oil level gauge.
4. Printout indicates increasing oil level.

079-46.10.7.2 Causes. This casualty can be caused by the following:

1. Misaligned oil system
2. Water in lube oil

079-46.10.7.3 Remedial Actions. When high lube oil level occurs in the reduction gear sump, proceed as follows to correct the condition:

1. Notify and keep Main Engine Control informed of casualty.
2. Investigate lube oil system for proper alignment.
3. Draw sample of oil, check for presence of water.
4. Investigate lube oil cooler for rupture.
5. Place lube oil purifier in operation.
6. Monitor sludge and water removed from oil.
7. Reduce oil level in sump to proper level.

079-46.10.7.3.1 Main Engine Control will perform the following:

1. Notify Bridge of casualty.
2. Report maximum speed available.
3. Take local control of turbines when turbines are remoted to Bridge.
4. Reduce speed of unaffected turbines as required.
5. Notify Bridge of casualty cause, action being taken, and estimated time needed to make repairs.

079-46.10.7.4 Possible Additional Casualties. Possible additional casualties are as follows:

1. Hot bearing
2. Reduced maneuverability
3. Loss of maneuverability.

079-46.10.8 LOW LUBE OIL LEVEL IN REDUCTION GEAR SUMP. The following paragraphs discuss this casualty, as well as symptoms, causes, actions to be taken, and possible additional casualties which may result.

079-46.10.8.1 Symptoms. Low lube oil level in reduction gear sump will be evident from the following:

1. Low lube oil alarm sounds.
2. Warning light alarm sounds.
3. Lube oil header pressure fluctuates.
4. Standby lube oil pump starts with fluctuating pressure.
5. Oil slick trails from ship.

079-46.10.8.2 Causes. This casualty can be caused by the following:

1. Rupture in lube oil system piping
2. Purifier misalignment
3. Crack in lube oil sump tank
4. Leak in gaskets, seals, or both

079-46.10.8.3 Remedial Actions. The following procedures shall be used to remedy low lube oil level in reduction gear sump:

1. Notify and keep Main Engine Control informed of casualty.
2. Stop and lock shaft immediately when lube oil pressure is lost.
3. Ensure purifier alignment correct.
4. Replenish oil in sump.
5. Shift and inspect lube oil strainer.
6. Investigate lube oil piping system for leaks.
7. Investigate lube oil sump tank for leaks.
8. Draw sample from water side of cooler.
9. Test for presence of oil.

079-46.10.8.3.1 Main Engine Control will perform the following:

1. Notify Bridge of casualty.
2. Report maximum speed available.
3. Take local control of turbines when turbines are remoted to Bridge.
4. Reduce speed of unaffected turbines as required.
5. Notify Bridge of casualty cause, action being taken, and estimated time needed to make repairs.

079-46.10.8.4 Possible Additional Casualties. Possible additional casualties resulting from low lube oil level are as follows:

1. Personnel injury
2. Loss of lube oil pressure
3. Class BRAVO fire
4. Reduced maneuverability
5. Loss of maneuverability

079-46.10.9 HIGH LUBE OIL PRESSURE IN REDUCTION GEAR. Causes and symptoms of high lube oil pressure in reduction gear are discussed in the paragraphs that follow. Actions to be taken when this casualty occurs and other possible subsequent casualties are also discussed.

079-46.10.9.1 Symptoms. High lube oil pressure in reduction gear will be recognized by the following symptoms:

1. Lube oil header high/low pressure alarm sounds.
2. Warning light illuminates.
3. Lube oil pressure gauge indicates high.
4. Remote bearing lube oil pressure gauge indicates high.

079-46.10.9.2 Causes. This casualty can be caused by the following:

1. Unloading valve failure
2. Loss of air pressure to unloading valve
3. Lube oil control system malfunction
4. Clogged header orifice plates, spray nozzles, or both
5. Defective pressure transducer

079-46.10.9.3 Remedial Actions. When high lube oil pressure in reduction gear occurs, proceed as follows:

1. Notify and keep Main Engine Control informed of casualty.
2. Monitor air pressure to unloading valve for proper pressure.

3. Monitor unloading valve operation.
4. Investigate lube oil pump control system for malfunction.
5. Investigate pressure transducer.
6. Investigate header orifice plates and spray nozzles.
7. Shift and inspect lube oil strainer.
8. Monitor lube oil sump level.

079-46.10.9.3.1 Main Engine Control will perform the following:

1. Notify Bridge of casualty.
2. Report maximum speed available.
3. Take local control of turbines when turbines are remoted to Bridge.
4. Reduce speed of unaffected turbines as required.
5. Notify Bridge of casualty cause, action being taken, and estimated time needed to make repairs.

079-46.10.9.4 Possible Additional Casualties. Additional casualties resulting from high lube oil pressure can be the following:

1. High lube oil temperature
2. Hot bearings
3. Reduced maneuverability
4. Loss of maneuverability

079-46.10.10 TURBINE FAILS TO START. Causes, symptoms, corrective actions, and possible additional casualties resulting from gas turbine failure to start are discussed in the following paragraphs.

079-46.10.10.1 Symptoms. The casualty and symptom here are identical although several types of starting failure are possible. Symptoms include the following:

1. Gas generator fails to rotate.
2. Gas generator rotates but fails to start.
3. False start indicator alarm sounds and light illuminates.
4. Emergency stop alarm sounds and warning light illuminates.
5. Low turbine inlet temperature is indicated.

079-46.10.10.2 Causes. Possible causes of this casualty are listed as follows (some only apply to one particular symptom):

1. Misaligned starting air pressure

2. Insufficient starting air pressure
3. Defective air starter motor
4. Controls system malfunction
5. Sheared radial drive shaft (fails to rotate only)
6. Reduction gear lube oil pressure low
7. Low fuel oil header pressure
8. Low starting bleed air pressure to starter motor (fails to rotate only)
9. Low fuel oil temperature (fails to start only)
10. Emergency trip not properly reset (fails to start only)
11. Fuel oil system misaligned (fails to start only)
12. Ignitor system fails (fails to start only)
13. Defective attached fuel oil pump (fails to start only)
14. Clogged fuel filter (fails to start only)
15. Excessive start sequence time required (fails to start only)
16. Insufficient gas generator air suction (fails to start only)
17. Defective starter air regulator valve
18. Exceeded limits of starter duty cycle
19. Fuel shutdown valves shut
20. Clogged fuel nozzles
21. Defective fuel control

WARNING

Prior to entering turbine module, ensure turbine is placed out of service and inert gas system is inhibited.

079-46.10.10.3 Remedial Actions. Proceed as follows to locate and eliminate cause of casualty:

1. Notify and keep Main Engine Control informed of casualty.
2. Monitor:
   a. Summary fault indicator
   b. Starting air pressure
   c. Reduction gear lube oil pressure
   d. Fuel oil header pressure
   e. Starting bleed air pressure
   f. Fuel oil temperature to starter motor

g. Gas generator inlet pressure
h. Ignition indicator
i. Fuel oil filter differential pressure
j. Turbine inlet temperature
k. Gas generator speed

3. Ensure emergency trip is properly reset.
4. Ensure fuel oil system aligned properly.
5. Investigate air starter motor for proper operation.
6. Investigate attached fuel oil pump for proper operation.
7. Investigate fuel oil filter for clogging.
8. Investigate starter air regulating valve for proper operation.
9. Check position of fuel shutdown valve.
10. Check main fuel control for proper operation.
11. Check fuel nozzles for clogging.
12. Ensure bleed air valve is shut.
13. Start gas turbine in accordance with **Engineering Operational Procedures** when cause has been determined and repairs made.

079-46.10.10.3.1 Main Engine Control will perform the following:

1. Notify Bridge of casualty.
2. Report maximum speed available.
3. Notify Bridge of casualty cause, action being taken, and estimated time needed to make repairs.

079-46.10.10.4 Possible Additional Casualties. Gas turbine failing to start may cause loss of gas turbine. In addition, demand for increase in ship speed will not be met.

079-46.10.11 TURBINE FAILS TO COME UP TO IDLE SPEED. Low turbine idle speed is discussed in the paragraphs which follow.

079-46.10.11.1 Symptoms. If the gas turbine fails to come up to idle speed, the following symptoms will appear:

1. False start indicator alarm sounds and light illuminates.
2. Emergency stop alarm sounds and warning light illuminates.
3. Gas generator has r/min.

079-46.10.11.2 Causes. The following causes may be responsible for idle speed being low:

1. Bleed air valve malfunction
2. Power level angle actuator malfunction
3. Fuel supply header pressure low
4. Starter motor malfunction
5. Insufficient start air
6. Gas turbine internal problems
7. Main fuel control malfunction
8. Clogged fuel nozzles

WARNING

Prior to entering turbine module, ensure turbine is placed out of service and inert gas system is inhibited.

079-46.10.11.3 Remedial Actions. Remedy idle speed as follows:

1. Notify and keep Main Engine Control informed of casualty.
2. Obtain group printout of affected turbine.
3. Monitor:
   a. Fuel manifold pressure
   b. Fuel oil temperature
   c. Power turbine inlet pressure
   d. Compressor discharge pressure
   e. Air inlet duct pressure
   f. Turbine inlet temperature
4. Ensure bleed air system is properly aligned.
5. Ensure fuel oil system is properly aligned.
6. Check air starter motor for proper operation.
7. Check fuel oil pump for proper operation.
8. Check fuel oil filter for clogging.
9. Check main fuel control for proper operation.
10. Check for clogged fuel nozzles.
11. Start gas turbine in accordance with **Engineering Operational Procedures** when cause has been determined and repairs made.

079-46.10.11.3.1 Main Engine Control will then:

1. Notify Bridge of casualty.
2. Report maximum speed available.
3. Notify Bridge of casualty cause, action being taken, and estimated time needed to make repairs.

079-46.10.11.4 Possible Additional Casualties. Possible casualties resulting from gas turbine failure to come up to idle speed are as follows:

1. High power turbine inlet gas temperature
2. Loss of gas turbine

079-46.10.12 EXCESSIVE VIBRATION. Discussion of excessive vibration in gas turbines contained in the following paragraphs includes symptoms, causes, remedial actions, and possible additional casualties.

079-46.10.12.1 Symptoms. Excessive vibration is both a symptom and a casualty. Additional symptoms may be as follows:

1. Activation of gas generator high vibration alarm or high vibration stop, or both.
2. Activation of power turbine high vibration alarm or high vibration stop, or both.
3. Vibration meter on power turbine shows excessive.
4. Vibration meter on gas generator shows excessive.
5. Power lever angle idle status indicator illuminates.
6. Normal stop illuminates.

079-46.10.12.2 Causes. Excessive vibration results from the following:

1. Faulty vibration sensor
2. Internal part failure
3. Misalignment
4. Loose hold-down bolts
5. Faulty turbine mounts
6. Bent high speed coupling shaft
7. Dirty compressor
8. Dirty or loose electrical connectors
9. Short in electrical system
10. Malfunction of signal conditioner

WARNING

Prior to entering turbine module, ensure turbine is placed out of service and inert gas system is inhibited.

079-46.10.12.3 Remedial Actions. The following procedures shall be used to correct excessive vibration of gas turbines:

1. Notify and keep Main Engine Control informed of casualty.
2. Slow gas turbine until vibration stops.
3. Investigate vibration sensors.
4. Water washdown compressor.
5. Shut down turbine.
6. Check turbine mounts.
7. Check turbine hold-down bolts.
8. Investigate for misalignment
9. Check for internal part failure or bent shaft or both.
10. Check electrical system.
11. Check signal conditioner for malfunction.
12. Start gas turbine in accordance with **Engineering Operational Procedures** when cause has been determined and repairs made.

079-46.10.12.3.1 Main Engine Control will then:

1. Notify Bridge of casualty.
2. Report maximum speed available.
3. Take local control of turbines when turbines are remoted to bridge.
4. Reduce speed on unaffected turbines as required.
5. Notify Bridge of casualty cause, action being taken, and estimated time required to make repairs.

079-46.10.12.4 Possible Additional Casualties. Other casualties which may result from excessive vibration are as follows:

1. Personnel casualties
2. Loss of engine
3. Reduced maneuverability
4. Loss of maneuverability

079-46.10.13 HIGH LUBE OIL TEMPERATURE. High lube oil temperature in the gas turbine is discussed in the following paragraphs.

079-46.10.13.1 Symptoms. High lube oil temperature in gas turbine will be indicated by the following:

1. Cooler lube oil outlet temperature alarm activated and warning light illuminated.
2. Turbine scavenge oil temperature alarm activated and warning light illuminated.
3. Lube oil pressure decreases.

079-46.10.13.2 Causes. This casualty is caused by the following malfunctions:

1. Improper alignment of the system
2. Faulty coolant regulator valve/ pilot
3. Loss of air to coolant regulator valve
4. Clogged synthetic lube oil cooler
5. Leaking synthetic lube oil cooler tube
6. Loss of reduction gear lube oil pressure
7. Cooler lube oil outlet temperature alarm activated and warning light illuminated
8. Hot turbine bearing
9. Low oil level in tank
10. Faulty supply/scavenging pump
11. Clogged supply/scavenge filter
12. Bearing sump seal leakage

WARNING

Prior to entering gas turbine module, ensure turbine is placed out of service and inert gas system is inhibited.

079-46.10.13.3 Remedial Actions. The following procedures shall be used to correct high lube oil temperature:

1. Notify and keep Main Engine Control informed of casualty.
2. Slow propulsion turbine/change engine.
3. Shift synthetic oil filter elements.
4. Monitor oil level in storage tank.
5. Monitor reduction gear lube oil pressure and temperature.
6. Check coolant oil system for proper alignment.

7. Check air pressure to temperature control valve pilot.
8. Obtain gas turbine module and lube oil printout for affected propulsion turbine and monitor the following:
   a. Gas turbine module lube oil scavenge differential pressure
   b. Gas turbine module oil cooler outlet temperature
   c. Gas turbine module lube oil supply filter differential pressure
   d. Gas turbine module lube oil supply pressure
   e. Gas turbine module lube oil scavenge temperatures
   f. Gas turbine module gearbox lube oil scavenge temperature.
9. Check temperature control valve for proper setting and operation.

WARNING

Synthetic lube oil is toxic.

10. Check synthetic oil for traces of coolant oil.
11. Check lube oil consumption rate.
12. Start gas turbine in accordance with **Engineering Operational Procedures** when cause has been determined and repairs made.

079-46.10.13.3.1 Main Engine Control will perform the following:

1. Notify Bridge of casualty.
2. Report maximum speed available.
3. Take local control of turbines when turbines are remoted to Bridge.
4. Reduce speed of unaffected turbines as required.
5. Notify Bridge of casualty cause, action being taken, and estimated time needed to make repairs.

079-46.10.13.4 Possible Additional Casualties. Possible additional casualties are as follows:

1. Damaged turbine bearings/ blading
2. Reduced maneuverability
3. Loss of maneuverability
4. Loss of engine

079-46.10.14 LOSS OF TURBINE LUBE OIL PRESSURE. Loss of lube oil pressure in the gas turbine engine is discussed in the paragraphs which follow, along with symptoms and causes, actions to be taken, and possible additional casualties.

079-46.10.14.1 Symptoms. Loss of gas turbine lube oil pressure symptoms include the following:

1. Low lube oil pressure alarm activates and the warning light illuminates.
2. Demand display indicates low scavenge oil pressure.
3. High bearing sump temperature indicated.

079-46.10.14.2 Causes. Loss of gas turbine lube oil pressure results from the following:

1. Low oil level in tank
2. Failure of attached lube oil pump
3. Obstruction in supply piping
4. Clogged supply filter
5. Major leak in lube oil piping
6. Improper alignment of system
7. Clogged oil cooler

WARNING

Prior to entering turbine module, ensure turbine is placed out of service and inert gas system is inhibited.

CAUTION

If turbine is operated for more than 2 minutes without oil pressure, place turbine out of commission until all bearings have been inspected.

079-46.10.14.3 Remedial Actions. Remedial actions for loss of lube oil pressure are as follows:

1. Notify Main Engine Control by stating, **"Shutting down and changing turbine."** Keep Main Engine Control informed.
2. Monitor the following:
   a. Lube oil supply pressure
   b. Gas turbine module lube oil scavenge temperatures
   c. Gas turbine module gearbox lube oil scavenge temperatures
3. Check oil level in tank.
4. Check lube oil system for proper alignment.
5. Check lube oil piping for leaks.
6. Shift lube oil supply filters.
7. Check lube oil piping for obstructions.

8. Start gas turbine in accordance with **Engineering Operational Procedures** when cause has been determined and repairs made.

079-46.10.14.3.1 Main Engine Control will perform the following:

1. Notify Bridge by stating, **“Shutting down and changing turbines.”**
2. Report maximum speed available.
3. Notify Damage Control Central if oil leak exists.
4. Take local control of turbines when turbines are remoted to Bridge.
5. Reduce speed on unaffected turbines as required.
6. Notify Bridge of casualty cause, action being taken, and estimated time required to make repairs.

079-46.10.14.4 Possible Additional Casualties. Other casualties resulting from loss of lube oil pressure in the gas turbine are as follows:

1. Damaged attached lube oil pump
2. Damaged bearings
3. Reduced maneuverability
4. Loss of maneuverability
5. Loss of affected engine
6. Class BRAVO fire

079-46.10.15 POWER TURBINE OVERSPEEDS. Discussion of power turbine overspeeding is contained in the following paragraphs.

079-46.10.15.1 Symptoms. When power turbine overspeeds, the following symptoms are evident:

1. Power turbine exceeds designed speed.
2. Power turbine overspeed trip is activated.
3. Auto-shutdown occurs.

079-46.10.15.2 Causes. Overspeeding can be caused by the following:

1. Power level angle malfunction
2. Fuel control valve malfunction
3. Fuel control linkage broken, loose, or binding
4. Loss of power turbine tachometers
5. Battle override on
6. Power turbine speed transducer malfunction

7. Control system malfunction

WARNING

Prior to entering turbine module, ensure turbine is placed out of service and inert gas system is inhibited.

079-46.10.15.3 Remedial Actions. The following procedure will correct overspeeding:

1. Notify Main Engine Control by stating, **“Shutting down and changing turbines.”** Keep Main Engine Control informed.
2. Check power lever angle.
3. Check fuel control valve.
4. Check fuel control/governor linkage.
5. Check power turbine tachometers.
6. Check power turbine speed transducer.
7. Check control system.
8. Start gas turbine in accordance with **Engineering Operational Procedures** when cause has been determined and repairs made.

079-46.10.15.3.1 Main Engine Control will perform the following:

1. Notify Bridge that turbines are being shut down and changed.
2. Report maximum speed available.
3. Take local control of turbines when turbines are remoted to Bridge.
4. Reduce speed on unaffected turbine as required.
5. Notify Bridge of casualty cause, action being taken, and estimated time needed to make repairs.

079-46.10.15.4 Possible Additional Casualties. Possible additional casualties may include the following:

1. Damaged bearings or blading/casing
2. Reduced maneuverability
3. Loss of maneuverability.

079-46.10.16 ICING AT TURBINE INLET. This casualty is discussed in the paragraphs that follow. Discussion includes symptoms and causes of inlet icing, remedial actions, and possible additional casualties.

079-46.10.16.1 Symptoms. Icing at the turbine inlet will produce the following symptoms:

1. Icing indicator light illuminates.
2. Loss of r/min.
3. Air intake duct pressure indicates low.
4. Decrease of power turbine inlet gas pressure.
5. Increase of power turbine inlet gas temperature.
6. Duct pressure low indicator light illuminates.
7. Decrease in compressor inlet temperature.

079-46.10.16.2 Causes. Icing can be caused by the following:

1. Improper bleed/anti-icing air alignment
2. Faulty anti-icing valve (auto/remote/local)
3. Ruptured or damaged anti-icing air piping
4. Faulty ice detector, signal conditioner, or both

WARNING

Prior to entering turbine module, ensure turbine is out of service and inert gas system is inhibited.

079-46.10.16.3 Remedial Actions. Proceed as follows to locate source of problem and eliminate casualty:

1. Notify and keep Main Engine Control informed of casualty.
2. Change turbine and monitor bellmouth and icing indicator for operating turbine when operating in split mode.
3. Shut down turbine when operating in full power mode.
4. Ensure bellmouth is free of ice.
5. Ensure blow-in doors are properly seated.
6. Monitor the following:
   a. Intake duct pressure
   b. Intake duct temperature
   c. Turbine inlet temperature
   d. Turbine inlet pressure
   e. Gas generator r/min.
7. Check bleed/anti-icing air alignment
8. Check anti-icing air piping.
9. Check anti-icing valve.

10. Check for ice, signal condition, or both.
11. Start turbine in accordance with **Engineering Operational Procedures** when cause is determined and repairs made.

079-46.10.16.3.1 Main Engine Control will perform the following:

1. Notify Bridge of casualty.
2. Report maximum speed available.
3. Take local control of turbines when turbines are remoted to Bridge.
4. Reduce speed of unaffected turbines as required.
5. Notify Bridge of casualty cause, action being taken, and estimated time required to make repairs.

079-46.10.16.4 Possible Additional Casualties. Possible additional casualties include the following:

1. Activation of blow-in doors
2. Damaged compressor blades
3. Reduced maneuverability
4. Loss of maneuverability

079-46.10.17 HIGH POWER TURBINE INLET TEMPERATURE. Symptoms, causes, remedial actions, and possible additional casualties arising from high power turbine inlet temperature are discussed in the following paragraphs.

079-46.10.17.1 Symptoms. Symptoms of high inlet temperature are as follows:

1. Rapid rise in power turbine inlet gas temperature.
2. Corresponding reduction in gas generator speed, compressor discharge pressure, or both.
3. Activation of turbine over temperature alarm.

079-46.10.17.2 Causes. High power turbine inlet temperature results from the following:

1. Obstructed compressor air intake ducting
2. Dirty compressor blading/staying
3. Damaged compressor blading/ staying
4. Damaged compressor bearing
5. Loose fuel nozzle
6. Leaking fuel nozzle
7. Fuel control malfunction
8. Incorrect compressor variable stator vane angle

9. Obstructed power turbine exhaust ducting
10. Clogged demisters
11. Power level angle actuator malfunction

WARNING

Prior to entering turbine module, ensure turbine is placed out of service and inert gas system is inhibited.

079-46.10.17.3 Remedial Actions. Remedial actions for high power turbine inlet temperature are as follows:

1. Notify and keep Main Engine Control informed of casualty.
2. Slow affected propulsion turbine until power turbine inlet gas temperature is within limits.
3. Obtain a group printout.
4. Monitor gas generator and power turbine vibration levels.
5. Change engines or shut down affected propulsion turbine if power turbine inlet gas temperature fails to stabilize within operating limits.
6. Inspect for loose or leaking fuel nozzles.
7. Inspect for restrictions in gas generator air intake ducting.
8. Water-wash affected propulsion turbine.
9. Inspect power lever angle for proper alignment and response to integrated throttle a control commands.
10. Inspect fuel control for malfunction.
11. Inspect control system for malfunction.
12. Inspect for restrictions in power turbine exhaust ducting.
13. Inspect for clogged demisters.
14. Start turbine in accordance with **Engineering Operational Procedures** when cause has been determined and repairs made.

079-46.10.17.3.1 Main Engine Control will perform the following:

1. Notify Bridge of casualty.
2. Report maximum speed available.
3. Take local control of turbines when turbines are remoted to Bridge.
4. Reduce speed of unaffected turbines as required.
5. Notify Bridge of casualty cause, action being taken, and estimated time needed to make repairs.

079-46.10.17.4 Possible Additional Casualties. Other casualties resulting from high power turbine inlet casualties are as follows:

1. Damage to compressor
2. Damage to turbine
3. Damage to combustor
4. Post shutdown fire in turbine casing
5. Reduced maneuverability
6. Loss of maneuverability

079-46.10.18 POST SHUTDOWN CASING FIRE. The fire in propulsion turbine casing after shutdown (see paragraph 079-46.10.17.4) is discussed in the following paragraphs.

079-46.10.18.1 Symptoms. Post shutdown fire in propulsion turbine casing will be indicated by the following:

1. Excessive differential between ventilation inlet and exit temperature indicated.
2. Cooling air system shuts down.
3. Excessive smoke from exhaust stack after shutdown.
4. Turbine inlet gas temperature exceeds critical temperature within 3 minutes after shutdown.
5. Power turbine inlet gas temperature begins to decrease, then rapidly rises and exceeds critical temperature within 3 minutes after shutdown.
6. Fire alarm in module sounds.

079-46.10.18.2 Causes. Fire in propulsion turbine casing can be caused by the following:

1. Defective fuel control valve
2. Defective power lever angle
3. Plugged combustor drains
4. Leaking fuel shutdown valves
5. Control system malfunction

WARNING

Prior to entering turbine module, ensure turbine is placed out of service and inert gas system inhibited.

079-46.10.18.3 Remedial Actions. Proceed as follows to contain and extinguish fire:

1. Notify and keep Main Engine Control informed of casualty.

2. Trip emergency fuel trip valve.
3. Shut manual fuel supply valve to affected turbine.
4. Motor gas generator until power turbine inlet gas temperature decreases below critical temperature.
5. Stop gas generator motoring.
6. Inspect for possible causes of fire:
    a. Power lever angle
    b. Fuel shutdown valves
    c. Fuel nozzles
    d. Casing/appendages drains
    e. Fuel pump and hose connections
7. Inspect propulsion turbine for damage.
8. Make necessary repairs.
9. Motor turbine and monitor for:
    a. Unusual vibration
    b. Normal lube oil pressure
10. Place propulsion turbine back in service:
    a. Open manual fuel oil supply valve.
    b. Reset emergency fuel trip valve.
11. Start propulsion turbine.
12. Test propulsion turbine at idle speed.

079-46.10.18.3.1 Main Engine Control will notify Bridge of casualty and action being taken.

079-46.10.18.4 Possible Additional Casualties. Possible additional casualties are as follows:

1. Cracked casing
2. Blade damage
3. Bearing failure
4. Module fire

079-46.10.19 CLASS BRAVO FIRE IN MODULE. The following paragraphs discuss fire occurring in turbine module, along with symptoms, causes, corrective actions and possible additional casualties.

079-46.10.19.1 Symptoms. Class BRAVO fire in turbine module will produce the following symptoms:

1. Cooling fan stops while engine is in operating mode.
2. Vent damper closes while engine is in operating mode.
3. Loss of fuel oil pressure.

4. Fire alarm in module sounds.
5. Smoke visible through observation windows.
6. Fire stop initiated.

079-46.10.19.2 Causes. Fire may be started by the following:

1. Ruptured fuel oil piping
2. Leaky fuel fittings or gaskets
3. Module drain clogged
4. Faulty check valves in drain lines

079-46.10.19.3 Remedial Actions. The following procedures will contain and extinguish fire in module:

1. Notify Main Engine Control.
2. Shut down turbine.
3. Keep Main Engine Control informed of situation.
4. Ensure fire stop is activated.
5. Ensure fuel emergency shutdown valve is shut.
6. Ensure module ventilation fan is stopped, vent damper is closed and doors shut.
7. Ensure inert gas system is activated.
8. Deploy the Twin Agent Fire Extinguishing System (TAFES).

WARNING

Synthetic turbine lube oil is toxic. Do not open module for at least 15 minutes to clear module of possible toxic fumes. In addition, a 10-minute purge shall be accomplished.

9. Clear module, open ventilation doors and start fan when fire is out.
10. Check module for combustible/toxic gases.
11. Stop ventilation fan.
12. Check for fuel leaks.
13. Check for lube oil leaks.
14. Check module for interior damage.
15. Test turbine when module interior damage has been corrected.
16. Ensure all module doors are shut and latched.
17. Motor turbine for test.

18. Monitor motoring r/min.
19. Check turbine for unusual noise.
20. Place turbine Out Of Commission (OOC), until repairs made, if motoring is unsatisfactory.
21. Start and test turbine if motoring is satisfactory.

079-46.10.19.3.1 Main Engine Control will perform the following:

1. Notify Bridge of casualty.
2. Report maximum speed available.
3. Take local control of turbines when turbines are remoted to Bridge.
4. Reduce speed of unaffected turbines as required.
5. Notify Bridge of casualty cause, action being taken, and estimated time needed to make repairs.

079-46.10.19.4 Possible Additional Casualties. Possible additional casualties resulting from fire are as follows:

1. Cracked casing
2. Damaged wiring
3. Damaged gaskets
4. Damaged seals
5. Warped casing
6. Warped module
7. Warped ducting
8. Reduced maneuverability
9. Loss of maneuverability
10. Damage to other spaces

079-46.10.20 LOSS OF HYDRAULIC OIL PRESSURE TO CONTROLLABLE REVERSIBLE PROPELLER. This casualty is discussed in detail in the paragraphs which follow.

079-46.10.20.1 Symptoms. Loss of controllable reversible propeller hydraulic oil pressure will be indicated by the following:

1. Sump hydraulic oil pressure gauge is low.
2. Sump tank level low alarm actuates.
3. Filter differential pressure high alarm illuminates.
4. Electric pump fault alarm illuminates.

079-46.10.20.2 Causes. Oil pressure loss is caused by the following:

1. Defective suction strainer
2. Defective hydraulic oil pump
3. Defective pressure reducing valve
4. Defective pressure relief valve
5. Low sump oil level
6. Ruptured hydraulic oil lines
7. Defective oil pressure transmitter/indicators

079-46.10.20.3 Remedial Actions. To restore hydraulic pressure to propeller, proceed as follows:

1. Notify and keep Main Engine Control informed of casualty.
2. Stop hydraulic pump if sump level low alarm or electric pump fault alarm(s) is illuminated.
3. Stop shafts.
4. Staff for emergency maneuvers.
5. Apply shaft brake on affected shaft.
6. Check oil level in sump.
7. Check suction strainer.
8. Check hydraulic oil pump for proper operation.
9. Ensure pressure relief and reducing valves are operating properly.
10. Inspect system for possible leaks.

NOTE

It may be necessary to stop and lock shaft in order to lock in emergency pitch.

11. Transfer throttle control to propulsion local control console.
12. Ensure pressure transmitter and pressure indicator(s) are properly functioning.
13. Ensure hydraulic oil pump is stopped.
14. Lock affected shaft pitch in EMERGENCY AHEAD (astern when required) position.
15. Release shaft brake and assume operation as required.
16. Stop shafts when repairs have been made:
    a. Apply shaft brake on affected shaft.
    b. Remove EMERGENCY AHEAD (astern when required) pitch.
17. Test pitch control at local station.
18. Release shaft brake.
19. Transfer throttle control to Central Control Station when test is satisfactory.
20. Test throttle control in MANUAL and AUTOMATIC.

079-46.10.20.3.1 Main Engine Control will perform the following:

1. Notify Bridge of casualty.
2. Report maximum speed available.
3. Take local control of turbines when turbines are remoted to Bridge.
4. Reduce speed of unaffected turbines as required.
5. Notify Bridge of casualty cause, action being taken, and estimated time needed to make repairs.

079-46.10.20.4 Possible Additional Casualties. Possible additional casualties include:

1. Hydraulic oil pump damage
2. Loss of pitch control
3. Reduced maneuverability

079-46.10.21 CONTROL LOSS OF CONTROLLABLE REVERSIBLE PROPELLER. Loss of control of the controllable reversible propeller is discussed in the following paragraphs, along with symptoms and causes of the casualty, remedial actions, and additional problems which may result.

079-46.10.21.1 Symptoms. When control of controllable reversible propeller is lost, check the following:

1. Filters differential pressure high alarm illuminates.
2. Electric pump fault alarm illuminates.
3. Sump tank level low alarm illuminates.
4. Erratic pitch is indicated, without lever movement.
5. Controllable reverse propeller hydraulic pressure indicates less than 690 Pa (100 lb/in g).
6. No response in pitch angle when integrated throttle control lever is moved.

079-46.10.21.2 Causes. The following problems will cause loss of propeller control:

1. Defective suction strainer
2. Defective motor-driven hydraulic oil pump
3. Defective pressure reducing valve
4. Defective pressure relief valve
5. Ruptured oil lines
6. Defective oil pressure transmitter/indicators
7. Insufficient oil supply in sump

079-46.10.21.3 Remedial Actions. To regain control of the propeller, use the following procedures:

1. Notify and keep Main Engine Control informed of casualty.
2. Monitor pitch setting.
3. Test throttle control.
4. Check electrical system for possible failure, if pitch is controllable at Central Control Station.
5. Transfer pitch control to manual control at propulsion and auxiliary control console if pitch remains uncontrollable at Central Control Station.
6. Inspect controllable reversible propeller piping system for leaks (if ruptured, secure pump immediately).
7. Check controllable reversible sump level (if low, replenish oil).
8. Monitor system pressures and temperatures for normal indications.
9. Verify that propulsion and auxiliary control console, if pitch control is erratic at propulsion and auxiliary control console.
10. Transfer control to propulsion local control console if pitch control is erratic at propulsion and auxiliary control consoles.
11. Verify control of pitch at local station.
12. Investigate control system for malfunction if pitch is controllable at local station.
13. Stop shafts and set affected shaft pitch in the EMERGENCY AHEAD (astern when required) position if pitch is not controllable.

NOTE

It may be necessary to stop and lock shaft in order to lock in emergency pitch.

14. Stop shafts when cause has been determined and repairs made:

a. Remove EMERGENCY AHEAD (astern when required) pitch.

b. Test pitch control at all operating stations.

079-46.10.21.3.1 Main Engine Control will perform the following:

1. Notify Bridge of casualty.
2. Report maximum speed available.
3. Take local control of turbines when turbines are remoted to Bridge.
4. Reduce speed of unaffected turbines as required.
5. Notify Bridge of casualty cause, action being taken, and estimated time required to make repairs.

079-46.10.21.4 Possible Additions Casualties. Other casualties resulting from loss of controllable reversible propeller control are as follows:

1. Damage to controllable reversible propeller oil pump
2. Reduced maneuverability.

079-46.10.22 STOPPING, LOCKING, AND UNLOCKING SHAFT UNDERWAY. This operation can be considered a deliberate maneuver rather than a casualty and is discussed in paragraphs 079-46.10.22.1 and 079-46.10.22.2.

WARNING

It is dangerous to attempt stopping a shaft if ship speed is greater than 20 knots. The ship should be slowed and shaft stopped using the controllable reversible propeller and power turbine brake with the clutch engaged.

079-46.10.22.1 Locking. To lock the shaft underway, come to emergency standard speed and proceed as follows.

1. Set sea state adjust switch to a setting of 1.0 on unaffected shaft.
2. Transfer throttle control from ship's control console to propulsion and auxiliary control console.
3. Move throttle control levers to 100 shaft r/min.
4. Unlatch throttle levers, bring affected shaft throttle control lever to stop.
5. Staff engine rooms as required.
6. Turn affected engine(s) key operated logic override switch to ACTIVATE position.
7. Depress shaft brake switch on affected shaft.
8. Ensure manual power lever angle control know(s) for affected engine(s) is at zero percent.
9. Ensure manual pitch control knob for affected shaft is at zero percent.
10. Shift affected shaft throttle control to MANUAL.
11. Ensure MANUAL pushbutton indicator is illuminated.
12. Monitor demand display indicator for ZERO THRUST indication (approximately + 4 - 7).
13. Stop affected engine(s) using emergency stop switch(s).
14. Apply negative pitch to affected engine if shaft is still rotating at -10 percent to -20 percent pitch.
15. Observe shaft deceleration, as shaft decelerates to 60 shaft r/min (ahead).
16. Observe shaft brake engage.

WARNING

Do not adjust pitch of affected shaft while lock is being engaged. Maintain ship speed constant until lock is fully engaged.

17. Adjust pitch such that propeller is at zero percent pitch when shaft stops rotating as soon as shaft brake engages.
18. Shift affected engine(s) brake/ clutch mode to MANUAL.

CAUTION

Do not attempt to engage lock while rotating turning gear motor shaft, since this may damage teeth.

19. Lock affected shaft as follows:
    a. Remove locking pin from turning gear operating handle.

NOTE

Since the locking device can only be engaged when there is no torque being applied to the turning gear motor shaft, it may be necessary to turn past the aligned position, then return to it.

    b. Engage turning gear to TURNING GEAR ENGAGED position.
    c. Using wrench, turn motor shaft to align marks on the shaft tooth position indicator.
    d. Move engaging lever to the LOCKED position.
20. Position turning gear motor shaft at the center of its backlash position.
21. Set affected shaft pitch at 100 percent.
22. Monitor shaft for possible movement.
23. Install danger tag(s) on:
    a. Turning gear engaging lever
    b. Turning gear motor controller
    c. Circuit breaker
24. Maintain unaffected shaft r/min as required.
25. Motor gas turbine(s) of affected shaft for 2 minutes when plant condition is stabilized.

079-46.10.22.2 Unlocking. To unlock shaft underway:

1. Ensure main reduction gear lube oil pressure is greater than 17 lb/in^2 .
2. Ensure lube oil flowing through all bearing sight flow glasses.
3. Ensure affected shaft engine throttle control is in MANUAL mode.
4. Ensure power lever angle(s) of affected engines are at zero percent.
5. Ensure affected shaft pitch is at zero pitch.
6. Back ship down at FULL BACK to relieve applied torque.
7. With a wrench, apply a light counterclockwise turning force on turning gear motor shaft.
8. Monitor affected shaft torque meter for indication.
9. Stop ship to unlock shaft when torque on affected shaft has been relieved.
10. Adjust affected shaft pitch so both pitch valves reach zero percent simultaneously as ship speed decreases.
11. Unlock affected shaft:

a. Apply counterclockwise force with wrench to relieve all torque on turning gear shaft.
b. Move turning gear engaging lever to ENGAGED position.
c. Remove wrench from turning gear shaft.
d. Move turning gear engaging lever to DISENGAGED position.

12. Ensure affected shaft pitch is zero percent (zero thrust point).
13. Monitor affected shaft for abnormal conditions.
14. Maintain unaffected shaft speed as required.
15. Ensure fuel oil trip valves have been reset.
16. Ensure brake/clutch logic override key has been turned to its NORMAL position.

CAUTION

If engines have been secured for an extended period of time, system alignment procedures should be utilized prior to startup of affected engines. If cause for locking shaft was a problem with the reduction gear, it may be desirable to trail shaft prior to starting affected engines.

17. Start affected gas turbines for online status testing, in accordance with **Engineering Operational Procedures.**

079-46.11 BATTLE DAMAGE CASUALTIES

079-46.11.1 OVERVIEW. Major battle damage casualties considered here involve securing and isolating compartments in which extreme damage has occurred. No attempt has been made to include control of casualties caused by battle damage in other areas.

079-46.11.2 GENERAL PROCEDURES. In applying to ownship, the general procedures for remedying casualties are given in this volume. It is desirable that the casualties in other areas caused by shock, failure of service, or both, from a damaged compartment be included in each ship's battle problems.

079-46.11.3 SIMULATION TRAINING. It is suggested that battle problems be made up to simulate less than total damage to a particular area. The various machinery and electrical casualties discussed in this volume should be included.

079-46.11.4 COMPARTMENT BATTLE DAMAGE. Battle damage casualties to compartments are described in the following paragraphs.

079-46.11.5 MAJOR STEAM LEAK/RUPTURE. Rupture or major leakage of steam piping in any compartment may be expected to fill that compartment with steam to an extent requiring evacuation of personnel, unless source of steam leak is secured immediately. When a major steam leak occurs, personnel should attempt to secure equipment if circumstances permit. If immediate evacuation is required, however, they must evacuate the space immediately and report to Repair 5 area for muster.

NOTE

Ships provided with Emergency Escape Breathing Devices (EEBD) for engineering space personnel should require personnel to don them prior to evacuation.

079-46.11.5.1 Notify and keep Main Engine Control informed of situation. Report major steam leak/piping rupture, space affected (port or starboard side, upper or lower level, and frame number, if determined).

079-46.11.5.2 Stop and lock affected propulsion shaft, if at all possible. If not, secure throttle and allow shaft to trail.

NOTE

The Commanding Officer and the Engineer Officer shall have a set policy as to when, if ever, the shaft may not be locked. In determining such a policy, such instances as entering and leaving port, alongside replenishment, air operations, and combat operations shall be considered.

079-46.11.5.3 Attempt to locate and isolate rupture with the following procedures:

1. Shut appropriate adjacent upstream and downstream isolation valves.
2. Shut bulkhead stop valves and cross-connect valves between affected space and steaming boiler.
3. Secure steaming boiler(s) feeding the affected space, if otherwise unable to locate and isolate leak.
4. Place supply ventilation on high speed.
5. Attempt to secure equipment in affected space, if time permits.

079-46.11.5.4 If evacuation becomes necessary, personnel should don EEBD's when provided. If possible, evacuate through escape trunks or scuttle in overhead of enclosed operating station in order to minimize casualties from burns and ingestion of steam, which tends to collect in upper areas of compartment.

NOTE

Personnel must be trained in advance to find a safe escape route from the watch station, even in total darkness.

CAUTION

To avoid the chimney effect, when evacuating a main machinery space that has been filled with live steam, ensure all personnel are inside the escape trunk or enclosed operating station with the door/scuttle secured before opening the upper door/scuttle. At no time should both the lower and upper doors be opened simultaneously.

079-46.11.5.5 Notify Main Engine Control upon completion of evacuation; report personnel casualties. Attempt to minimize damage to equipment which may not have been secured prior to evacuation. Secure steaming boilers, using remote operating gear for fuel oil quick-closing valve and boiler stop valves if fire room must be evacuated.

079-46.11.5.6 If main engine was not stopped and locked, EOOW must consider how best to protect engine and make appropriate recommendations to Bridge. Steam and electric lube oil pumps cannot be counted on to continue operating; hence, the shaft is dependent upon the attached lube oil pump, if installed, for its lubrication.

079-46.11.5.7 If attached lube oil pump is operational, maintaining way on the ship should provide adequate lubrication. If, on the other hand, the attached pump is inoperative, or not installed, the other engine(s) should be backed, situation permitting, to stop ship and prevent further rotation of affected shaft.

079-46.11.5.8 Secure electric power to affected space except for lighting, ventilation and vital circuits, such as electric main lube oil pump, if installed.

NOTE

Vital circuits to remain energized should be designated in advance.

079-46.11.5.9 Isolate affected space by closing bulkhead stop valves using remote operators as required.

079-46.11.5.10 When space affected has been isolated and is safe, re-enter.

1. Locate, isolate, and repair steam leak or rupture.
2. Inspect for and repair other damage.

079-46.11.5.11 If in doubt as to water level in steaming boiler(s) prior to securing, allow boiler(s) to cool and inspect for damages. If in doubt as to whether main engine lube oil pressure was maintained, inspect one or more bearings. Electric power panels, controllers, motors, and so forth, may have to be dried out prior to use.

079-46.11.5.12 When directed by Main Engine Control, restore steam to space and cautiously commence equipment light-off and testing in accordance with **Engineering Operational Procedures** (if installed) to restore full operation.

079-46.11.6 MAJOR FLOODING OF A PROPULSION MACHINERY SPACE. Flooding of a propulsion machinery space normally is not an immediate hazard to personnel unless accompanied by other damage, such as battle or collision damage. Thus, actions of most immediate importance are as follows:

1. Locating and stopping source of flooding water
2. Minimizing equipment damage
3. Preventing progressive flooding and attendant loss of ship stability

079-46.11.6.1 Notify and keep Main Engine Control informed. Main Engine Control should establish flooding boundaries and, for serious flooding, request that General Quarters be set.

079-46.11.6.2 Main Engine Control will alert Damage Control Central. Additionally, all drainage eductors except those serving the main drains must be secured in order to maintain firemain pressure. Additional fire pumps should be started as necessary.

079-46.11.6.3 Attempt to locate and stop source of flooding water. Holes in the ship's hull require plugging, patching, and shoring. Use conventional damage control techniques, described in **NSTM Chapter 079, Volume 2** .

079-46.11.6.4 If the main condenser or its associated seawater piping is suspected as the flooding source, immediately commence shutting main sea valves, using electrical or hydraulic assist devices if installed. If assist devices fail, do not stop the effort to shut the valves while troubleshooting, but continue shutting valves manually as long as the operating gear is accessible in conjunction with the troubleshooting effort.

CAUTION

In this case, do not use the main circulating pump for dewatering. Stop and lock shaft if possible. Isolate all heat sources from the main condenser, including exhaust and drains, to prevent overheating.

079-46.11.6.5 If flooding is due to ruptured space, firemain, or cooling water piping, the leak must be located and isolated at nearest valves. If cooling water or firemain is affected, it may be necessary to rig jumper lines around the ruptured/damaged area.

079-46.11.6.6 Commence dewatering immediately to attempt to bring flooding under control.

NOTE

Pollution control measures are of secondary concern when a genuine emergency exists.

079-46.11.6.7 Procedures to be followed are listed below:

1. Line up installed eductors to take suction on bilge. Be aware, however, that improper lineup, or attempting to operate with insufficient actuating water pressure may actually increase flooding.
2. Start available bilge pumps.

079-46.11.6.8 Most main circulating pumps have provisions for taking suction on engine room bilges; however, do not attempt this if main condenser or its associated piping is source of flooding. If necessary, as the situation permits, rig portable dewatering equipment.

079-46.11.6.9 Secure and protect equipment to minimize damage from flooding or spray. The following hazards are present as water rises. Take appropriate measures.

079-46.11.6.10 As bilge water level rises, seawater contamination of feed system may be expected through the freshwater drain system and condensate pump glands.

079-46.11.6.11 A hot boiler will suffer from thermal shock due to water quenching and actually may rupture in extreme cases. Before water level reaches boiler brick pans, secure steaming boiler(s) and associated auxiliary machinery and lift safeties by hand.

079-46.11.6.12 As water reaches the lower level deck plates, horizontal electric pumps will begin to fail, causing possible loss of evaporators, turbogenerators, fire-main, and cooling water.

079-46.11.6.13 Once water rises above lower level deck plates, the following events are possible.

079-46.11.6.13.1 Seawater Contamination of the Main Engine Lube Oil or Failure of the Main Lube Oil Pumps. Stop and lock shaft if possible; otherwise, it may be necessary to stop the way on the ship to prevent further shaft rotation, tactical situation permitting.

079-46.11.6.13.2 Progressive Shorting and Loss of Electric Motors, Controllers, Power Panel, and Lighting. Protect electrical components from water spray where possible and secure electric power to space as required.

079-46.11.6.13.3 Loss of Communications through Shorting and Grounding. Rig casualty sound-powered phone circuits.

079-46.11.6.13.4 Quenching and Possible Rupture of Hot Steam Lines. Secure steam to affected space by closing cross-connect valves and bulkhead stop valves. Vent DFT to atmosphere using auxiliary exhaust relief valve and three-way vent valve.

079-46.11.6.13.5 Increased Fire Hazard from Flammable Liquid in Bilges Rising with Flood Water and Coming in Contact with Hot Surfaces. The best prevention for this hazard is maintaining clean bilges; however, if a fire hazard is present, firefighting apparatus should be rigged.

079-46.11.6.13.6 Contamination of Potable and Feedwater Tanks by Seawater Entry through Sounding Tubes. Ensure sounding tube valves are shut and caps are installed on feed and potable water tanks.

079-46.11.6.13.6.1 Once source of flooding is stopped, dewatering should continue until space is dry. If a significant amount of equipment has been submerged and if the amount of flooding is not a major threat to ship's stability and buoyancy, it may be desirable to make all preparations for restorative measures prior to exposing the flooded equipment to the air. The rate of corrosion of immersed equipment will be markedly accelerated upon exposure to air (see Section 48.)

079-46.11.7 RUPTURE IN AUXILIARY EXHAUST PIPING. In low pressure systems, patches, blank flanges, or plugs may be used freely and the system can be operated even though damaged. In event of a major break, take action similar to that for a rupture in the auxiliary steam piping (see paragraphs 079-46.11.1 through 079-46.11.2).

079-46.11.7.1 When Section of Auxiliary Exhaust Piping is Ruptured in Fire Room. Take following steps:

1. Notify and keep Main Engine Control informed of situation.
2. Closely observe operating condition of DFT to prevent a feedwater casualty.
3. Isolate section of damaged piping, venting it through atmospheric exhaust. (Use only necessary machinery, which exhausts into damaged section.)
4. Make repairs to damaged piping.

079-46.11.7.2 When Section of Auxiliary Exhaust Piping is Ruptured in Engine Room. Take same steps as those listed in paragraph 079-46.11.7.1.

079-46.11.8 RUPTURE IN MAIN FEED PIPING. When this casualty occurs, take the following actions:

1. Notify and keep Main Engine Control informed of situation.
2. Stop main feed pump.
3. Start emergency feed pump and feed thorough auxiliary feed system if fitted.
4. Close main feed stop and check valve.
5. Close main feed stop and check valve.
6. Secure boiler if danger of low water exists.
7. Isolate section of damaged piping and restore main feed service, if practicable, using main or emergency feed pump as appropriate.

079-46.11.9 RUPTURE IN FUEL OIL SUCTION AND TRANSFER PIPING. When this casualty occurs actions to be taken are as follows:

1. Notify and keep Main Engine Control informed of situation.
2. Stop transfer pump.
3. Isolate damaged section and use transfer line on opposite side when provided.
4. Repair or replace damaged section.

079-46.11.10 RUPTURE IN HIGH PRESSURE DRAIN PIPING. In event of this casualty take following steps:

1. Notify and keep Main Engine Control informed of situation.
2. Close bulkhead stop(s) to isolate damaged section of high-pressure drain system.

079-46.11.10.1 If escaping vapor hinders operation, close traps and crack funnel and bilge drains.

NOTE

To conserve feedwater, crack drains in piping system only at points where condensate is likely to accumulate.

079-46.11.10.2 If rupture is at DFT, close high pressure drain valves at entrance to DFT.

NOTE

When high pressure drainage system cannot be used, drain units to the funnel drain system as frequently as required.

079-46.11.11 RUPTURE IN FUEL OIL HEATING DRAIN PIPING. If this casualty occurs, take following steps:

1. Notify and keep Main Engine Control informed of situation.
2. Isolate damage section by securing bulkhead stops.
3. Allow drainage from isolated section to flow into bilge.
4. Plug drain piping.
5. Repair or replace damaged or ruptured piping.

079-46.11.12 RUPTURE IN FIREMAIN PIPING. When this casualty occurs, notify and keep Main Engine Control informed. Main Engine Control will alert Damage Control Central.

079-46.11.12.1 When firemain is ruptured on the discharge side of firemain pump:

1. Secure cutout valves at point where pump discharge line connects to firemain.
2. Secure pump discharge valves.
3. Secure cutoff valves at either side of firemain rupture.
4. Slow or stop fire pump as required.

079-46.11.12.2 Fire hose jumpers can be rigged between fire plugs located on pressure side of cut-off valves at both sides of the piping rupture (see **NSTM Chapter 555, Firefighting-Ship**). Rig portable gasoline-driven pump to discharge flooding water over the side, through discharge fittings in upper hull.

NOTE

When portable gasoline-driven pumps are in use, provisions shall be made to vent off engine exhaust fumes.

079-46.11.13 RUPTURE IN SEAWATER COOLING SERVICE PIPING. If this casualty occurs, actions to be taken are as follows:

1. Notify and keep Main Engine Control informed of situation.
2. Secure cut-off valves nearest to both sides of rupture.
3. Plug or repair damaged piping (see **NSTM Chapter 079, Volume 2**).
4. Rig hose jumpers across, or cross-connect around ruptured piping section to provide cooling water to machinery components which require this cooling feature.

079-46.11.14 MAIN TURBINE CASUALTY CAUSED BY SHOCK OF EXPLOSION OUTSIDE ON HULL. In event of this casualty, actions to be taken are as follows:

1. Notify and keep Main Engine Control informed of situation.
2. Stop turbine and lock shaft.
3. Make shaft repairs as practicable.
4. Make piping repairs as necessary if lubrication oil lines are damaged.
5. Make repairs as necessary if lubricating oil sump tank is damaged.
6. Calk seams when required.

079-46.11.14.1 If turbine or reduction gears have been damaged, take action as described in the portions of this section discussing turbine casualties. Also, see **NSTM Chapter 244, Bearings** , **Chapter 231, Propulsion and SSTG Steam Turbines** , and **Chapter 9420, Propulsion Reduction Gears, Couplings, and Associated Components.**

079-46.11.15 FIRE ROOM EXPLOSION - TORPEDO HIT. If this casualty occurs surviving personnel will evacuate area and Main Engine Control will be notified and kept informed. Main Engine Control will notify Damage Control Central.

079-46.11.15.1 Additional steps to be taken are as follows:

1. Shut down, by remote control, operation of all machinery components, such as pumps, that may be operating.
2. Extinguish fires (see **NSTM Chapter 555**).
3. Close all openings giving free access to the sea if practicable.
4. Shore surrounding boundaries to prevent their failure and progressive flooding (see **NSTM Chapter 079, Volume 2**).
5. Dewater area if practicable, using whatever stationary and portable pumps that may be available.
6. Repair damage as practicable.

079-46.11.16 FIRE ROOM EXPLOSION - SHELL HIT. When this casualty occurs, notify and keep Main Engine Control informed of situation. Main Engine Control will notify Damage Control Central.

079-46.11.16.1 When boilers remain undamaged, take following steps:

1. Secure all damaged machinery components and their associated pumps and piping.
2. Extinguish fires in area except in furnace unless fuel oil pumps and piping have been damaged.
3. Vent smoke to atmosphere.
4. Take action to dewater compartment by using stationary or portable pumps available.
5. Plug or patch fragment holes in all boundaries of the compartment.
6. Make repairs to damaged components as may be practical.

079-46.11.16.2 When boiler is damaged:

1. Extinguish fires in furnace.
2. Secure fuel oil pumps.
3. Secure feedwater pumps.
4. Extinguish fires in compartment.

NOTE

Escaping steam can be useful in combating fires. Personnel must be equipped with Oxygen Breathing Apparatus (OBA) or airline hose masks.

5. Vent smoke and steam to atmosphere when fires have been extinguished.
6. Dewater compartment by using available stationary or portable pumps.
7. Plug or patch fragment holes in compartment boundaries.
8. Make whatever repairs are necessary and practicable.

079-46.11.17 ENGINE ROOM EXPLOSION - TORPEDO HIT. When this casualty occurs surviving personnel shall evacuate area and Main Engine Control will be notified and kept informed. Main Engine Control will notify Damage Control Central.

079-46.11.17.1 Additional steps to be taken are as follows:

1. Secure plant by remote control.
2. Lock shaft, if practicable.
3. Extinguish fires (see **NSTM Chapter 555, Firefighting - Ship**).
4. Close all openings giving free access to sea, if practicable.
5. Shore surrounding boundaries to prevent their failure and progressive flooding (see **NSTM Chapter 079, Volume 2**).
6. Dewater compartment, if practicable, using available stationary and portable pumps.
7. Repair damage as practicable and restore service.

079-46.11.18 ENGINE ROOM EXPLOSION - SHELL HIT. If this occurs, notify and keep Main Engine Control informed. Main Engine Control will notify Damage Control Central.

079-46.11.18.1 If turbine is damaged, stop turbine and lock shaft. If there is damage to machinery components:

1. Secure damaged machinery.
2. Start up auxiliary, if undamaged.

079-46.11.18.2 Additional steps to be taken are as follows:

1. Secure main and auxiliary steam lines to engine room.
2. Secure auxiliary exhaust lines.
3. Extinguish fires (see **NSTM Chapter 555, Firefighting - Ship**).
4. Repair or replace damaged piping and electrical cables.
5. Plug or patch damaged watertight boundaries (see **NSTM Chapter 079, Volume 2**).
6. Shore weakened watertight boundaries (see **NSTM Chapter 079, Volume 2**).
7. Dewater compartment of flooding water, using all available installed or portable pumps as necessary to accomplish job.
8. Make necessary repairs to damaged machinery as practicable and restore to service.

079-46.11.19 STEERING GEAR CASUALTY - NEAR MISS. If this casualty occurs, take following actions:

1. Notify and keep Main Engine Control informed of situation.
2. Stop engine(s) and lock shaft if damaged rudder is fouling propeller(s) and if situation permits.
3. Take action on orders from Main Engine Control.

079-46.11.19.1 If electric power supply to steering gear is damaged:

1. Switch to alternate power supply.
2. Rig casualty power cables as necessary.

079-46.11.19.2 If steering motors are damaged:

1. Shift to emergency steering unit.
2. Rig for and operate manual steering.
3. Use main engines for steering.
4. Plug, patch, or replace ruptured lubrication oil piping, as required.
5. Repair damaged machinery and restore to service if practicable.

079-46.11.20 PROPELLER CASUALTY - NEAR MISS. When this occurs, notify and keep Main Engine Control informed.

079-46.11.20.1 If shaft races, indicating possible loss of propeller, stop engine(s) and lock shaft. If shaft vibrates, indicating broken propeller or bent shaft, stop engine(s) and lock shaft.

NOTE

Although time is of the essence in taking the action indicated in paragraph 079-46.11.16, it is a command decision, predicated upon the situation (cruising, combat, and so forth).

079-46.11.20.2 Investigate, as soon as practicable, cause of apparent malfunction. Make repairs or proceed, using other engine(s).

079-46.11.21 FUEL OIL FIRE. Presence of flames, smoke, and excessive heat on bulkheads, casings, and decks all are symptoms of a fuel oil fire.

079-46.11.21.1 Such a fire may be caused by the following:

1. Ruptured fuel lines
2. Oil spray impinging upon surfaces hot enough to cause ignition
3. Excessive priming causing oil to flow and contact surfaces hot enough to cause ignition
4. Blast, explosion, or both

WARNING

Personnel should be instructed in the procedures contained in NSTM Chapter 555, Volume 1, Section 6 - Machinery Space Firefighting Doctrine for Class B Fires in Surface Ships, and all personnel should be required to attend a firefighting school.

079-46.11.21.2 Fire room actions to be taken if fire occurs in fire room bilges:

1. Notify and keep Main Engine Control informed of situation.
2. Shift to remote manual control and reduce loading pressure.
3. Shut boiler fuel oil supply quick-closing valve, master oil valve, stop fuel oil service pumps, and shut service tank suction valve.
4. Secure burners and forced draft blowers.
5. Secure boiler.

6. Employ firefighting procedures as necessary (see **NSTM Chapter 555 , Volume 1 Section 6 - Machinery Space Firefighting Doctrine for Class B Fires in Surface Ships**) .

079-46.11.21.3 If an oil tank fire occurs, use twin agent system, fog or foam, on open tank. On closed tank, steam hose can be connected and used. As a last resort, flood tank completely with seawater.

079-46.11.21.4 Engine room action if fire occurs in engine room includes:

1. Close throttle, as necessary, to maintain stream pressure.
2. Cross-connect plant, when directed by Main Engine Control, if boiler is secured or steam pressure drops below allowable minimum.
3. Start additional fire pump(s) as necessary.
4. Start drainage eductors with suction to affected areas.

079-46.11.21.5 Main Engine Control will perform the following:

1. Notify Bridge and keep informed.
2. Notify Damage Control Central.
3. Request Bridge to adjust speed, as necessary.
4. Direct engine room to take necessary action.

079-46.12 TURBOGENERATOR CASUALTIES

079-46.12.1 HOT BEARING. Hot bearing casualty in the turbogenerator is discussed in the paragraphs that follow. Symptoms and causes of the condition, corrective action to be taken, and possible additional casualties are included.

079-46.12.1.1 Symptoms. Hot turbogenerator bearing can be recognized by the following symptoms:

1. Bearing lube oil outlet temperature exceeds 82°C (180°F).
2. Oil temperature differential between inlet and outlet exceeds 28°C (50°F).
3. Bearing cover is excessively hot to the touch.
4. Rapid rise in bearing temperature indicated, exceeding 1°F per minute.
5. Generator bearing high temperature alarm sounds.
6. Bearing emitting smoke.

079-46.12.1.2 Causes. Causes of hot bearing include the following:

1. Insufficient lube oil pressure to bearing
2. Obstructed bearing oil supply

3. Clogged bearing oil return line
4. Grit or dirt in lube oil
5. Poor condition of journal/bearing surface
6. Improper lube oil temperature from cooler
7. Improperly fitting or aligned bearing
8. Water in lube oil

079-46.12.1.3 Remedial Actions. To correct hot bearing casualty:

1. Notify and keep Main Engine Control informed. Request electrical load be removed.
2. Decrease turbogenerator speed when electrical load has been shifted.
3. Increase flow of cooling water through lube oil cooler.
4. Shift turbogenerator auxiliary condensate circulating water pump discharge strainers.
5. Apply artificial cooling.
6. Monitor oil flow sight glasses for normal oil flow.
7. Monitor sump oil level.
8. Monitor all bearing temperatures.
9. Shift and inspect lube oil strainers.
10. Take turbine rotor position clearance.
11. Continue to slow turbogenerator until bearing temperature stabilizes.
12. Remove alternate methods of cooling when bearing temperature indicates a return to normal.
13. Return lube oil cooler to normal operating conditions.
14 Increase speed of turbogenerator slowly.
15. Shift and inspect lube oil strainers when turbogenerator is at operating speed and bearing temperatures are normal.

CAUTION

Bearings which have indicated temporary signs of stress (hot bearing) and return to normal temperatures should be inspected thoroughly at the earliest opportunity.

079-46.12.1.3.1 If bearing temperature is uncontrollable, proceed as follows:

1. Reduce speed of turbogenerator until bearing temperature is reduced.
2. Stop turbogenerator.
3. Remove affected bearing.

4. Inspect bearing.

079-46.12.1.3.2 Main Engine Control will perform the following:

1. Notify Bridge of casualty, action being taken, and estimated time required to make repairs.
2. Order electrical load shifted, reduced, or both, as required.
3. Order unaffected generators started as required.

079-46.12.1.4 Possible Additional Casualties. Possible additional casualties may be as follows:

1. Reduced electrical capability
2. Wiped bearing
3. Reduction gears/turbine damage

079-46.12.2 HIGH OIL LEVEL. The following paragraphs discuss high oil level in the turbogenerator and list symptoms and causes, remedial action procedures, and a possible additional casualty.

079-46.12.2.1 Symptoms. High oil level in turbogenerator will produce the following:

1. Increase in oil level in turbogenerator sump, indicated on sump oil level dipstick
2. Overflow of foaming oil through gear casing vent
3. Oil leakage appearing at gear casing joints or flanges
4. A rapid increase in bearing temperature

079-46.12.2.2 Causes. High oil level can be caused by the following:

1. Leaking or improperly aligned valves in purifying system
2. Water in lubricating system
3. Defective gear casing vent

079-46.12.2.3 Remedial Actions. Proceed as follows to reduce high oil level in turbogenerator:

1. Notify and keep Main Engine Control informed. Request electrical load be removed.
2. Ensure sump vents are clear.
3. Ensure lube oil supply line valve from lube oil purifier discharge is shut.
4. Monitor bearing temperatures.
5. Stop turbogenerator when electrical load has been shifted.
6. Draw sample of lube oil for test.
7. Start lube oil purifier.

8. Transfer lube oil from turbogenerator sump to lube oil settling tank.
9. Shift and inspect lube oil strainer.
10. Stop purifier when lube oil in sump is at proper level.
11. Ensure lube oil purifying system is in proper alignment.

NOTE

If lube oil is contaminated, turbogenerator sump shall be drained, cleaned and replenished with new oil from lube oil storage tank.

079-46.12.2.3.1 Main Engine Control will perform the following:

1. Notify Bridge of casualty, action being taken, and estimated time needed to make repairs.
2. Order electrical load shifted, reduced, or both, as required.
3. Order unaffected generator started as required.

079-46.12.2.4 Possible Additional Casualty. Hot bearings are a possible additional casualty resulting from high oil level.

079-46.12.3 LOSS OF LUBE OIL PRESSURE. This casualty is discussed in detail in the following paragraphs.

079-46.12.3.1 Symptoms. Loss of lube oil pressure to turbogenerator produces the following symptoms:

1. Lube oil pressure to bearings is below normal.
2. Low lube oil pressure alarm sounds.
3. No oil flow is observed in bearing oil flow sight glasses.
4. Excessively high bearing temperature is indicated.
5. Turbogenerator trips off the line.

079-46.12.3.2 Causes. Causes of lube oil pressure loss are as follows:

1. Failure of operating lube oil pump
2. Obstruction in piping or strainer
3. Improper shifting of lube oil strainers
4. Leaking or improperly aligned valves in purifying or lube oil transfer system
5. Grit or dirt in governor lube oil system
6. Dirty governor oil strainer (where installed)

079-46.12.3.3 Remedial Actions. The following procedures will correct pressure loss:

1. Notify Main Engine Control by stating, **“Stopping turbogenerator.”** Keep Main Engine Control informed.
2. Trip turbogenerator manually.
3. Attempt to restore lube oil pressure with electric or hand pump.
4. Shift and inspect lube oil strainer.
5. Monitor lube oil sump level.
6. Monitor bearing temperature.
7. Secure turbogenerator using **Engineering Operational Procedures.**
8. Investigate piping for leaks.
9. Take turbine rotor position clearances.
10. Start and test turbogenerator, using **Engineering Operational Procedures,** when repairs have been made.

079-46.12.3.3.1 Main Control will perform the following:

1. Notify Bridge of casualty, action being taken, and estimated time required to make repairs.
2. Order electrical load shifted or reduced, or both, as required.
3. Order unaffected generator started, as required.

079-46.12.3.4 Possible Additional Casualties. Possible additional casualties are as follows:

1. Hot bearings
2. Damage to turbogenerator

079-46.12.4 LUBE OIL LEAK. Lube oil leak casualty in the turbogenerator, its symptoms and causes, are discussed in the following paragraphs. Procedures for correcting the conditions and possible additional casualties also are listed.

079-46.12.4.1 Symptoms. The following symptoms will result from a lube oil leak in turbogenerator:

1. Oil spraying/pouring from vicinity of leak
2. Low lube oil pressure alarm sounds
3. Low level indicated on sump oil level gauge
4. Lube oil on deck, bulkhead, or bilge

079-46.12.4.2 Causes. Causes of lube oil leak may be the following:

1. Defective gaskets in piping
2. Defective fittings in piping
3. Splits/cracks in reduction gear casing

4. Damage resulting in ruptured piping
5. Damage resulting in sheared fittings
6. Improper operation of lube oil strainer

079-46.12.4.3 Remedial Actions. Use the following procedures to locate and correct leak:

1. Notify Main Engine Control by stating, **“Stopping turbogenerator.”** Keep Main Engine Control informed.
2. Stop turbogenerator using manual trip device.
3. Monitor bearing temperatures.
4. Monitor oil flow sight glasses for normal oil flow.
5. Ensure auxiliary oil pump is operating.
6. Secure turbogenerator, using **Engineering Operational Procedures.**
7. Investigate for source of leak.
8. Shift and inspect lube oil strainers.
9. Remove all fire hazards and spilled oil.
10. Pump bilges as necessary, observing Oil Pollution Act.
11. Make repairs.
12. Replenish oil in turbogenerator sump.
13. Start and test turbogenerator using **Engineering Operational Procedures.**

079-46.12.4.3.1 Main Engine Control will perform the following:

1. Notify Bridge of casualty, action being taken, and estimated time needed to make repairs.
2. Notify Damage Control Central.
3. Order electrical load shifted, reduced, or both, as required.
4. Order unaffected generator started as required.

079-46.12.4.4 Possible Additional Casualties. Possible additional casualties include the following:

1. Loss of lube oil pressure
2. Class BRAVO fire

079-46.12.5 LOSS OF VACUUM IN AUXILIARY CONDENSER. Vacuum loss in auxiliary condenser is discussed in the paragraphs that follow, which includes symptoms and causes of casualty, as well as remedial action.

079-46.12.5.1 Symptoms. Loss of vacuum in auxiliary condenser will result in the following symptoms:

1. Vacuum gauge indicating below normal.

2. Hot condenser indicated.
3. Flooded condenser indicated.
4. Turbogenerator sentinel valve lifts.
5. Turbogenerator speed decreases.

079-46.12.5.2 Causes. Vacuum loss in the turbogenerator can be caused by the following:

1. Insufficient gland seal steam pressure to turbine
2. Insufficient flow of circulating water through condenser
3. Inadequate drainage of condensate from condenser
4. Casualty to condensate pump
5. Pump improperly aligned
6. Air ejector improperly functioning
7. Dirty condenser steam side
8. High seawater injection temperature
9. Air leak in condenser steam side fitting or piping
10. Broken hot well sight glass

079-46.12.5.3 Remedial Actions. Correct vacuum loss in the auxiliary condenser by use of the following procedures:

1. Notify and keep Main Engine Control informed. Request electrical load be removed.
2. Monitor vacuum continuously.
3. Ensure gland seal steam regulator is aligned and properly operating.
4. Shut make-up feed valve.
5. Ensure operating and idle air ejectors are properly aligned.
6. Ensure air ejector steam pressure and condensate outlet temperatures are normal. If condensate outlet temperature is above normal:
    a. Open condensate recirculating valve.
    b. Vent air ejector condenser.
7. Monitor first stage and condenser vacuums. If first stage and condenser vacuums are equal, charge loop seal.
8. Ensure condensate pump is aligned and operating properly. If hot well level is high, shut condensate recirculating valve.
9. Ensure injection and overboard valves are open, vent seawater headers.
10. Check condenser shell and headers for excessive heat.
11. Ensure circulating water pump is properly operating.
12. Cross-connect auxiliary exhaust when ordered by Main Engine Control:

   a. Secure auxiliary exhaust to affected turbogenerator.
   b. Shift auxiliary exhaust to main condenser when main condenser is in operation.

13. Investigate piping and fittings under vacuum for leaks.
14. Stop turbogenerator, using **Engineering Operational Procedures** when auxiliary vacuum drops below 15 inches of mercury.
15. Make necessary tests and repairs.
16. Start and test turbogenerator using **Engineering Operational Procedures.**

079-46.12.5.3.1 Main Engine Control will perform the following:

1. Notify Bridge of casualty, action being taken, and estimated time required to make repairs.
2. Order electrical load shifted, or reduced, or both, as required.
3. Order unaffected generator started, as required.

079-46.12.6 UNUSUAL NOISE/VIBRATION IN TURBOGENERATOR. This casualty is discussed in detail in the following paragraphs.

079-46.12.6.1 Symptoms. Unusual noise or vibration in turbogenerator will be detected in turbogenerator turbine, reduction gears, or generator.

079-46.12.6.2 Causes. The following list includes causes of unusual noise and vibration:

1. Broken or chipped brush
2. Damaged commutator
3. Water carryover from a boiler into turbine
4. Broken or loose turbine blading
5. Broken reduction gear teeth
6. Generator arcing
7. Turbogenerator bearing casing loose, broken, or missing
8. Foundation hold-down bolts loose, broken, or missing
9. Bowed turbine rotor
10. Defective shaft-driven lube oil pump
11. Misalignment of reduction gears or bearings

079-46.12.6.3 Remedial Actions. Locate and correct unusual noise or vibration as follows:

1. Notify and keep Main Engine Control informed. Request electrical load be removed.

WARNING

When a loud metallic noise is emanating from turbine or reduction gear, stop turbogenerator immediately, using hand trip.

2. Reduce turbogenerator speed when electrical load has been removed.
3. Investigate turbine for abnormalities.
4. Investigate reduction gear for abnormalities.
5. Investigate generator for abnormalities.
6. Open main steam line and turbine casing drains to freshwater drain main.
7. Shut lines and drains when drains are clear.
8. Ensure proper lubricating oil flow to bearings.
9. Monitor bearing temperatures.
10. Shift and inspect lube oil strainers.
11. Take turbine rotor position clearance.
12. Stop turbogenerator when noise/ vibration persists at all speeds.
13. Ensure auxiliary oil pump is operating.
14. Inspect for damage and repair.

079-46.12.6.3.1 Main Engine Control will perform the following:

1. Notify Bridge of casualty, action being taken, and estimated time needed to make repairs.
2. Order electrical load shifted, reduced, or both, as required.
3. Order unaffected generator started, as required.

079-46.12.6.4 Possible Additional Casualties. Possible additional casualties are as follows:

1. Damaged turbogenerator turbine
2. Damaged turbogenerator bearings
3. Damaged turbogenerator reduction gears
4. Damaged generator

079-46.13 DIESEL GENERATOR CASUALTIES

079-46.13.1 LOSS OF LUBRICATING OIL PRESSURE. Loss of lubricating oil pressure and its symptoms and causes are discussed in the following paragraphs. Procedures for correcting this condition and possible additional casualties are also listed.

079-46.13.1.1 Symptoms. Loss of lubricating oil pressure to diesel generator displays the following symptoms:

1. Pressure gauge indicates low lubricating oil pressure.
2. Low lube oil pressure alarm sounds.
3. Engine noise increases.

079-46.13.1.2 Causes. Lubricating oil loss is caused by the following:

1. Low lubricating oil level
2. Restricted lubricating oil strainer/filters and lines
3. Broken lubricating oil line
4. Lubricating oil pump failure
5. Clogged internal suction strainer
6. Improper operation of regulating valve

079-46.13.1.3 Remedial Actions To ready diesel generator for inspection of casualty:

1. Notify Main Engine Control of casualty by stating, **"Stopping diesel generator."** Keep Main Engine Control informed.
2. Secure diesel generator using **Engineering Operational Procedures.**

NOTE

When affected emergency diesel generator is in use as initial source of electric power, affected emergency switchboard may have to remain deenergized until casualty to diesel engine can be corrected or until additional power source becomes available.

CAUTION

Do not remove engine crankcase covers or access covers until 30 minutes after shutdown of an engine when it is known or suspected that there has been an explosion, fire, or an overheated part in the crankcase.

079-46.13.1.3.1 Switchboard operator will perform the following:

1. Open generator circuit breaker.
2. Position voltage regulator control switch to MANUAL.
3. Reduce voltage to minimum possible.
4. Place emergency diesel lockout switch in lockout position when generator is an emergency generator.

CAUTION

Do not parallel emergency diesel generator with any other generator.

079-46.13.1.3.2 When steps in paragraph 079-46.13.1.3 are accomplished, proceed as follows to correct casualty:

1. Inspect diesel Engine lubricating oil system for the following:
   a. Position voltage regulator control switch to MANUAL.
   b. Proper lube oil level in engine sump
   c. Leaks and obstructions in strainers/filters
   d. Lube oil pump failure
   e. Regulating valve failure.
2. Make repairs as necessary.
3. Start diesel engine and test, using **Engineering Operational Procedures** when casualty has been restored.

NOTE

If diesel engine is emergency generator and is required as a source of power, switchboard operator will ensure feedback circuit breakers are open prior to closing generator circuit breaker.

079-46.13.1.3.3 Main Engine Control will perform the following:

1. Notify Bridge of casualty, action being taken, and estimated time required to make repairs.
2. Notify Damage Control Central if oil leak exists.
3. Notify Bridge of loss of power to steering engine when diesel engine is emergency generator for steering engines.
4. Order diesel generators lockout as required.
5. Order diesel generator started.
6. Order diesel generator placed back in operation as a source of power, as required.

079-46.13.1.4 Possible Additional Casualties. Possible additional casualties include the following:

1. Seizing of bearings
2. Seizing of shafts
3. Seizing of pistons
4. Crankcase explosion
5. Class BRAVO fire

079-46.13.2 DIESEL GENERATOR ENGINE OVERHEATS. Causes, symptoms, remedial actions and a possible additional casualty resulting from overheated engine are discussed in the following paragraphs.

079-46.13.2.1 Symptoms. When diesel generator engine overheats, symptoms occur as follows:

1. Freshwater thermometers indicate high temperature.
2. High temperature alarm sounds.
3. Low freshwater pressure indicated.
4. Low seawater pressure indicated.
5. High freshwater level in expansion tank and air bubbles escape.
6. Air bubbles escape from expansion tank.

079-46.13.2.2 Causes. Causes of diesel generator engine overheating are as follows:

1. Fresh or seawater pump failure
2. Low water level in freshwater system
3. Air leak in suction side of:
    a. Freshwater system pump
    b. Seawater system pump
4. Plugged freshwater or seawater system
5. High compression leak in freshwater system
6. Engine overload
7. Temperature regulator failure
8. Low lube oil level

079-46.13.2.3 Remedial Actions To locate cause of overheating, proceed as follows:

1. Notify and keep Main Engine Control informed of casualty.
2. Inspect diesel engine for:
    a. Proper freshwater temperature
    b. Freshwater or seawater pump failure. If seawater pump is cause of failure, shift to firemain cooling water system
    c. Proper level in freshwater expansion tank
    d. Air entrainment in fresh or seawater system
    e. Proper operation of freshwater temperature regulator
    f. Proper oil sump level

079-46.13.2.3.1 When ordered by Main Engine Control, switchboard operator will perform the following:

1. Reduce electrical load.
2. Open generator circuit breaker.
3. Position voltage regulator control switch to MANUAL.
4. Reduce voltage to minimum possible.
5. Place emergency diesel lockout switch in LOCKOUT position when affected generator is an emergency generator.

NOTE

When affected emergency diesel generator is in use as initial source of electric power, affected emergency switchboard may have to remain deenergized until casualty to diesel engine can be corrected or until additional power source becomes available.

079-46.13.2.3.2 If procedures described in paragraph 079-46.13.2.3 have no effect:

1. Inspect for high compression leak into freshwater system when reduction of electrical load has no effect on cooling water temperature.
2. Stop engine when cause of overheating cannot be determined and is uncontrollable.

CAUTION

Do not remove engine crankcase covers or access covers until 30 minutes after shutdown of an engine when it is known or suspected that there has been an explosion, fire, or an overheated part in crankcase.

3. Secure diesel generator using **Engineering Operational Procedures.**
4. Make repairs as necessary.
5. Start diesel engine and test using **Engineering Operational Procedures** when casualty is corrected.

CAUTION

Do not parallel emergency diesel generator with any other generator.

NOTE

If diesel engine is emergency generator and is required as a source of power, switchboard operator will ensure feedback circuit breakers are open prior to closing generator circuit breaker.

079-46.13.2.3.3 Main Engine Control will perform the following:

1. Notify Bridge of casualty, action being taken, and estimated time needed to make repairs.

2. Notify Bridge of power loss to steering engines when diesel engine is emergency generator for steering engines.
3. Order diesel generator lockout, as required.
4. Order diesel generator started and placed back in operation as a source of power, as required.

079-46.13.2.4 Possible Additional Casualty. Stopping of the engine may result from diesel generator engine overheating.

079-46.13.3 FAILURE OF SPEED CONTROL GOVERNOR. The following paragraphs discuss diesel generator engine speed control governor failure.

079-46.13.3.1 Symptoms. When diesel generator engine speed control governor fails, symptoms listed below will appear:

1. Engine is operating at excessive speed.
2. Engine suddenly stops.
3. Erratic operation of speed control governor.
4. Speed control governor fails to respond to load changes.

079-46.13.3.2 Causes. This casualty results from the following:

1. Low oil level in speed control governor
2. Speed control governor pilot valve stuck
3. Speed control governor pilot valve leak
4. Improper adjustment of speed control governor needle valve
5. Dirty lubricating oil in speed control governor
6. Speed control governor actuating arms and linkage binding
7. Speed control governor actuating arms and linkage loose

079-46.13.3.3 Remedial Actions. Proceed as follows to locate and correct casualty:

1. Notify and keep Main Engine Control informed of casualty.
2. Inspect speed control governor for:
   a. Proper oil level
   b. Proper adjustment of needle valve
   c. Freedom of movement of actuating arms
3. Stop diesel engine if cause of governor failure cannot be determined and corrected.

079-46.13.3.3.1 Switchboard operator will, as needed:

1. Investigate for electrical fluctuations.
2. Reduce electrical load as required.
3. Open generator circuit breaker.
4. Position voltage regulator control switch to MANUAL.
5. Reduce voltage to minimum possible.
6. Place emergency diesel lockout switch in lockout position when generator is an emergency generator.

CAUTION

Do not parallel emergency generator with any other generator.

NOTE

When affected emergency diesel generator is in use as initial source of electric power, affected emergency switchboard may have to remain deenergized until casualty to diesel engine can be corrected or until additional power source becomes available.

079-46.13.3.3.2 Continue corrective action as follows:

1. Secure diesel generator using **Engineering Operational Procedures.**
2. Inspect speed control governor for the following:
   a. Dirty oil
   b. Needle valve for leaks or sticking
   c. Actuating arms for binding or breaks
3. Start diesel engine and test using **Engineering Operational Procedures** when casualty is corrected.

NOTE

If diesel engine is emergency generator and is required as a source of power, switchboard operator will ensure feedback circuit breakers are open prior to closing generator circuit breaker.

079-46.13.3.3.3 Main Engine Control will perform the following:

1. Notify Bridge of casualty, action being taken, and estimated time required to make repairs.
2. Notify Bridge of power loss to steering engines, as required when diesel engine is emergency generator for steering engines.
3. Order diesel generator lockout as required.
4. Order diesel generator started and placed back in operation as a source of power, as required.

079-46.13.3.4 Possible Additional Casualty. Engine stopping may result from speed governor failure.

079-46.13.4 DIESEL GENERATOR ENGINE OVERSPEEDS. Overspeeding, its symptoms, causes, corrective action and possible additional casualties is discussed in the following paragraphs.

079-46.13.4.1 Symptoms. When diesel generator engine overspeeds, the following symptoms will be in evidence:

1. Rapid increase in engine speed occurs.
2. Overspeed trip stops engine.

079-46.13.4.2 Causes. The two causes of overspeeding are as follows:

1. Improper adjustment or failure of speed control governor
2. Throttle linkage loose or binding

079-46.13.4.3 Remedial Actions. Actions to be taken are as follows:

1. Notify and keep Main Engine Control informed of engine stopped by overspeed trip.

NOTE

When affected emergency diesel generator is in use as initial source of electric power, affected emergency switchboard may have to remain deenergized until casualty to affected diesel engine can be corrected, or additional power source becomes available.

2. Secure diesel generator using **Engineering Operational Procedures.**
3. Inspect diesel engine for the following:
   a. Proper adjustment or failure of speed control governor
   b. Proper oil level in speed control governor
   c. Binding or loose throttle linkage
4. Start diesel engine and test, using **Engineering Operational Procedures** when casualty has been restored.

CAUTION

Do not remove engine crankcase covers of access covers until 30 minutes after shutdown of an engine when it is known or suspected that there has been an explosion, fire, or overheated part in crankcase.

079-46.13.4.3.1 Switchboard operator will perform the following:

1. Open generator circuit breaker.
2. Position voltage regulator control switch to MANUAL.
3. Reduce voltage to minimum possible.

4. Place emergency diesel lockout switch in lockout position when generator is an emergency generator.

CAUTION

Do not parallel emergency diesel generator with any other generator.

NOTE

If diesel engine is emergency generator and is required as a source of power, switchboard operator will ensure feedback circuit breakers are open prior to closing generator circuit breaker.

079-46.13.4.3.2 Main Engine Control will perform the following:

1. Notify Bridge of casualty, action being taken, and estimated time needed to make repairs.
2. Notify Bridge of power loss to steering engines when diesel engine is emergency generator for steering engines.
3. Order diesel generator lockout, as required.
4. Order diesel generator started and placed back in operation as a source of power, as required.

079-46.13.4.4 Possible Additional Casualty. A crankcase explosion can result from diesel generator engine overspeeding.

079-46.13.5 CRANKCASE EXPLOSION. This casualty, its symptoms, causes, remedial actions, and possible additional casualties are discussed in the following paragraphs.

079-46.13.5.1 Symptoms. Crankcase hand hole relief valve lifts are symptomatic of this casualty.

079-46.13.5.2 Causes. Explosion in diesel generator crankcase is a result of the following:

1. Engine being overheated
2. Contaminated lube oil
3. Hot bearings

079-46.13.5.3 Remedial Actions. When explosion occurs, proceed as follows:

1. Notify Main Engine Contro by, stating, **"Stopping engine."** Keep Main Engine Control informed.

NOTE

When affected emergency diesel generator is in use as initial source of power, affected emergency switchboard may have to remain deenergized until casualty to affected diesel engine can be repaired or additional power source becomes available.

2. Secure diesel generator using **Engineering Operational Procedures.**

CAUTION

Do not remove engine crankcase covers or access covers until 30 minutes after shutdown of engine, when it is known that an explosion has occurred in crankcase.

3. Make repairs as necessary.
4. Start diesel engine using **Engineering Operational Procedures** when casualty has been repaired.

NOTE

If diesel engine is emergency generator and is required as a source of power, switchboard operator will ensure feedback circuit breakers are open prior to closing generator circuit breaker.

079-46.13.5.3.1 Switchboard operator will perform the following:

1. Open generator circuit breaker.
2. Position voltage regulator control switch to MANUAL.
3. Reduce voltage to minimum possible.
4. Place emergency diesel lockout switch in lockout position when generator is an emergency generator.

CAUTION

Do not parallel emergency diesel generator with any other generator.

079-46.13.5.3.2 Main Engine Control will perform the following:

1. Notify Bridge of casualty, action being taken, and estimated time required to make repairs.
2. Notify Damage Control Central.
3. Notify Bridge of power loss to steering engines when diesel engine is emergency generator for steering engines.
4. Order diesel generator lockout, as required.
5. Order diesel generator started and placed back in operation as a source of power, as required.

079-46.13.5.4 Possible Additional Casualties. Possible additional casualties are as follows:

1. Personnel casualties
2. Class BRAVO fire

079-46.13.6 DIESEL GENERATOR SUDDENLY STOPS. The following paragraphs discuss sudden stopping of diesel generator.

079-46.13.6.1 Symptoms. Symptoms are as follows:

1. Engine will not respond to governor control.
2. Unable to restart engine.

079-46.13.6.2 Causes. Sudden stopping of diesel generator may result from the following:

1. Obstructed fuel oil supply
2. Governor not properly functioning
3. Control not properly functioning
4. Fuel oil system airbound
5. Seized bearings
6. Malfunctioning overspeed trip
7. Hydraulic lock
8. Blockage of intake
9. Blockage of exhaust
10. Failed fuel pump
11. Engine overheated

079-46.13.6.3 Remedial Actions. Proceed as follows to locate and correct casualty:

1. Notify and keep Main Engine control informed, stating, **“Engine stopped, cause unknown.”**
2. Secure diesel generator using **Engineering Operational Procedures.**

CAUTION

Do not remove engine crankcase covers or access covers until 30 minutes after shutdown of an engine when it is known or suspected that there has been an explosion, fire, or an overheated part in the crankcase.

3. Inspect diesel engine for the following:
   a. Fuel oil supply obstructions
   b. Proper operation and adjustment of overspeed trip
   c. Seized bearings
   d. Obstructed air system
   e. Water in cylinders
   f. Proper operation of fuel pump

g. Cooling system for proper cooling

NOTE

If diesel engine is emergency generator and is required as a source of power, switchboard operator will ensure feedback circuit breakers are open prior to closing generator circuit breaker.

4. Make repairs as necessary. Start diesel engine and test, using **Engineering Operational Procedures,** when casualty has been repaired.

079-46.13.6.3.1 Switchboard operator will perform the following:

1. Open generator circuit breaker.
2. Position voltage regulator switch to MANUAL.
3. Reduce voltage to minimum possible.
4. Place emergency diesel lockout switch in lockout position when generator is an emergency generator.

CAUTION

Do not parallel emergency generator with any other generator.

079-46.13.6.3.2 Main Engine Control will then:

1. Notify Bridge of casualty, action being taken, and estimated time needed to make repairs.
2. Notify Bridge of power loss to steering engines when diesel engine is emergency generator for steering engines.
3. Order diesel generator lockout, as required.
4. Order diesel generator started and placed back in operation as a source of power, as required.

079-46.13.6.4 Possible Additional Casualty. A crankcase explosion may result from sudden stopping of diesel generator.

079-46.14 GAS TURBINE GENERATOR CASUALTIES

079-46.14.1 UNUSUAL NOISE/VIBRATION IN GAS TURBINE GENERATOR. Symptoms, causes, remedial actions and possible additional casualties resulting from unusual noise and vibration are discussed in the paragraphs that follow.

079-46.14.1.1 Symptoms. Unusual noise or vibration in gas turbine generator will produce the following:

1. Audible and visual high vibration alarm (when installed) sounds.
2. Unusual noise in generator turbine, reduction gears or generator.

3. Unusual vibration in gas turbine generator.

079-46.14.1.2 Causes. Unusual noise or vibration can be caused by the following:

1. Broken or chipped brush
2. Turbine blading broken
3. Turbine blading loose
4. Broken reduction gear teeth
5. Misalignment of reduction gears
6. Misalignment of reduction gear bearings
7. Loose, broken or missing bearing cover
8. Turbine generator foundation hold-down bolts loose, broken or missing
9. Bowed turbine rotor
10. Debris riding against shaft
11. Defective gear driven electric pump

079-46.14.1.3 Remedial Actions. To locate and correct noises and vibrations, proceed as follows:

1. Notify and keep Main Engine Control informed of casualty.
2. Remove electrical load from generator or depress load shed activated pushbutton, when installed.
3. Depress auto parallel pushbutton to start system configuration change to remove affected generator from the line, when pushbutton is installed.
4. Stop gas turbine generator.
5. Water-wash gas turbine generator.
6. Restart turbine when waterwash completed.
7. Check for proper lubrication.
8. Check for bearing temperatures.
9. Observe oil pressure gauges for normal oil pressure.
10. Shift and inspect lube oil strainers.
11. Monitor noise/vibration at all speeds; if present, stop gas turbine generator.
12. Investigate turbine reduction gears, bearings, couplings, and other moving parts for indications of damage.
13. Make necessary repairs.
14. Start and test affected gas turbine generator in accordance with **Engineering Operational Procedures** .

079-46.14.1.3.1 Main Engine Control will notify Bridge of casualty, action being taken, and estimated time needed to make repairs.

079-46.14.1.4 Possible Additional Casualties. Other casualties which may result from unusual noise and vibration are as follows:

1. Damage to turbine
2. Damage to reduction gears
3. Damage to generator bearings
4. Reduced electrical capability

079-46.14.2 HOT BEARING. Discussion of hot bearing in gas turbine generator casualty is contained in the following paragraphs. It includes symptoms and causes, remedial actions to be taken, and additional casualties which may result.

079-46.14.2.1 Symptoms. A hot bearing in the gas turbine generator will produce the following symptoms:

1. Bearing outlet lube oil temperature exceeds alarm set point.
2. Oil temperature difference between inlet and outlet of bearing is 28°C (50°F).
3. Bearing cover is excessively hot to the touch.
4. Rapid rise in bearing temperature occurs, exceeding 1°F per minute.
5. Audible and visual generator bearing high temperature alarm indicated.

079-46.14.2.2 Causes. Causes of hot bearing are as follows:

1. Insufficient lube oil pressure to bearings
2. Malfunction of generator driven lube oil pump
3. Obstructed bearing oil supply on return line
4. Grit or dirt in lube oil
5. Improperly fitted or aligned bearings
6. Poor condition of journal or bearing surface
7. Oil film lost due to water in oil
8. High oil temperature from cooler

079-46.14.2.3 Remedial Actions. Proceed as follows to correct hot bearing casualty:

1. Notify and keep Main Engine Control informed of casualty.
2. Remove electrical load from generator or depress load shed activated pushbutton, when installed.
3. Depress auto parallel pushbutton to start system configuration change removing affected generator from the line, when pushbutton is installed.
4. Shift and inspect lube oil strainers.
5. Monitor:

   a. Bearing temperatures
   b. Sump oil level

6. Observe sight flow indicator for normal oil flow.

7. Increase flow of cooling water through lube oil cooler.

8. Stop gas turbine generator when bearing temperatures are uncontrollable.

9. Sample lube oil for contamination.

10. Take turbine rotor clearances.

11. Remove and inspect:
    a. Bearings
    b. Lube oil supply
    c. Return lines

12. Refit or replace bearing(s).

13. Ensure lube oil lines are clear.

14. Restart and test gas turbine generator in accordance with **Engineering Operational Procedures** when repairs have been made.

079-46.14.2.3.1 Main Engine Control will notify Bridge of casualty, action being taken, and estimated time required to make repairs.

079-46.14.2.4 Possible Additional Casualties. Possible additional casualties include the following:

1. Wiped bearing

2. Reduced electrical capability

079-46.14.3 LOSS OF LUBE OIL PRESSURE. The following paragraphs discuss loss of lube oil pressure to the gas turbine. Symptoms, causes, remedial actions to restore pressure, and possible additional casualties are also discussed.

079-46.14.3.1 Symptoms. The following symptoms will arise with loss of lube oil pressure to gas turbine generator:

1. Below normal lube oil pressure to bearings indicated.

2. Audible and visual low lube oil pressure alarm indicated.

3. High bearing temperature alarm sounds.

4. Gas turbine generator trips off the line.

5. Reduction gear lube oil header pressure gauge indicates low.

079-46.14.3.2 Causes. Loss of oil pressure can result from the following:

1. Worn or damaged lube oil pump
2. Obstruction in piping or strainer filter
3. Ruptured piping or fittings in lube oil system, or both
4. Lube oil pressure relief valve malfunction

079-46.14.3.3 Remedial Actions. Restore oil pressure to gas turbine generator with following procedures:

1. Notify and keep Main Engine Control informed of casualty.
2. Remove electrical load from generator or depress load shed activated pushbutton, when installed.
3. Stop gas turbine:
   a. Depress stop button, or
   b. Depress auto parallel pushbutton to start system configuration removing affected generator from the line, when pushbutton is installed.
4. Shift and inspect lube oil strainers.
5. Monitor lube oil sump level.
6. Investigate piping and fittings for leaks.
7. Inspect all bearings.
8. Inspect lube oil pressure relief valve for malfunction. Test gas turbine generator in accordance with **Engineering Operational Procedure** when cause has been determined and repaired.

079-46.14.3.3.1 Main Engine Control will notify Bridge of casualty, action being taken and estimated time needed to make repairs. Main Engine Control also will notify Damage Control Central if oil leak exists.

079-46.14.3.4 Possible Additional Casualties. Possible additional casualties include the following:

1. Damage to turbine
2. Damage to reduction gears
3. Damage to generator bearings
4. Reduced electrical capability
5. Class BRAVO fire

079-46.14.4 OVERSPEEDING OF GAS TURBINE GENERATOR. This casualty, along with symptoms and causes, actions to be taken, and possible additional casualties is discussed in the following paragraphs.

079-46.14.4.1 Symptoms. Overspeeding of gas turbine generator is evident from the following symptoms:

1. Audible and visual high frequency alarm is observed.
2. Gas turbine generator trips off the line.
3. Engine speed gauge indicates excessively high r/min.

079-46.14.4.2 Causes. Overspeeding results from:

1. Speed governor malfunction
2. Malfunction of fuel control assembly
3. Speed monitor malfunction

079-46.14.4.3 Remedial Actions. Correct overspeeding as follows:

1. Notify and keep Main Engine Control informed of casualty.
2. Remove electrical load from generator or depress load shed activated pushbutton, when installed.
3. Depress auto parallel pushbutton to start configuration change removing affected generator from the line, when pushbutton is installed.
4. Inspect speed control assembly.
5. Inspect fuel control assembly.
6. Restart gas turbine generator in accordance with **Engineering Operational Procedures** when cause of casualty has been determined.

079-46.14.4.3.1 Main Engine Control will notify Bridge of casualty, action being taken, and estimated time required to make repairs.

079-46.14.4.4 Possible Additional Casualties. Possible additional casualties are as follows:

1. Damage to turbine
2. Damage to generator
3. Reduced electrical capability

079-46.14.5 HIGH GAS TURBINE GENERATOR TEMPERATURE. High gas turbine generator temperature, its symptoms, causes, remedial actions for repair, and possible additional casualties are discussed in the following paragraphs.

079-46.14.5.1 Symptoms. Symptoms of high gas turbine generator temperature are as follows:

1. Audible and visual alarm indicated with simultaneous automatic shutdown of gas turbine generator.
2. Rapid rise in turbine temperature without corresponding increase in turbine speed occurs.
3. Excessively high turbine exhaust temperature indicated.

079-46.14.5.2 Causes. Causes of high temperature may be the following:

1. Gas turbine surging
2. Restriction in engine air inlet system

3. Restriction in air exhaust system
4. Turbine compressor contaminated

079-46.14.5.3 Remedial Actions.

1. Notify and keep Main Engine Control informed of situation.
2. Stop engine:
   a. Depress stop button.
   b. Depress auto parallel pushbutton to start system configuration change removing affected generator from line, when pushbutton is installed.
3. Inspect engine air inlet and exhaust for restrictions in air flow.
4. Inspect turbine compressor internally for presence of contamination and dirt.
5. Restart and test gas turbine generator using **Engineering Operational Procedures** when cause has been determined and repairs made.

079-46.14.5.3.1 Main Engine Control will notify Bridge of cause of casualty, action being taken, and estimated time needed to make repairs.

079-46.14.5.4 Possible Additional Casualties. Possible additional casualties include the following:

1. Damage to turbine
2. Damage to generator
3. Class BRAVO fire

079-46.14.6 CUTTING OUT GAS TURBINE GENERATOR IN EMERGENCY. Cutting out the gas turbine generator in an emergency may be regarded as a maneuver rather than a casualty. Reasons that justify this action, procedures to accomplish it, and the casualty which may result are discussed in the following paragraphs.

079-46.14.6.1 Reasons. Cutting out gas turbine generator may be required because of the following casualties:

1. Class CHARLIE fire in switchboard or generator
2. Casualty to prime mover such as:
   a. Loss of lube oil pressure
   b. Unusual noise or vibration
   c. Overspeeding
   d. Major lube oil leak
   e. High turbine temperature

079-46.14.6.1.1 Indications confirming the casualties will be the following:

1. Audible and visible alarms

2. Decreasing engine speed
3. Decreasing oil pressure
4. Low frequency/voltage indication

079-46.14.6.2 Procedures. To cut out generator in any casualty, proceed as follows:

1. Notify and keep Main Engine Control informed of casualty. Main Engine Control will notify Bridge of casualty, action being taken, and estimated time needed to make repairs.
2. Remove electrical load from generator or depress load shed activated pushbutton, when installed.
3. Stop turbine by depressing stop button or depress auto parallel pushbutton to start system configuration change removing affected generator from line, when installed.
4. Staff fire fighting equipment when Class CHARLIE fire is casualty.
5. Investigate and make necessary repairs when prime mover casualty has occurred.
6. Start and test gas turbine generator in accordance with **Engineering Operational Procedures** when repairs are completed.

079-46.14.6.3 Additional Casualty. Cutting out the gas turbine generator during a casualty will cause a reduction in electrical capability.

079-46.14.7 OVERLOAD (GAS TURBINE GENERATOR SUPPLIED SHIPS ONLY). Gas turbine generator overload is discussed in the following paragraphs.

079-46.14.7.1 Symptoms. Symptoms of gas turbine generator overload are as follows:

1. Excessive load indicated by electric plant control console meter.
2. Generator air temperature, stator temperature, and enclosure temperature alarms on electric plant control console sound.
3. High current alarm on electric plant control sounds.
4. Load shedding activates.

079-46.14.7.2 Causes. Overload on gas turbine generators is caused by the following:

1. Load requirement too great for generator(s) on the line
2. Shorts to ground
3. Unbalanced load if generators are in parallel
4. Generator air temperature is greater than 68°C (155°F)
5. Clogged generator air/water cooler
6. Defective cooling water pump
7. Cooling water bypass valve open

079-46.14.7.3 Remedial Actions. To relieve overload, proceed as follows:

1. Notify and keep Main Engine Control informed of casualty.
2. Main Engine Control will notify Bridge of casualty, action being taken, and estimated time needed to make repairs.
3. Depress load shed activated pushbutton.
4. Determine cause of high load.
5. Reduce load within generator(s) capacity.
6. Bring additional generator on the line when required.

079-46.14.7.4 Possible Additional Casualty. A Class CHARLIE fire may be caused by gas turbine generator overload.

SECTION 47.

ELECTRIC PLANT

079-47.1 GENERAL

079-47.1.1 ELECTRIC PLANT DESIGN. In designing a naval ship’s electric plant, every effort is made to obtain the greatest reliability and continuity of service under casualty conditions. Full understanding of these design features can best be attained by training and practice in proper use of the equipment and systems provided. Programs of education, training and maintenance are of vital importance for effective damage control.

079-47.1.2 DAMAGE CONTROL BOOKS. Damage Control Books contain diagrams of various systems and other valuable information for electric casualty control. NWP 62-1, **Surface Ship Damage Control,** requires that an **Engineering Casualty Control Book** be prepared for use in the Engineering Department and the type of information it shall contain is specified.

079-47.1.3 REMOVE ELECTRIC POWER. In any casualty involving damage to electric cable and equipment, the corresponding electric circuits may be a hazard if they remain energized. Circumstances surrounding each case of damage will dictate action to be taken. In case of serious damage, usually it is necessary to remove electric power from all cables in the damaged area, to prevent ignition of combustible liquids and gases.

079-47.1.4 OPERATIONAL REQUIREMENTS. Operational circumstances, however, may require reestablishment of power to undamaged circuits, including those which extend through the damaged area.

079-47.1.5 ELECTRIC SYSTEM FAMILIARITY. Time and labor that will be required to accomplish these actions will depend on familiarity with and availability of information regarding ship’s electric plant.

079-47.1.6 FAMILIARITY WITH ELECTRICAL DAMAGE CONTROL EQUIPMENT. Personnel must be familiar with the purpose and use of electrical damage control equipment. This is particularly true with respect to the Casualty Power System, because maintenance of watertight integrity may require personnel, other than those in the Electrical Department, to make cable connections. In casualty power drills, it is desirable to interrupt normal power and reenergize equipment by means of the Casualty Power System.

079-47.1.7 ELECTRICAL EQUIPMENT DAMAGE. Some equipment could be damaged by power interruption. In these cases:

1. The equipment must be deenergized carefully prior to the casualty power drill.
2. The equipment must be supplied with a source of power not involved in the drill.
3. The interruption must be limited to portions of the power system not involving the susceptible equipment.
4. The drill must be only simulated (see Volume 2 of this chapter).

079-47.1.8 ELECTRICAL CASUALTIES IN BATTLE. A damaged ship is almost certain to suffer some form of electrical casualty and preparations must be made to meet the situation. Organization, frequent realistic drills, and proper maintenance could enable a ship to survive.

079-47.1.8.1 The following electrical casualties have occurred frequently in battle:

1. Loss of power to elements of the Fire Control System
2. Loss of steering engine control
3. Loss of all or part of lighting
4. Failure of the diesel emergency generators to take over emergency load
5. Electrical fires
6. Loss of essential ventilation
7. Loss of power to interior communication equipment

079-47.1.9 MAINTENANCE. Maintenance of electrical equipment is described in **NSTM Chapter 300, Electric Plant-General.** All inspections and tests must be conducted and performed in such a manner that they do not become perfunctory and thus lose their value. Although maintenance of electrical equipment is not a primary function of damage control personnel, survival under damaged conditions could depend upon their working knowledge of electrical equipment. The end sealing of electric cables and the condition of casualty power equipment are a direct concern to damage control personnel, as well as maintenance of such items. Any component which is out of service for lack of proper maintenance is as useless as if it were damaged in action.

079-47.2 THE ELECTRIC PLANT

079-47.2.1 USES OF ELECTRIC POWER. Electric power is used in naval ships to operate numerous services which are indispensable to its fighting effectiveness. Electric power trains and elevates guns and missile launchers, moves the rudder, runs important auxiliaries, supplies light, and operates interior communication, as well as radio, radar, and sonar systems. A ship without electric power has little value as a fighting unit. **NSTM Chapter 320, Electric Power Distribution Systems,** describes fundamentals of a ship’s electric power and lighting plant.

079-47.2.2 RECORD OF ELECTRICAL INSTALLATIONS. A knowledge of the electric plant in a particular ship, as required for successful electrical damage control, can be attained only by actual observation and operating experience.

079-47.2.2.1 As an aid to personnel in understanding the principles underlying design of the electric plant on ships, each ship is supplied with **Record of Electrical Installations and Electrically Operated Auxiliaries** or the **Ship's Information Book (SIB)** . Each presents an overall picture of the electrical installation concerned, so those whose supervisory duties involve care and operation of the system and equipment may quickly and easily become familiar with the characteristics and operation of the entire system. In this volume, the discussion can be followed by referring to the circuit diagrams in the record and SIB, or the generalized diagrams in **NSTM Chapter 320.**

079-47.2.3 COMPONENTS. Ship's power and lighting electric plant consist of generators, switchboards, power panels, cables, circuit breakers, and other types of associated equipment necessary for generation, distribution, and control of power supplies to electrically driven auxiliaries, lighting, interior communication, electronics equipment, and other electrically powered devices.

079-47.2.3.1 The distribution system is the vital link connecting the generators with the equipment which uses electric power. Its purpose is to transmit electric power from one place to another and, by means of protective devices, protect from damage the distribution system itself and the generators. To some extent, the distribution system also protects equipment using power from damage which might otherwise be caused by failure in the distribution system or any connected equipment.

079-47.2.3.2 Protective devices must not be rendered inoperative without the approval of the Engineer Officer.

079-47.2.4 RELIABILITY. Ship's power and lighting electric systems have been designed to provide a high degree of flexibility to ensure continuity of essential power and lighting services under normal and casualty conditions.

079-47.2.4.1 Basically, ship's power and lighting electric systems consist of three principal elements:

1. The Ship's Service Electric System
2. The Emergency System
3. The Casualty Power System

079-47.2.4.2 Each of these systems is designed with inherent damage control features to provide a continuous supply of power under casualty conditions. General arrangement of Ship's Service Electrical System is such that a faulty circuit will be removed automatically, through the selective operation of protective devices, without an appreciable interruption of power supply to other circuits. On failure of ship's service generators, however, the emergency generator is automatically placed in operation.

079-47.2.4.3 If both ship's service and emergency systems fail, temporary casualty power circuits can be rigged to supply power to vital auxiliaries. For example, in event of a power failure on the normal ship's service power supply feeder to the steering gear, the load will automatically be transferred to the emergency feeder. If power is not available from either normal or emergency feeders, power can be supplied temporarily by rigging the

Casualty Power System. Thus, with these generator plant arrangements and the temporary casualty power arrangements, maximum reliability and flexibility are ensured.

079-47.2.5 POWER SYSTEMS. Electrical power is so essential to the military effectiveness of the ship that maximum effort must be made to ensure continuity of service under casualty conditions. To provide an electric plant arrangement so this fundamental requirement can be attained, design arrangements include consideration of the relative locations of the ship's service and emergency generator plants, wire-ways and bus-ties, and provision of a casualty power system.

079-47.2.5.1 The ship's service generator plant is divided into units, each unit consisting of one or two generators connected to an associated switchboard for their control and a distribution system to carry power to the ship's service power and lighting systems. The plant design provides for a standby generator capacity in event of loss of part of the generator plant. Usually, the normal feeders to the various loads will be taken from the nearest ship's service generator plant.

079-47.2.5.2 The emergency generator and switchboard are generally located as far forward and as far aft as practicable, separated from the nearest ship's service generator and switchboard by at least two watertight transverse bulkheads. This arrangement minimizes the possibility of damage to ship's service and emergency generators from the same cause. Each emergency generator has its own switchboard for control of the generator and distribution of power.

079-47.2.6 SEALED CABLES. Certain cables, such as those at switchboards, panels, or transfer switches, are sealed at their ends to prevent flow of water; end seals also will prevent entrance of water into electric equipment, thus avoiding malfunctioning of intact electrical circuits.

079-47.2.7 SPLIT-PLANT OPERATION. Ship's service generator plants can be operated independently, that is, split-plant (see **NSTM Chapter 320**). Each plant carries its own connected load. When operating in split-plant condition, the bus-tie between ship's service switchboards is open. In event of a casualty to one generator plant, power can be supplied to the equipment of the casualty-stricken plant by way of the bus-tie, as soon as the bus-tie circuit breaker is closed. The bus-tie breaker must not be closed, however, until damaged equipment has been isolated from the system.

079-47.2.7.1 Circuit-breakers on the bus-tie feeder, from ship's service switchboards to emergency switchboards, are kept closed to permit utilization of the emergency system as an additional means of distributing power from the ship's service generators. Upon loss of ship's service power on these bus-tie feeders, automatic starting of emergency generators will immediately provide emergency power to the Ship's Service System.

079-47.2.7.2 Setup of the electric plant must be consistent with, and provide the same degree of security as, the material and personnel Condition of Readiness set by the Commanding Officer.

079-47.2.8 DUPLICATE FEEDERS. These independent power supply circuits are provided to increase reliability of the power supply to vital equipment. To obtain maximum benefit from use of normal and emergency feeders, they are separated vertically and athwartships as much as practicable, to minimize the chance of all feeders being lost from the same casualty.

079-47.2.9 PROTECTIVE DEVICES AND TRANSFER SWITCHES. The electric distribution system is arranged to provide, as far as possible, selective tripping of all protective devices; that is, tripping of the circuit-breaker or overload devices nearest to the overload or fault, without tripping of other devices. By this coordination of all the protective devices, minimum disturbance of the distribution system will result from a short-circuit or overload.

079-47.2.9.1 Power distribution feeders originate at ship's service switchboards and emergency switchboards, supply power to distribution panels (and in some cases to single auxiliaries). The distribution panels distribute power to individual auxiliaries. Emergency feeders are provided for a limited number of systems or auxiliaries, so emergency power can be supplied to this equipment through automatic bus-transfer switches, in case of failure of ship's service power feeders.

079-47.2.10 LIGHTING SYSTEM. Ship's service and emergency lighting systems are energized from the 450-volt, three-phase buses on generator and distribution switchboards, through suitable 450/120-volt transformers.

079-47.2.10.1 Emergency Lighting. Uninterrupted lighting is provided in certain vital locations and for all exterior signals, by use of automatic bus-transfer equipment which supplies immediate emergency lighting upon failure of the ship's service supply. Provision is made for manual operation of these bus-transfers in event of failure of any automatic feature.

079-47.2.10.2 Hand Lanterns Relay Operated. In event of complete failure of ship's service and emergency lighting systems, automatic-type lanterns are provided to supply an instantaneous source of illumination. Hand lanterns are installed at vital stations, engine rooms and firerooms, at gauge boards for main and auxiliary machinery, and ship's service switchboards, steering gear room, crew's quarters, below deck passageways, and essential access passageways leading to weather decks.

079-47.2.10.2.1 Automatic-type hand lanterns are supplemented by non-automatic-type hand lanterns, installed at strategic locations throughout the ship, to provide a dependable self-contained source of light for performing emergency action when other means of lighting are inoperative (see **NSTM Chapter 330, Lighting**).

079-47.2.10.2.2 Since hand lanterns obtain energy from dry cell batteries which have a limited life, each unnecessary use of a lantern will reduce its potential period of usefulness as an emergency light. Lanterns are provided for emergency use only and should not be used under normal working conditions as flashlights.

079-47.2.10.3 Portable Floodlight Lanterns. Portable, storage-battery-powered, high intensity floodlight lanterns are provided in each ship for use by damage control repair parties. These lanterns consist of a sealed beam lamp, adjustably mounted on a carrying case. The lamp is rated at six volts, but is operated at eight volts to increase light output. The lantern will burn for about three hours on one charge. After approximately two hours, light intensity will be about one-half that of full charge.

079-47.2.10.3.1 Lanterns are stowed in locations most convenient to their use for emergency illumination of equipment and compartments essential to repair operations and continued operation of the ship.

079-47.2.10.4 Special Lighting Features. To prevent interior lighting from showing through weather deck doors and hatches operated by traffic to and from topside and second deck compartments (under darkened-ship conditions), switches operated by the door or hatch are provided to extinguish light in these compartments when the door or hatch starts to open. In addition to the normal lighting, low level illumination is provided by the installation of redlight fixtures (see **NSTM Chapter 330**).

079-47.2.11 SAFETY PRECAUTIONS. Safety precautions must always be observed by personnel working on and around electric circuits and equipment to avoid injury from electric shock or short circuits caused by accidentally placing or dropping a metal tool or other conducting article across an energized line. The arc and fire that can be started on relatively low voltage circuits may cause extensive damage to equipment and serious injury to personnel.

WARNING

The danger of shock from the 450-volt ac ship's service system is recognized by operating personnel. Low voltage (115 volts and less) circuits also are dangerous; they can cause death when resistance of the body has been lowered by moisture, especially in cases where current passes through the chest. Shipboard conditions are particularly conducive to the severity of shock, because personnel are likely to be in contact with ship's metal structure and body resistance may be lowered because of perspiration, damp clothing, or both. All of this is particularly true under damage control conditions, when extreme care is essential.

079-47.2.11.1 It is necessary that personnel be alert to the following dangers:

1. Electricity strikes without warning.
2. Speed often reduces caution and invites accidents. Personnel must take time to be careful because care eventually saves time.
3. All electrical circuits, including those as low as 35 volts and possibly lower, are potential sources of danger and must be treated as such.
4. Taking chances or short-cutting invites trouble; following proper procedures is safest. It is important that personnel learn correct procedures before being exposed to dangerous situation.

079-47.2.11.2 Personnel should never work on an energized circuit, except in an emergency. A circuit must be considered energized until a thorough and specific investigation has been made to ensure the switch is open and tagged and the circuit has been tested with a voltage tester.

079-47.2.11.3 Energized switchboards are a source of danger. No work shall be undertaken on switchboards, either energized or deenergized, without first obtaining approval of the Commanding Officer. For additional information on safety requirements when working on electrical equipment see **NSTM Chapter 300** .

079-47.3 EMERGENCY EQUIPMENT AVAILABLE FOR DAMAGE CONTROL PURPOSES

079-47.3.1 EMERGENCY POWER SYSTEM. The emergency power system is provided to supply an immediate source of emergency power to vital ship functions requiring continuity of service for sustaining ship control, communication, detection, interior communications, and lighting. It is designed to provide a source of emergency power for damage control functions, and limited operation of ordnance and aircraft facilities.

079-47.3.1.1 The emergency power system will provide power from the emergency switchboard, a normal source of ship's service power, through bus-tie feeders to selected electrical loads, thus utilizing the emergency switchboard as a ship's service load center under normal conditions. Emergency generator (motor-driven) seawater booster pumps are connected on the generator side of the generator circuit-breaker.

079-47.3.2 ELECTRICAL ITEMS IN DAMAGE CONTROL LOCKER. The following electrical equipment is stowed in damage control stations for use by damage control repair parties:

1. Cable
2. Cable cutters
3. Cable connectors
4. Insulating sleeves
5. Electrical repair kits
6. Flashlights
7. Hand lanterns
8. Casualty power portable switch
9. Casualty power riser terminal
10. Rubber boots

079-47.3.3 OUTLETS FOR PORTABLE SUBMERSIBLE PUMPS AND PORTABLE WELDERS. In addition to the regular 115-volt outlets installed throughout the ship for use with small portable tools, fans, and so forth, multi-purpose outlets are installed in selected locations for use with portable welding sets and portable submersible pumps. These outlets are 450-volts, 25 amperes, three-phase, interlocked switch type and are installed in locations that make it possible to concentrate two portable submersible pumps in any watertight compartment. It is also possible to reach any compartment with portable type welding sets.

079-47.3.3.1 In order to increase flexibility of the power supply to all portable submersible pumps and to permit concentration of all submersible pumps in one area, portable triple outlet extension cables are provided. An adapter is provided with these cables which will permit connection of submersible pumps to the casualty power terminals. The adapter consists of a length of cable having one end prepared for insertion into a casualty power terminal and 450-volt, three-phase, receptacle at the other end. To avoid shock hazard, the grounding wire clip at the casualty power terminal end of the cable should be connected to ground before the power leads are connected to the casualty power terminal. It should remain connected until after the power leads are disconnected.

079-47.4 DESCRIPTION OF CASUALTY POWER SYSTEM

079-47.4.1 FUNCTION. The Casualty Power System makes temporary power connections if the permanently installed ship's service and emergency distribution cables are damaged. It does not, however, supply circuits to all electrical equipment in the ship. It is limited to the facilities necessary to keep the ship afloat and get it out of a danger area.

079-47.4.1.1 This system also supplies power to a limited number of ordnance items such as anti-aircraft guns and their directors, which are necessary for defense and protection of the ship.

079-47.4.1.2 Although the Casualty Power System is rigged and connected by ship's electricians and other qualified personnel, final authority to energize any casualty power circuit rests with the Damage Control Assistant, who ensures that the system is ready to be energized and directs that such action be taken.

079-47.4.1.3 Casualty power for rigging temporary circuits differs from electrical damage control equipment in that the latter consists of tools and appliances for cutting cables and making splices for temporary repair of the permanently installed ship's service and emergency distribution systems.

079-47.4.1.4 Important features of the basic design of the Casualty Power System include the following:

1. Preservation of watertight integrity of the ship
2. Simplicity of installation and operation
3. Flexibility of application
4. Interchangeability of parts and equipment
5. Minimum weight and space requirements
6. Ability to accomplish desired functions

079-47.4.1.5 Since the Casualty Power System is an emergency method of providing power and not a method of making temporary repairs, it is purposely limited in its scope to retain its effectiveness. The more equipment added and the more the system is expanded, the greater the possibility of error in making connections, with the possibility that failure in relatively unimportant equipment will cause loss of power needed for vital equipment. It is also probable that, should the Casualty Power System be so expanded, it would be so burdened with miscellaneous loads that its ability to supply the required power load for vital needs would be dangerously reduced.

079-47.4.2 COMPONENT PARTS. Component parts of the casualty power distribution system include permanent and portable cables, risers, bulkhead and switchboard terminals, and portable switches. Suitable lengths of portable cables are stowed throughout the ship close to the locations where they are needed. Each terminal provides a connection point for three-phase portable cables.

079-47.4.2.1 Risers. Risers, consisting of a terminal at each end connected by permanently installed cable, provide connection points for three-phase portable cables between decks. Suitable terminals are provided at switchboards and some distribution panels for connecting portable cables at these points, to obtain power from, or supply power to the bus bars. Locations of the portable cables, bulkhead terminals, and risers are chosen such that connections can be made to many vital electrical auxiliaries from any of the ship's service and emergency generators (see paragraph 079-47.4.2.3). Portable cable ends and terminals are marked to identify the three phases visually, or by touch when illumination is insufficient for visual identification.

079-47.4.2.1.1 Vertical risers are provided from the deck containing the horizontal portable cable run to the switchboard compartments and to compartments that have power loads that receive casualty power on other deck levels. Where the total capacity of the generators supplying a switchboard is greater than 500 kw, two vertical port risers and two vertical starboard risers are provided. Where the total generator capacity is less than 500 kw, one vertical port riser and one vertical starboard riser are provided.

079-47.4.2.2 Cables. In small ships, the system generally provides a horizontal run of portable cable along the main deck and inside the deck housing where possible, with risers for power and loads projecting to and from this level.

079-47.4.2.2.1 In larger ships, two horizontal portable cable runs, one port and one starboard, are provided and are located on the lowest deck having through fore-and-aft access, or on the damage control deck.

079-47.4.2.2.2 For ships that have no through access deck below the main deck, the fore-and-aft casualty power cable runs are made on the main deck within the main deckhouse structure and on the first platform below the main deck (for compartments forward and aft of the main deckhouse structure).

079-47.4.2.2.3 The main horizontal fore-and-aft portable cable runs are arranged for easy access to casualty power terminals, using through passageways where practicable. These portable cable runs consist of bulkhead terminals installed through watertight transverse bulkheads when the portable cable run is above the tightness level.

079-47.4.2.2.4 The casualty power supply system contains no permanently installed circuits. Portable cables are provided for the forming of all circuits which are required for supplying power to equipment designated to receive casualty power. Portable cable has a normal rating of 93 amperes and a casualty power application rating of 200 amperes.

079-47.4.2.2.5 Portable cables are dispersed and stored throughout the damage control area on cable racks thus reducing the possibility of damage to the cable. Because of its portability, damage to cable on one or more racks will not seriously alter the effectiveness of the system, since cable from other racks can be employed as replacement cable.

079-47.4.2.2.6 To prevent fraying of the ends of cable conductors and consequent difficulties in making terminal connections, each conductor end is tipped with a copper sleeve (ferrule) which is compressed in place. Each ship is allowed a quantity of sleeves and a die for compressing the sleeves to the conductors. The pressure obtained by means of a bench vise is adequate for attachment of sleeves. The ends of the portable casualty power cables must be maintained in good order at all times.

079-47.4.2.2.7 The simplicity of the cable ends permits them to be connected to a wide variety of controllers and other devices, by simply removing the regular power cables and inserting the casualty power ends into the lugs provided on the equipment. Casualty power cable ends are illustrated in Figure 079-47-1.

079-47.4.2.2.8 Phase identification of the cable conductors is by color and the old method, which also employed servings of cotton cord. For ac three-phase cable identification, one serving for phase A (black wire), two servings for phase B (white wire), and three servings for phase C (red wire) were used. (See Figure 079-47-2.) The servings are separated so the phases can be identified by touch when no light is available and varnished for protection.

079-47.4.2.2.9 The current method of phase identification is similar to the old method, described above, except that O-rings and heat shrinkable tubing have been substituted for the cotton cord servings, as illustrated in Figure 079-47-1.

079-47.4.2.2.10 The best method of detecting over-aged insulation is to sharply bend all conductors by hand. Should no cracks appear, the insulation is satisfactory. If cracking is noted, repairs should be made in accordance with the procedures in **NSTM Chapter 320.** Megger readings are to be taken annually to determine insulation effectiveness.

079-47.4.2.2.11 Terminating casualty power cables. There are two acceptable methods of terminating casualty power cables.

The first method utilizes heat shrink tubing. The tubing is applied to the cable and should be extended 1/8″ up onto the ferrule to provide water tightness.

The alternate method does not utilize heat shrink tubing. The cable insulation is stripped back 1/8″ from the ferrule and varnish is applied to provide water tightness.

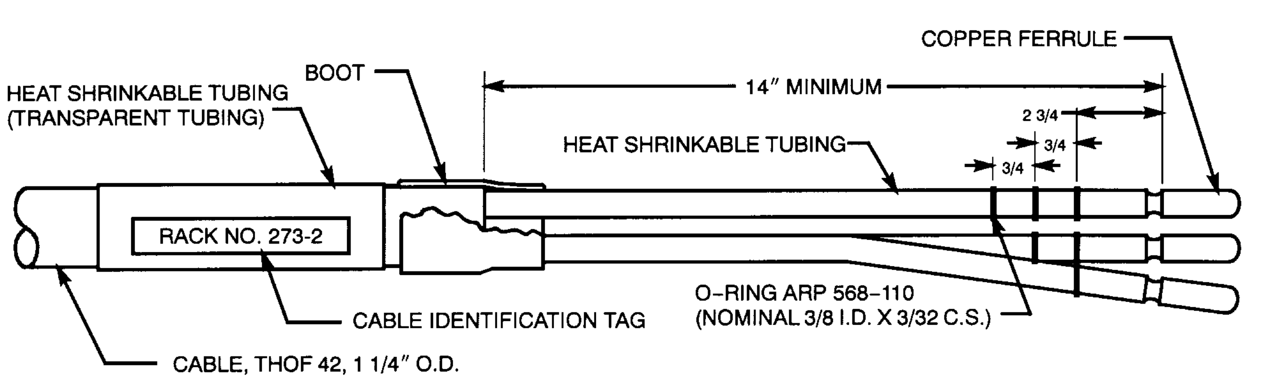

Figure 079-47-1 Casualty Power Cable Ends.

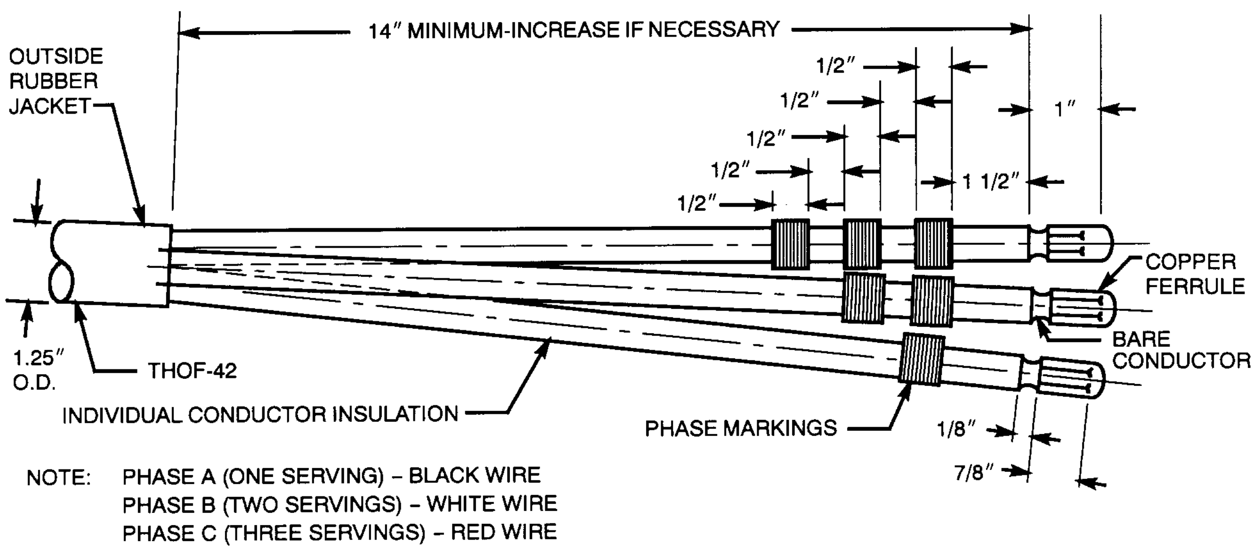

Figure 079-47-2 Phase Identification of Cable Conductors.

NOTE

For additional information pertaining to cable termination refer to Technical Manual: S9086-KY-STM-000/CH-320

079-47.4.2.3 Terminals. To aid in the rigging of casualty power circuits and to permit retaining the watertight integrity of compartments, a minimum amount of permanently installed equipment is provided.

079-47.4.2.3.1 Bulkhead terminals are provided for making horizontal or longitudinal cable runs, to permit a circuit to be carried through a bulkhead without repairing watertight integrity. Three phase portable cables can be connected to either end of the bulkhead terminal.

079-47.4.2.3.2 Both bulkhead and riser terminals are marked with the phase letter A, B, and C as a means of obtaining the proper phase sequence when hooking up circuits. In addition, raised buttons are provided on the molded type terminals for identification when no light is available; one button for phase A, two buttons for phase B, and three buttons for phase C. Raised buttons were not provided on the earlier type terminals; however, the Naval Sea Systems Command (NAVSEA) has issued instructions to file V notches on the outer edge of the terminal cover for this purpose.

079-47.4.2.3.3 A square-shank, insulated hand tool is required to secure portable cable in the terminals. A pair of these tools is provided in a rack mounted on the bulkhead at each point where they are required. When not in use, these tools must be in the racks at all times.

079-47.4.2.3.4 All bulkhead and riser terminals are kept covered at all times, except when in use. Terminals exposed to the weather and those terminals which are normally energized, such as those connected to power panels, lighting transformers, and so forth, must be housed in watertight enclosures.

079-47.4.2.3.5 Casualty power terminals which normally are energized must be clearly marked as such.

079-47.4.2.3.6 Terminals not provided with covers must be fitted with removable covers, made by the ship's force or a repair activity, so terminals are kept free from dust, paint, and other contaminating substances. Since canvas covers are not completely dust-tight, terminals are to be disassembled at periodic intervals and all dust removed from between the internal lugs.

079-47.4.2.3.7 An insulation resistance test shall be made after each cleaning, using a 500-volt dc, resistance-indicating instrument (megger). These readings should indicate at least one megohm. If the reading is below one megohm, reclean, repair, replace, and retest as necessary to bring it above one megohm.

079-47.4.2.4 Power Panels. Power panels supplying equipment designated for casualty power service are equipped with terminals, so casualty power can be fed into the panels. These panels also can be used as a source of power for the Casualty Power System in the event that power is still available from the permanent feeders to the panels. Portable switches are located in several strategic positions throughout the ship for use with the Casualty Power System.

NOTE

Casualty power circuit breakers are installed at switchboards so terminals can be deenergized before personnel connect cables.

079-47.4.2.4.1 Each emergency switchboard, ship's service switchboard, and Interior Communications (IC) switchboard having a 450-volt, 60-Hz bus is provided with a casualty power riser terminal installed on the back of the switchboard and connected to the buses through a 225-ampere, a 250-ampere AQB, or a 250-ampere AQB-LF circuit breaker. The circuit breaker is connected such that if the necessity arises, the generator may be isolated from the switchboard and used exclusively for casualty power purposes.

079-47.4.2.5 Terminal At Lighting Transformers. To permit use of sections of the ship's lighting system which may remain undamaged after a casualty, lighting transformers outside the switchboard compartments are provided with casualty power terminals which are connected to the primary side of the transformer.

079-47.5 APPLICATION OF CASUALTY POWER SYSTEM

079-47.5.1 RESPONSIBILITY FOR ENERGIZING THE SYSTEM. In every instance of rigging and energizing any part of the casualty power system, either for training or under damaged conditions, the final energizing connections will be made upon direct orders of the Damage Control Assistant, only after ensuring that all is in readiness in every respect for such action.

WARNING

Portable cable connections shall always be made by connecting first at the load and then working back to a source of power. This method will eliminate the necessity of handling live cables, and reduce danger to personnel.

CAUTION

Aside from personnel hazards, the possible shorting of live conductors may damage cables, fuse cable ends, and trip protective devices, causing unnecessary delays. If there is doubt as to a circuit being energized, it must be tested. Voltage testers are provided in electrical damage repair party kits.

079-47.5.2 DISCONNECTING PERMANENT CABLES. In making casualty power connections at a load, first disconnect incoming feeders. It is always possible that feeders may be faulted by the casualty which caused loss of power. Such faulted feeders would probably cause circuit breakers in the casualty power system to open, resulting in delay while the source of trouble was being investigated.

079-47.5.2.1 Incoming feeders are disconnected because they may be reenergized, presenting a hazard to personnel handling casualty power cables and preventing the possibility of paralleling generators through the Casualty Power System. The feeder cable may either be disconnected or cut near the point where casualty power connections are to be made. The conductors must be spread and taped to prevent possible grounding and shorting.

079-47.5.3 CIRCUIT CONTROLS. In making casualty power connections to a load, connections are to be made so they include the motor controller in the circuit. On ac installations, casualty power switches provided may be used, should the controller be damaged, or they may be used as auxiliary switches. Since a limited number of these switches are provided, they are to be used only at the most critical areas in the overall damage conditions.

079-47.5.4 PHASE AND POLARITY. As a casualty power circuit may involve a considerable number of connections which may be made by personnel unfamiliar with electrical apparatus, motor rotation must be determined, to ensure that no mistake has been made in making phase connections. The motor rotation can be reversed on three-phase ac machines by interchanging two of the three cable conductors. Ordinarily, a reversed polarity on dc circuits will not affect operation of power equipment.

079-47.5.5 POWER PANEL CONNECTIONS. In making casualty power connections to power panels for energizing the panel, the precautions for disconnecting normal feeder supply and obtaining proper phase sequence must be observed. When a power panel is used as a source of casualty power supply, judgment should be exercised in choice of the panel. Heavy casualty power loads shall be connected to power panels having large incoming feeders, to ensure that feeder circuit breakers will not trip and that cable will not be overheated.

NOTE

For casualty power purposes, a current loading, which will allow the cable to be tested by touching with the back of the hand without burning, is not considered excessive. Because there is a time lag due to thermal capacity of the cable, this test shall be made from time to time during use of the Casualty Power System.

079-47.5.6 USE OF PORTABLE CABLE. In design of the system, sufficient portable cable has been provided to connect all cable runs simultaneously, although such may never be required. Cable is provided in lengths determined in each case by the distance between each two points of connection, with sufficient slack to permit bypassing obstructions and to tie cable to the overhead in order to prevent traffic damage to the cable and to keep passageways and work areas clear.

079-47.5.6.1 Cables are stowed on cable racks in the vicinity of intended use. An additional quantity of cable is provided, equal to approximately 25 percent of that required to connect all runs simultaneously, but not exceeding 600 feet. This additional cable is provided in lengths of 150 feet and is stowed in damage control lockers. It is intended for bypassing large damage areas where casualty power terminals may have been destroyed and for paralleling heavy current circuits. These cables may be used in the lengths supplied, or they may be cut into shorter lengths if necessary.

NOTE

In making portable cable runs with additional cable provided, short length cables should be used for short runs so the longer cable will be available for long runs.

079-47.5.6.2 Casualty power cables shall normally be triced to the overhead to reduce the hazard of possible damage and allow freedom of traffic movement. On large deck areas or in compartments with high overheads, where it would be impractical to trice the cable in this manner, it is permissible to run the casualty power cables along the deck, if provisions are made to ensure the cable has maximum protection from damage.

079-47.5.7 RIGGING CASUALTY POWER. Procedure for rigging casualty power is described in the following sequence:

079-47.5.7.1 Sequence of Steps. Steps are to be taken in the following sequence:

1. Ensure that power is not available at damaged panel or switchboard.
2. Ensure that all power supplies are tagged open; if a type K switch is installed on the panel, open it.
3. Ensure that no short circuits exist in the panel or equipment; if supply cables are damaged and no switch is available, disconnect leads.

NOTE

The Engineer Officer will designate the switchboard and riser to be used as source of supply. Casualty power cables then should be taken from their stowage and laid out ready for connecting. Personnel making connections must be provided with rubber gloves, a voltage tester, and rubber boots or a rubber mat. (Rubber boots protect against seawater; a rubber mat does not.)

4. Connect all horizontal cables beginning at the riser or bulkhead terminal at the casualty and work toward the riser or bulkhead terminal entering the compartment from which power will be supplied.
5. Test, then connect damaged equipment to the riser or bulkhead terminal leaving the compartment.

NOTE

Under no circumstances is the riser terminal to be used for a connection block unless the other end of the riser is to supply some piece of equipment.

6. Install a portable switch in the line near the casualty to kill power in event of an emergency, or for reversing leads to correct reverse phase rotation.
7. When all cables have been connected (including horizontal connections) to the panel or equipment to be supplied to the riser leading to the compartment designated as power supply, inform Damage Control Central.

079-47.5.7.1.1 The Damage Control Assistant will request the Bridge to pass the word,**"Stand clear of casualty power cables rigged."** During drills, this should be repeated every five minutes.

079-47.5.7.1.2 When work has been passed, the Damage Control Assistant will request Main Engine Control to issue command regarding the emergency diesel by stating, **"Rig and energize casualty power to riser (or bulkhead terminal) in the engine room."**

NOTE

Just prior to energizing casualty power, have electrician walk from source to load to ensure all cable run work is complete.

079-47.5.7.1.3 When the operator of the designated switchboard receives word from Main Engine Control to rig and energize casualty power cables, the operator shall perform the following:

1. Test bulkhead terminal and rig only that end.

2. Rig cable to switchboard terminal after checking to ensure that switchboard casualty power circuit breaker is open and, after testing the casualty power terminal in the switchboard, to ensure that the terminal is deenergized.

CAUTION

No switch should be opened or closed until the officer or Chief Petty Officer in charge of the casualty connections states, "Connections complete, all personnel clear."

3. Close and open casualty power switch momentarily to ensure correct equipment rotation (if not correct, rotation can be reversed by deenergizing the circuit at the portable switch, installed controller or the switchboard and reversing two of the three leads). If rotation is good, close casualty power supply breaker.

4. Report to Main Engine Control or CCS, **"Casualty power is rigged and energized."** Main engine control or CCS then notifies Damage Control Central.

079-47.5.7.2 Sequence of Command. Table 079-47-1 gives the dialog which shall take place as commands are given during rigging of casualty power.

Table 079-47-1 DIALOG SHOWING SEQUENCE OF COMMAND RIGGING CASUALTY POWER

TO	FROM	COMMAND
1. Repair	Damage Control Central	Investigate loss of power to __________ (Load).
2. Damage Control Central	Repair	All sources of power to __________ (Load) are lost. Secure all sources of power to __________ (Load).
3. Main Control	Damage Control Central	Secure all sources of power to _______ (Load).
4. Damage Control	Main Control Central	All sources of power to ________ (Load) are secured.
5. Repair	Damage Control Central	All sources of power to ________ (Load) are secured.
6. Main Control	Damage Control Central	Designate source of power to __________ (Load).
7. Damage Control Central	Main Control	Riser terminal ________ (Source) is source of power to ____ (Load).
8. Repair	Damage Control Central	Rig casualty power cable from _______ (Load) to riser terminal _______ (Source).
9. Damage Control Central	Repair	Casualty power cable rigged from _________ (Load) to riser terminal __________ (Source). (Electrical person-in-charge report to Damage Control Center)
10.	Main Control	Damage Control
11.	Damage control	Main Control
12. Repair	Damage Control Central	________ power available to _____________.
13. Damage Control Central	Repair	Operating on casualty power.

079-47.5.8 SECURING. In the following paragraphs, actions to be taken to deenergize and disconnect the Casualty Power System are described.

079-47.5.8.1 The Damage Control Assistant will request Main Engine Control to issue command by stating, **“Deenergize and disconnect casualty power from riser (or bulkhead terminal).”**

079-47.5.8.2 The switchboard electrician will then perform the following:

1. Open casualty power circuit breaker.
2. Test for deenergization.
3. Disconnect the casualty power cable from the switchboard terminal.
4. Test for deenergization.
5. Disconnect casualty power cable from riser (or bulkhead terminal) leading from switchboard compartment.
6. Casualty power deenergized and disconnected from riser (bulkhead terminal) and switchboard.

079-47.5.8.3 Main Engine Control will notify Damage Control Central of this action. After Damage Control Central has been notified that the casualty power has been deenergized and disconnected the repair party(s) will be ordered to unrig and restow casualty power cables.

079-47.5.9 UNRIGGING CASUALTY POWER. Procedure for unrigging casualty power is described in the following paragraphs.

079-47.5.9.1 Sequence of Steps. Steps are to be taken in the following sequence:

1. Test each connection block to ensure it is deenergized before removing cable.
2. Disconnect cable at the casualty.
3. Disconnect horizontal cables.

079-47.5.9.1.1 In disconnecting, keep leads separated between fingers of the rubber glove. When the three leads are free they shall be dropped to the deck, making sure that no personnel are in the immediate area of the point of drop. The operator shall turn head away from point of contact of cable with deck, to prevent personnel casualties, should the circuit be energized inadvertently.

079-47.5.9.1.2 After casualty has been repaired and casualty power cables have been unrigged, repair parties will notify Damage Control Central of this action. The Damage Control Assistant will inform the Engineer Officer, who will direct the energizing of appropriate power supply circuits.

079-47.5.9.1.3 The Engineer Officer will notify the Bridge when casualty has been repaired and normal power source has been restored.

079-47.5.9.2 Sequence of Command. Table 079-47-2 gives the dialog which shall take place as commands are given during unrigging casualty power.

Table 079-47-2 DIALOG SHOWING SEQUENCE OF COMMAND UNRIGGING CASUALTY POWER

TO	FROM	COMMAND
1. Main Control	Damage Control Central	Deenergize and unrig casualty power cable to riser terminal ______________.
2. Damage Control	Main Control	Casualty power deenergized and unrigged to riser terminal _______________.
3. Repair ________	Damage Control Central	Unrig casualty power cable from riser to terminal _______ to _________ (load).
4. Damage Control	Repair ________	Casualty power cable unrigged from riser terminal ________ to _________ (load).
5. Main Control	Damage Control Central	Return all normal sources of power to ________ (load).
6. Damage Control Central	Main Control	All sources of power restored to _________ (load).
7. Damage Control Central	Repair ________	All normal sources of power available to ________ (load).
8. Damage Control Central	Repair ________	_________ (load) operating on normal power.

079-47.6 TYPICAL TYPES OF ELECTRICAL CASUALTIES

079-47.6.1 ELECTRICAL FIRES. In combatting and extinguishing electrical fires, specially designed and supplied chemicals, extinguishing devices, and measures for personnel protection must be employed. A detailed description and methods of using these electrical fire extinguishing agents and associated equipment is given in **NSTM Chapter 555, Volume I, Surface Ship Firefighting.**

079-47.6.1.1 The following procedure is outlined for a typical switchboard fire, with one generator on the line.

1. Simultaneously trip ac generator circuit breaker (switchboard electrician sounds off, **"Fire in switchboard"**) and perform one of the following as applicable:
   a. Transfer exciter mode control switch to OFF.
   b. Transfer voltage regulator mode control switch to MANUAL and change manual voltage control rheostat to minimum voltage position.
2. Secure prime mover and notify the Engineering Officer of the Watch (EOOW).
3. Operate ac bus-tie circuit breaker.
4. Notify other switchboard to trip ac bus-tie circuit breaker.
5. Trip both emergency switchboard feeder circuit breakers.
6. Fight the fire. See **NSTM Chapter 555.**

WARNING

A high concentration of CO_2 in the atmosphere is dangerous. Any extensive or continuing use of CO_2 (more than the expenditure of two 50-pound CO_2 bottles) requires that firefighters be protected by using oxygen breathing apparatus (OBA).

a. Direct CO_2 (or other chemical provided) to base of flame.
b. Attack fire from both sides of switchboard.
c. Set a reflash watch.

7. Using rubber gloves, rubber mats, or rubber boots (firemen's boots), investigate cause and extent of damage and report findings to Engineer Officer.
8. Test for and place undamaged sections of switchboard in commission.

WARNING

Do not energize a damaged section or component until it has been repaired or replaced.

079-47.6.1.2 In cases where power is received from other ship's service switchboard, same action is taken as in paragraph 079-47.6.1 except that action indicated for securing of generators shall be disregarded.

079-47.6.2 LOSS OF ALL SHIP'S SERVICE POWER. In event all ship's service power is lost, initiate following procedures at forward (after) ship's service switchboard:

1. Trip both generator circuit breakers.
2. Trip all feeder circuit breakers.
3. Trip shore power circuit breaker (forward switchboard).
4. Trip segregated power-bus circuit breakers.
5. Notify forward (after) emergency switchboard to close the feedback circuit breaker.
6. Feed power to forward (after) switchboard.

079-47.6.2.1 When the forward (after) emergency switchboard receives power from emergency switchboard feeder, close emergency switchboard feeder circuit breaker. This action will energize main power bus on forward (after) ship's service switchboard. Close feeder circuit breakers to necessary equipment. Do not overload emergency diesel generators.

079-47.6.2.2 Take following action at forward (after) emergency switchboard:

1. Turn diesel start lockout switch to LOCKOUT when diesel has started.
2. Challenge by questioning, **"Are emergency switchboard feeders open?"** Verify LOCKOUT when word is received from forward (after) ship's service switchboard to feedback.
3. Turn control switches to MANUAL upon verification of step 2.
4. Ensure all necessary contacts are closed.
5. Close feedback circuit breaker.

6. Notify forward (after) switchboard by stating, **“Feedback circuit breaker is closed, supplying power to the forward (after) ship’s service switchboard.”**

079-47.6.2.3 To restore power, initiate the following at forward (after) ship’s service switchboard:

1. Raise ac voltage using manual voltage control rheostat.
2. Turn voltage regulator control switch to AUTO.
3. Adjust ac voltage using voltage adjusting unit.
4. Adjust frequency to 60 Hz by using the governor motor control switch.
5. Close all feeder circuit breakers.
6. Close ac generator circuit breaker.
7. Close all segregated power-bus circuit breakers.
8. Energize feeder circuit breakers on segregated power-buses.

079-47.6.2.4 Check with other ship’s service switchboard to ascertain if power is required. When such is the case, close the ac bus-tie circuit breakers.

CAUTION

Make certain that all emergency switchboard feeder circuit breakers are open before closing bus-ties.

079-47.6.2.5 Inform emergency switchboard to stand by to receive power. When information is received that the feedback is open and emergency switchboard is ready to receive power, close the emergency switchboard feeder circuit breaker. Inform emergency switchboard to secure diesel and set switchboard for AUTOMATIC.

079-47.6.2.6 Initiate following action at forward (after) ship’s service switchboard upon receipt of word to stand by to receive power:

1. Open feedback circuit breakers.
2. Report to forward (after) ship’s service switchboard by stating, **“Feedback circuit breaker is open, ready to receive power.”**
3. Turn control switches to MANUAL.

079-47.6.2.7 Upon receiving power and word is passed to secure diesel:

1. Turn selector device to SHIP’s position.
2. Turn selector device to indicate source of power selected for use.
3. Throttle diesel slowly by using hand control.
4. Return hand control to RUN position after diesel has stopped.

5. Set up emergency switchboard for automatic operation.
6. Report to forward (after) ship's service switchboard that emergency switchboard is set up for automatic operation.

079-47.6.3 STEAMING SPLIT-PLANT, ONE GENERATOR EACH SWITCHBOARD, ONE GENERATOR LOSES POWER LOAD. Causes of this casualty are as follows:

1. Loss of prime mover due to steam failure
2. Loss of vacuum
3. Loss of lubrication oil pressure, or other mechanical failure
4. Overspeeding generator

079-47.6.3.1 When this casualty occurs, proceed as follows:

1. Open affected generator circuit breaker.
2. Open all feeder circuit breakers on affected switchboard.

079-47.6.3.2 If the casualty is to forward plant, close ac bus-tie circuit breaker to after switchboard and close bus-tie on after switchboard to forward switchboard.

079-47.6.3.3 If casualty is to after plant, close ac bus-tie circuit breaker to forward switchboard and close bus-tie breaker on the forward switchboard to after switchboard.

079-47.6.3.4 Close feeder breakers on affected switchboard one at a time, taking care not to overload generator receiving load.

079-47.6.3.5 Additional actions to take include the following:

1. Operate voltage regulator cutout switch to MANUAL.
2. Operate manual voltage control rheostat to minimum voltage position.
3. Parallel and split the load when casualty has been corrected to affected generator.

079-47.6.4 MALFUNCTION WHEN STEAMING WITH GENERATORS IN PARALLEL PLANT SPLIT- OR CROSS-CONNECTED. With any type of malfunction to one generator:

1. Trip generator circuit breaker.
2. Operate associated voltage regulator control switch to MANUAL.
3. Strip switchboard as necessary to limit load on remaining generator(s).

SECTION 48.

RECONDITIONING IMMERSED MACHINERY

079-48.1 GENERAL

079-48.1.1 The possibility of damage due to enemy action or other causes which results in flooding of machinery compartments cannot be overlooked by a Commanding Officer. Such disasters generally occur with little or no warning.

079-48.1.2 The exigencies of war preclude any but the barest preparations to put the ship in a condition that will allow safe withdrawal from the scene of action. Personnel must know what to do and how and when to do it, so that damaged ships can be returned to service in the minimum amount of time.

079-48.1.3 Damaged ships have returned to naval shipyards for overhaul and repairs after having one or more main machinery compartments flooded. In many instances ships have not exercised all precautions and care in preserving and reconditioning submerged machinery to the maximum extent possible. This has resulted in damage far exceeding that inflicted by the enemy.

079-48.1.4 **NSTM Chapter 300, Electric Plant - General,** contains instructions for repair and reconditioning of submerged electrical equipment and shall be followed as closely as conditions permit. This section will provide a logical and standard plan for efficient salvaging of water-soaked machinery. Commanding Officers will ensure that the personnel of the Engineering Department are thoroughly familiar with the basic principles included in the NSTM. See also **Cleaning Practices for Flooded Equipment in Electronics Installation and Maintenance Book,** NAVSEA 0967-LP-000-0160.

079-48.2 PLANNING

079-48.2.1 The plan of salvage procedure shall, if possible, be worked out prior to dewatering the compartment. Where immediate pumping is not required by considerations of the ship's ability to survive, it is far better to spend one or more watches in an orderly appraisal of the situation, assembly of preservation compounds, equipment for skimming the surface of the water of oil and debris, hoses and P-250 pumps for washing down with freshwater, a supply of solvent for cleaning oil from motor windings, and primarily, jury-rig lighting and ventilation.

079-48.2.2 Each individual piece of equipment in the compartment shall be considered and a decision reached as to whether it is to be restored to immediate service or placed in a state of care and preservation until arrival at the repair activity. The services available, either from the ship's own plant or from alongside, shall be determined and the plans for repairs outlined accordingly.

079-48.2.3 It must be considered at all times that damage to water soaked equipment proceeds more rapidly after dewatering and exposure to the action of the air if prompt adequate action is not taken to ensure protection. After drainage, flush with warm fresh water and wash down and dry exterior surfaces. Where entrance has occurred and where seawater corrosion could result, drain, wash, and flush, or where not practicable or pockets are involved, disassemble and clean.

079-48.2.4 Where thermal insulation is involved, check if seawater has penetrated outer coating and sheathing. Insulation subjected to seawater immersion will most likely be completely saturated and should be removed and replaced as soon as is practical. This will prevent the long term corrosive action of the salt impregnated lagging on the piping and other metal surfaces. If the ship is due to report to a repair facility, the lagging and insulation does not have to be removed immediately unless it is believed to conceal damage. Lagging covering austenitic stainless steel piping shall be removed immediately, as corrosion damage can occur in a few days or weeks, depending on temperature.

079-48.2.5 When water is purged and equipment is dried, operate equipment (for immediate use) or apply rust preventive compound.

079-48.2.6 The exact technique to be employed in salvaging machinery and equipment will depend to a certain extent on the immediate objective. Thus, if a ship is sent to a naval shipyard or similar activity before returning to service, salvage efforts will be directed almost entirely to ensuring that no additional deterioration of equipment will occur between beginning of operations and arrival at the yard.

079-48.2.7 Operational considerations may require that equipment be returned to service in the shortest possible time, regardless of any reduction in total service life which such emergency actions may ultimately produce.

079-48.2.8 Both situations may be present in the same ship; a ship whose main machinery plant is damaged beyond hope of immediate repair may still require light, heat, fresh water, and flushing pumps while under tow to the repair yard and the success of engineering personnel in providing them will do much to promote the health, comfort, and safety of ship’s force on board.

079-48.3 DEWATERING THE COMPARTMENT

079-48.3.1 Whenever possible, an investigation to determine location and sizes of ruptured oil lines shall be undertaken simultaneously with compartment pumping. Investigation first will often eliminate the necessity for later cleaning a great deal of oil from bulkheads and machinery. For this, a shallow diving outfit is invaluable, together with a well-rounded assortment of damage control plugs and wedges, a supply of rubber sheet packing cut into convenient widths, and an underwater burning outfit.

079-48.3.2 Damaged lines which cannot be controlled by line stops are plugged or wrapped with sheet packing and wire rope and made secure against the pressures to be encountered. With pressure in excess of those to which the foregoing measures are suitable, it will be necessary to disconnect at a flanged joint and fit a blank flange and gasket (refer to Volume 2 of this chapter).

079-48.3.3 When water level has been lowered to a foot or two below the overhead, an effort should be made to remove as much oil and floating debris as possible. This is highly desirable in any case and vital in compartments containing electrical motors or generators, so the dropping water level will not deposit oil on winding.

079-48.3.4 When entering a compartment without the protection of shallow water diving apparatus or rescue breathing equipment, it is of the utmost importance that the air be tested for the presence of toxic gases which may have generated by action of the fire, arcing of electrical equipment, passages of current through seawater, or chemical action of seawater with material in the flooded compartment. While it is unlikely that live electrical equipment will remain in a flooded compartment without making its presence immediately obvious, it has happened. This possibility must not be overlooked.

079-48.3.5 The method used in skimming the surface of oil and debris will depend upon equipment available and conditions within the compartment. An ordinary tin funnel, with the spout taped and pushed into the end of the suction hose, moved over the surface of the water makes a serviceable skimmer, the suction being provided by a pump in another compartment, a jury-rig pump, or an eductor. The latter is a useful piece of equipment for handling debris-laden water. If none is available, one may be improvised from pipe fittings and hose nozzle, using compressed air, steam, water from the firemain, or a P-250 pump. The latter is suited only for pumping clean water, since its parts are very closely fitted; but it will operate an eductor and remove any floating solid material. The open funnel may be screened by a piece of hardware, cloth, expanded metal, or similar material.

079-48.3.6 Another simple and effective way of skimming oil and sludge from water surface is to lower a bucket into the water, so its edge is just below the surface. Take a suction from the bucket and the oil and sludge will flow into it.

079-48.3.7 In certain cases, it may be practicable to prevent an individual motor or similar equipment from becoming coated with fuel oil floating on the water by nailing together four boards forming a frame or cofferdam which may be placed in position over the machinery to be protected and skimming the oil from the interior, allowing the frame to drop into place around the equipment as the water level recedes.

079-48.3.8 When surface oil and debris have been eliminated as far as practicable, pumping out the remainder of the compartment may proceed as fast as available equipment will permit. In general, nothing is to be gained by stopping the pump at the upper level while the machinery is worked over. It is best to begin the work of preservation at the earliest possible moment.

079-48.3.9 After drainage of compartment, the next step is to wash interior of the compartment and the exterior and interior of all machinery and equipment, in order to remove salt deposits and other contaminants. It is important that good judgment be used in the water washdown and use of cleaning agents to ensure that no damage is done and that the degree of cleaning and preservation is consistent with extent of contamination. If inspection shows little or no oil coating present, wash-down may be accomplished with hot fresh water.

079-48.3.10 In case oil coating is present, as well as salt and other contamination, it may be necessary to wash or spray with a hydrocarbon cleaning emulsion. For formulation of the cleaning emulsion, see **NSTM Chapter 631, Preservation of Ships in Service.**

079-48.3.11 After spraying on the cleaning emulsion, flush with fresh water and repeat wash-down and flushing operation until the exterior and interior surfaces are clean and ready for immediate preservation, or application of a water displacing formulation as described below. Drain and wipe down with rags to the maximum extent possible.

NOTE

In a relatively large compartment, such as engine room or fireroom, the work of preservation may be started at one side while washing down the other.

079-48.3.12 After and during washdown, adequate ventilation must be provided; warm dry air is best. After wiring is dry it shall be scrubbed its entire length with fresh water. This operation should be repeated about 24 hours later to wash off any salt crystals that may form. See **NSTM Chapter 300 for additional cable requirements.**

NOTE

Of the water-displacing rust preventive compounds, grade 5 is most suitable for all applications, if available, since it can best penetrate small interstices. If grade 3 or 5 are not readily available, lubricating oil or kerosene may be used as a substitute. These alternates do not provide long term corrosion protection, so thorough drying or other means of protection shall be provided as soon as possible.

079-48.4 CORROSION PREVENTION

WARNING

All grades of Corrosion Preventive Compound (CPC) are flammable materials with relatively low flash points (100°F or 38°C). Provision of adequate ventilation and precautions against ignition by flame and sparks, therefore, are important and discussed in detail in NSTM Chapter 050, Readiness and Care of Inactive Ships. Precautions are particularly important when CPC is applied by spraying and must be observed carefully to prevent ignition of CPC mist or vapor. It is recommended that personnel engaged in these operations be organized into groups of 10 to 12 Firemen and Machinist Mate ratings from both the fireroom and engine room, supervised by a Chief or First Class Petty Officer.

CAUTION

CPC shall not be used on rubber or electrical insulation intended for reuse as it will make the material soft and gummy.

079-48.4.1 As described in MIL-C-16173, CPC's are solvent-dispersed chemicals which deposit thin, easily removable films after evaporation of the solvent. They are intended for use in preventing corrosion of metal surfaces. For a more detailed discussion of their use and precautions when using, see **NSTM Chapter 555, Firefighting - Ship.** There are five grades of CPC, of which two grades are specified in this section. Grades 3 and 5 are for use where fresh water or seawater must be displaced from corrodible surfaces and corrosion prevented or arrested.

079-48.4.2 Both grades of CPC specified in paragraph 079-48.29 may be removed with hot alkaline solutions (approximately 5 percent caustic soda, sodium metasilicate, or anhydrous trisodium phosphate, plus 1/2 percent nonionic detergent, MIL-D-16791) and hydrocarbon solvents, including dry cleaning solvent, diesel oil, turbine cleaning oil (MIL-C-15348), and hot lubricating oil.

079-48.4.3 It is intended that grade 5 be used where removal by low pressure steam is appropriate. Where use of CPC is specified herein, grade 3 may be used unless grade 5 or some other grade is specified. Grade 3 is carried in the supply system under National Stock Number 8030-00-244-1294 (55 gallon drum). Grade 5 may be procured from Ashland Oil Co., Inc., 1404 Winchester Ave., Ashland, KY 41101 (order Valvoline Tectyl 511M) and Pennsylvania Refining Co., Butler, PA 16001 (order Petrotect 5).

079-48.4.4 In addition to CPC, use of water displacing compound may be indicated in many circumstances. Formulations for water displacing compounds are given in **NSTM Chapter 631.** This shall be used for application to relatively small units of machinery, equipment, and instrumentation which can be lubricated and put back in service shortly after application of the water displacing formulations (see **NSTM Chapter 631**). Assistance may be obtained from the Naval Research Laboratory (NRL), which has developed additional water displacing compound formulations.

079-48.4.5 CPC is intended for use on large equipment, where a substantial corrosion preventive coating is necessary. It can be used on any metal surface and is primarily for bearing surfaces, machined surfaces, and internal parts of large machines such as main propulsion reduction gears, turbines, blowers, and large pumps.

079-48.4.6 It is essential that the work of preserving the metal surfaces from corrosion be started immediately after the compartment has been washed down. It is also essential that no more equipment be opened for inspection and treatment than can be taken care of at once, since machined surfaces wetted with seawater and exposed to the air will be damaged quickly. This is particularly true in the case of aluminum parts, in which the rate of corrosion due to salt is many times as great in air as when the parts are completely submerged.

079-48.4.7 One of the first considerations is treatment of bearings. Sleeve type bearings shall have drain plugs removed to allow drainage of water which may have entered. This water is then immediately replaced with CPC grade 3.

079-48.4.8 With antifriction bearings a similar technique is used, except that grease fittings provided may be used in connection with the standard grease gun for forcing the CPC grade 3 in, thus forcing out the oil, grease and water through the relief plug. When no more grease or water runs out, relief plug is replaced and bearing housing filled with CPC grade 3. See **NSTM Chapter 300** for preserving electrical equipment. If time permits, remove end bells immediately. This and cleaning inside and out must be completed before treating with CPC grade 3. If there will be a delay of more than a few hours, the bearings are to be treated in place rather than risk corrosion of bearings and journals.

NOTE

Ultra-sonic cleaning is not suitable for laminated structures and shall not be used for such applications since the vibration tends to drive contaminants inward.

079-48.5 SPECIFIC UNITS

079-48.5.1 GENERAL. The following paragraphs discuss methods of reconditioning machinery, piping, insulation, instruments and gauges, bulkheads, and equipment surfaces.

079-48.5.2 PROPULSION STEAM TURBINES, GEARS, AND CONDENSERS. Assuming inspection has indicated that the entire system has become grossly contaminated with seawater, it will be necessary to drain components to maximum extent possible, wash all surfaces with cleaning emulsion (**NSTM Chapter 631**), flush with fresh water, drain, and immediately coat with CPC grade 3.

079-48.5.2.1 Have another repair party prepare main lube oil pumps for service as follows:

1. Remove packing gland and shaft packing, if any is installed.
2. Clean packing area thoroughly with cleaning emulsion (see **NSTM Chapter 631**).
3. Flush with fresh water.
4. Drain and apply CPC grade 3.
5. Disconnect pump discharge piping.
6. Clean pump with emulsion cleaner through discharge opening.
7. Flush with fresh water and coat with CPC grade 3 by forcing coating compound through pump.
8. Reassemble and replace packing if required.

079-48.5.2.2 Drain reduction gear bearings, sump tank, piping, and all components of oil and seawater to maximum extent possible. Pay particular attention to low points and dead ends where liquid may be pocketed. Add sufficient cleaning emulsion, diluted with fresh water, to the lube oil sump to permit circulation through the entire system, with a portable pump taking suction from the sump and discharging via the piping system through bearings and gear sprays. The proportion of cleaning solution to water depends on the amount of oil remaining in the system and should be from one part cleaning emulsion to three parts water, up to one to one.

CAUTION

Observe precautions inNSTM Chapter 050.

079-48.5.2.3 Velocity spray sump tank when filling with cleaning emulsion solution. During circulation of the cleaning emulsion solution, velocity spray the reduction gear through the inspection ports. Flush through all lube oil components and bearings. Flush with cleaning emulsion solution for several hours until the system is considered clean.

079-48.5.2.4 Drain cleaning solution thoroughly and follow with a freshwater rinse, flush, and velocity spray as above. Drain thoroughly and immediately fill the system, circulate, and velocity spray with CPC grade 3 to coat all surfaces. Take care to protect the control oil system and components. Drain excess CPC and reconnect the system to restore to service condition. If possible, spray gear case interior with CPC using compressed air to obtain complete coverage. Ensure that all appropriate surfaces have been coated with CPC by jacking the engines over.

NOTE

When returning lube oil system to service, flush for removal of CPC in accordance with the procedure in **NSTM Chapter 050,** except that initial flush may be with hot 2190TEP -[70 degree C to 75 degree C (160 degree F to 170 degree F)]- in lieu of turbine cleaning oil, MIL-C-15348.

079-48.5.2.5 Where saturated, remove all insulation and lagging from exterior of the turbines. Wash all surfaces which are oil coated with cleaning emulsion (**NSTM Chapter 631**) and follow with a freshwater flush. If exterior is not oil coated, only the freshwater flush should be employed. Drain, remove excess water with rags and apply a water-displacing compound to selected areas, such as threads and machined surfaces as appropriate.

CAUTION

Care shall be taken not to over-pressurize main condenser.

079-48.5.2.6 If contamination of interior exists, drain contents with turbines. Isolate steam piping and condensate system. Assuming turbine and condenser interiors are contaminated with oil and seawater, flush main turbine glands through the gland seal supply connection with cleaning emulsion (**NSTM Chapter 631**). Spray, flush, and flood the turbine casings and condenser with cleaning emulsion. Inspection openings or other openings may be used as feasible. Provide vent, overflow, and drains through high pressure drain piping.

079-48.5.2.7 If the engine can be jacked, fill bottom half of turbine casing and rotate until thorough cleaning is assured. Drain cleaning solution and repeat flush with hot fresh water to remove emulsion cleaner. After thorough draining, coat with CPC grade 5 by spraying the interior.

CAUTION

Observe the precautions of NSTM Chapter 050.

079-48.5.2.8 If possible, jack over engines during spraying to ensure thorough coating. Clean turbine packing and shaft in way of packing and coat with CPC grade 5. When restoring to service, the CPC grade 5 shall be removed using wet steam, in general accordance with the procedures in **NSTM Chapter 050** , for the turbine, condenser and associated steam piping.

079-48.5.3 SHIP'S SERVICE TURBOGENERATOR AND AUXILIARY STEAM TURBINES AND GEARS. General procedures given in paragraph 079-48.5.1 apply. Detailed procedures are given in the following paragraphs.

079-48.5.3.1 Controls for auxiliary steam turbine (generator, pump, and fan turbines) including governing systems and trip systems, overspeed trips, speed-limiting governors, speed-regulating governors, trip throttle valves, and nozzle control valves and linkages shall be restored as follows:

1. Wash exterior parts thoroughly with clean fresh water.
2. Disassemble
3. Clean parts with turbine cleaning oil, MIL-C-15348.
4. Reassemble and adjust.
5. Preserve with CPC grade 5.
6. Remove preservative by circulating MIL-C-15348 prior to start-up.

079-48.5.3.2 Lubricating oil systems of auxiliary steam turbines shall be thoroughly flushed with MIL-C-15348. Disk type filters and wire mesh strainers shall be disassembled and cleaned with MIL-C-15348. Automotive throw-away filter cartridges shall be disposed of and new ones installed.

079-48.5.3.3 MIL-C-15348 shall be used to clean the governor control system, which requires a high degree of cleanliness. Casing relief/exhaust valves and back pressure trips shall be disassembled and cleaned with MIL-C-15348.

079-48.5.4 PIPING SYSTEMS. Treatment of externals shall consist of removal of insulation and lagging (where saturated), flushing with fresh water, or with cleaning emulsion (**NSTM Chapter 631**) and fresh water when coated with oil. Valves, operating components, and other mechanical operating components should be treated with a water-displacing compound (**NSTM Chapter 631**) to displace water and prevent corrosion.

079-48.5.4.1 After pumps, tanks, and other major components have been separately cleaned as specified, entire systems, when required, shall be drained, flushed, and preserved as follows.

079-48.5.4.2 If lube oil systems are contaminated with seawater, drain and flush with emulsion cleaner and fresh water. Provide preservative coating by flushing through with CPC grade 3. To restore the system to operational status, flush, in general accordance with procedure in **NSTM Chapter 050,** to remove CPC coating, except that the initial flush may be with hot 2190TEP in lieu of turbine cleaning oil, MIL-C-15348.

079-48.5.4.3 After draining feed and condensate systems, flush as specified in **NSTM Chapter 050** if appropriate. As early as possible the system shall be placed in wet layup condition. Do not overlook the vacuum drag piping from the freshwater drain tank to the condenser. Flooding higher than the freshwater drain tank overflow will fill the piping with bilge water.

079-48.5.4.4 Other piping systems contaminated with seawater, oil, or both, shall be drained and cleaned in accordance with the previously described techniques. In general, coating with CPC grades 3 or 5 should be unnecessary, except possibly for ferrous piping where it is essential to prevent any degree of corrosion.

CAUTION

Assuming that the compartment has recently been dewatered, the possibility that the shell (steam side) may still be filled with water should not be overlooked.

079-48.5.5 CONDENSERS. Before starting the task of rehabilitating the steam condensers, tag-out for safety procedures must be carried out before personnel can safely enter the steam side of a condenser and before the seawater side can be opened to the machinery space preparatory to inspection, entry or work.

079-48.5.5.1 Each condenser should be visually inspected for evidence of damage. The nature of casualty which caused the flooding should be considered in determining how extensive an inspection will be appropriate (see **NSTM Chapter 254, Condensers, Heat Exchangers, and Air Ejectors).**

079-48.5.5.2 The basic procedure being used to remove a heavy coat of oil contamination from the compartment exterior, such as hosing down with hot fresh water, may be applied to the condenser exterior. This should be followed by drying and by sponging off accumulated water and then directing a stream of warm air to complete the drying. The seawater side will typically require minimal attention, unless abnormal amounts of foreign material are present in the condenser. The use of the emergency bilge suction may have deposited an oil film on the seawater sides of the condenser and the tubes should be cleaned by the procedure described in **NSTM Chapter 254.**

079-48.5.5.3 When abnormal amounts of foreign material have not found their way into the seawater side as a result of the casualty, remove any accumulation of debris from waterboxes and make sure that tubes are clear for flow of cooling water. If a few random tubes are found to have material lodged in them, record this fact so that a plan can be made for freeing them at the first subsequent opportunity. Give a final flush to the condenser with clean water.

079-48.5.5.4 When abnormal amounts of foreign material are present in condenser as a result of the casualty, remove foreign material from waterboxes to provide a degree of cleanliness suitable for proceeding with tube cleaning. Next, clean the tubes by one of the cleaning procedures described in **NSTM Chapter 254** as appropriate. Complete the cleaning of waterbox and give a final flush to condenser with clean water.

079-48.5.5.5 Reconditioning of the steam side will depend on the amount and type of contaminants (seawater, oil, and so forth) which are left as a residue on the tubes and the shell interior.

079-48.5.5.6 When abnormal amounts of dirt or oil are not found on surfaces, carry out routine removal of accumulated loose material via the hot well. Fill condenser with fresh water, let stand for 30 minutes and drain. Next fill with hot fresh water, let stand for three hours, and drain. If the condenser is to be returned to service in the very near future, no further steps are required prior to steam/condensate system clean up procedure before starting up. If circumstances of the casualty dictate that condenser will not be returned to service within three months, fill condenser with water meeting feedwater specifications, to the maximum extent possible to minimize moist air corrosion.

CAUTION

Do not use metal scrapers or wire brushes on copper-nickel tubes.

079-48.5.5.7 When abnormal amounts of dirt or oil have gotten into the condenser as a result of casualty, carry out routine procedure for removing loose material from the hot well. If deposits are heavy, scrape down steel surfaces to assist in this removal. Next, carry out steam side boiling out procedure in accordance with **NSTM Chapter 254.** If condenser will not be returned to service within three months, fill condenser with water meeting feedwater specifications to the maximum extent possible to minimize moist air corrosion.

079-48.5.6 PIPING AND VALVES. Piping and valves are not a major problem in most cases. The removal of lagging may be left until last, except where necessary to repair damage, as pointed out in paragraph 079-48.2 and where lagging is soaked with oil. Oil-soaked lagging will ignite from the heat of the steam line.

079-48.5.6.1 A hydrostatic test using cold water and checking for air or water venting through the insulation should be sufficient to indicate which portions of lagging must be removed immediately. All valves which are to remain in place should be sprayed with fireside deposit removal compound (MIL-C-22235) and packing removed as time permits, particularly in those portions of the system which are not to be used immediately, to avoid corrosion of the steam glands. Working parts should be covered with preservative.

079-48.5.7 BOILERS. Boilers and fireroom equipment which have been submerged are generally washed down with hot fresh water inside and out, then dried as much as possible with air. One or more fireroom blowers should be restored to service as soon as possible, since this will furnish a source of air for drying and for removing fumes. Compressed air or low pressure steam will furnish enough power to permit rapid drying of the fireroom.

079-48.5.7.1 The fact that a boiler has been submerged does not indicate at once that the brickwork is beyond repair and must be torn down. The immediate need is for thorough drying and treating with preservative.

079-48.5.7.2 After boiler has been washed down with fresh water on the exterior surfaces and debris removed from furnaces, casings, and tubes, the casing may be wiped down and the registers, sootblowers, and external fittings sprayed with fireside deposit removal compound (MIL-C-22235). If the interior is filled with seawater, it will be necessary to wash down in the usual manner. If not, drying out of furnace may proceed, provided inspection does not reveal any compelling reasons for removing brickwork.

079-48.5.7.3 If the boiler was hot or steaming during the flooding casualty, inspect the boiler structurals, air casing, and both the water (steam) sides and fireside of the boiler pressure parts. Conduct a hydrostatic pressure test (design working-pressure) of the boiler prior to steaming the boiler.

079-48.5.7.4 After accomplishing procedures in paragraph 079-48.5.6 (if the boiler was not steaming), the boiler may be dried out by hot air heaters or by firing the boiler with the smallest sprayer plate handy when feedwater and oil is available. A wood fire may be used if oil is not available. When the boiler is dried, it is filled with feedwater and steamed at atmospheric pressure by venting. The superheater shall be protected by operating it with protection steam, if available. Remove and replace all lagging which has been soaked with fuel oil before lighting fires.

079-48.5.7.5 The following description of the procedure used on a damaged destroyer will be of value in the reconditioning of boilers damaged by submergence.

079-48.5.7.6 The destroyer was on fire about three days and was then submerged for some time. After raising the ship the forward fireroom was found to contain a large amount of buckled machinery, soot, burned cork, and other debris. All bulkheads, boilers, casings, and other equipment were first washed down and cleaned with hot fresh water and air hoses.

079-48.5.7.7 The boilers were thoroughly washed inside and out, including tubes. All fuel oil and debris was removed from furnaces, tubes, and top casings of the boilers. Because the water in the boiler drums was tested and found to be fresh, there was no need for immediate concern about internal condition of the boilers.

079-48.5.7.8 All casings were wiped down with kerosene and all registers, sootblowers, and external machinery sprayed with fireside deposit removal compound (MIL-C-22235) and put in a state of preservation.

079-48.5.7.9 After firesides had been thoroughly cleaned with fresh water, a wood fire was built under the boilers and kept going for 24 hours. Steam was formed and the air cock opened, permitting steam to blow freely through the drum. An examination of brickwork showed that it would not be necessary to withdraw bricks. The brickwork was found to be sound enough to permit the ship to proceed under her own power. Once the boiler was cleaned and dried out, all blowers, fuel pumps, and other auxiliary machinery in the fireroom were tested.

079-48.5.7.10 Instruments in the fireroom which had been damaged by the fire were removed and a list made of those which would have to be temporarily or permanently replaced. Boilers were then given hydrostatic tests in accordance with **NSTM Chapter 221, Boilers.** The boiler stops were then opened and the main steam lines to the engine bulkhead were tested at working pressure with cold water. Because the ship was to report to a repair facility, it was not considered necessary to remove lagging from steam lines or boiler drums. The forced draft blower in the forward fireroom had been damaged by fire and it was found that the ball thrust bearings were gummed-up.

079-48.5.7.11 No parts had to be replaced, but the assembly had to be taken down and cleaned. The number two fireroom had not undergone such intense heat as number one and thus it was considered necessary only to clean the machinery with CPC grade 3. The blowers were run by air for several hours and found to be in satisfactory condition. Governors and overspeed trips operated perfectly. One boiler at a time was lighted-off and steam raised with boiler stops open to the main and auxiliary steam lines. When steam pressure was about 100 lb/in^2 , the machinery was tested.

079-48.5.7.12 It was discovered that in certain cases, relief valve springs had lost their tension and that the operation by steam of certain machinery disclosed conditions that had to be corrected. The safety valves were lifted by steam and were found to be operational without need of resetting. The engine room had not been seriously affected by water, but had been subjected to considerable heat. Damage was repaired.

079-48.5.7.13 Several important points should be noted in the foregoing example. Submergence of the boiler did not irreparably damage the brickwork and necessitate its being torn down. The immediate needs of the boiler were thorough cleaning, drying out, and being placed in a state of preservation. Immediate cleaning and testing of all boiler and fireroom machinery was the primary consideration when dewatering the fireroom.

079-48.5.8 INSULATION AND LAGGING. In removing lagging, bulkhead and overhead insulation, jackets obstructing fittings, and similar materials, time will be saved if canvas is rigged beneath portions to be cleared of lagging. This will keep lagging out of bilges and clear of cleaned and treated machinery.

079-48.5.8.1 Lagging which has been impregnated with seawater will cause no appreciable damage to piping, provided it is dried and kept hot, since dry salt has little or no corrosive effect. On cooling, the salt will quickly absorb moisture from the air and begin corrosive action. For this reason, once dried out, lines must be kept continuously warm if possible.

079-48.5.9 INSTRUMENTS AND GAUGES. All instruments and gauges shall be removed, immediately submerged, and rinsed thoroughly in a tank of hot fresh water. They shall then be dipped in a tank of CPC grade 3, allowed to drain, and assembled in boxes. They shall be tagged to indicate where they had been installed prior to casualty. All instruments such as electrically operated telegraphs are to be removed by electricians. Disassemble sufficiently to allow thorough washing with fresh water, spraying or dipping with CPC grade 3, and then reassembly and reinstallation in original locations.

079-48.5.10 EQUIPMENT SURFACES. Bright work and miscellaneous external machined surfaces are wiped down and coated with CPC grade 3. If casualty has involved fire in the compartment, it is necessary to give special attention to all mechanisms having springs as a component part before the equipment is returned to service. Heat will anneal the springs and render inoperative such devices as relief valves, regulators, and governors, which depend on spring loading for their action.

079-48.5.10.1 After preservation work is completed on any unit, the external bright parts which are most subject to corrosion should be inspected periodically to ensure that corrosion has not set in as a result of breaking the protective film.

NOTE

Put all used CPC grade 3 into one of the ship's lube oil treating tanks that has been cleaned beforehand. Heat the CPC grade 3 about 66 degree C (150 degree F) and pass through separator. By this operation, approximately 60 percent of the CPC grade 3 used in cleaning the main lubrication system can be reclaimed.

079-48.5.11 BULKHEADS. For mixing operations preparatory to washing down bulkheads, use steam and hot water in a 50-50 proportion and get close to bulkheads to remove all mud and fuel oil. For washing out machinery and boilers, an ample supply of hot fresh water is necessary. Final cleaning is best done using steam cleaners. These shall be assembled ahead of time with sufficient cleaning compound. Numerous air hoses shall be provided (two or three for each engine room), especially the larger size, to secure the necessary volume of air to jack over and operate all pumps and machinery.

079-48.5.12 DIESEL ENGINES. The degree of drying out and salvaging necessary for an engine depends on the type of casualty. Varying degrees of clean-up, repair, and preservation required depend upon whether the engine is partially or completely submerged, the period of time it was exposed to seawater, and the damage it sustained.

079-48.5.12.1 If engine is externally wetted by a fire hose or leak where the engine is not submerged, it can be dried out by flushing the wetted surfaces with fresh water and running at normal operating temperatures. Lubricating oil should be checked for water contamination which can be detected by a milky appearance or water droplets on the dipstick. If severe, the oil shall be changed and the engine run immediately.

079-48.5.12.2 If engine is partially or completely submerged in clean seawater for a short time (for example, capsized small boat or engine room flooding) and the engine is not physically damaged, follow directions in the following paragraphs.

079-48.5.12.3 Completely drain the service fluid systems and other enclosed areas. Visually inspect internal areas where hand hole covers and inspection plates are provided. Connections in liquid and oil systems shall be broken where possible. If the engine is not equipped with plugs or valves to drain the combustion areas, fuel injectors shall be removed and thoroughly cleaned. Engine exterior surfaces shall be flushed with fresh water, if available.

079-48.5.12.4 After surface seawater has been removed, the lubricating system shall be filled with clean oil. Freshwater system shall be flushed with clean water, drained, and refilled with water and inhibitor as described in **NSTM Chapter 233, Diesel Engines.** Fuel system shall be filled with clean fuel and pressurized. The engine should then be started and brought up to normal operating temperatures. Heat generated by normal running is sufficient to boil off any remaining seawater residue. Running will also thoroughly mix the fresh water and inhibitors.

079-48.5.12.5 If engine has been submerged for longer than a week, or has sustained damage to piping or housings that would permit entry of mud and debris into the internal areas, the following procedures shall be followed:

1. Disassemble the engine to the extent that all enclosed areas may be observed and cleaned.

NOTE

If a casualty is of such nature that engine cannot be run after being dewatered and serviced, appropriate preservation criteria described in **NSTM Chapter 233** shall be used.

2. Rebuild the engine using new parts where necessary.
3. Run the engine (as described in paragraph 079-48.5.11) as soon as possible after reassembly and servicing.

079-48.5.13 GAS TURBINES. Gas turbine engines can be affected by seawater immersion in two ways: the engine compartment may be partially flooded or submerged, or the engine air inlet system may be flooded.

079-48.5.13.1 Engine Compartment Flooded. In the case of propulsion and ship's service gas turbine generators, immediate and complete disassembly, inspection, and repair at the appropriate Naval Air Rework Activity for the type of engine involved is recommended after compartment has been dewatered. In most cases, only gas generator and power turbine will have to be reworked.

079-48.5.13.1.1 In the interim, the following remedial actions shall be taken.

1. Drain turbine lube oil system, flush with fresh water, and then flush with CPC grade 3.
2. Clean and thoroughly dry all electrical and electronic components.
3. Wipe down cabling with fresh water.
4. Repeat after 24 hours to remove salt crystals still present.

NOTE

See **NSTM Chapter 300** for additional electrical/electronic procedures to be followed after components have been subjected to seawater immersion.

079-48.5.13.1.2 If the engine uses starting batteries and the battery wells become flooded with seawater, concentrated sulfuric acid will be given off. Along with seawater, the sulfuric acid will rapidly corrode the engine and its accessories.

079-48.5.13.1.3 All exterior surfaces shall be wiped down with warm fresh water, CPC applied, and dried with service air. Check for obvious seawater entrance into internal surfaces. If seawater entrance is detected, turbine must be torn down at the earliest possible time for inspecting and cleaning. If possible, water-wash the engine as soon as practical to prevent further internal deterioration.

079-48.5.13.1.4 Engine may be restarted without teardown inspection and repair if its service is absolutely necessary. This should be done only in an extreme emergency, after which the engine must be replaced as soon as possible.

079-48.5.13.1.5 When returning the lube oil system to service, flush for removal of CPC in general accordance with the procedure in **NSTM Chapter 050** , except that initial flush may be with hot 2190TEP -[70 degree C to 75 degree C (160 degree F to 170 degree F)]. Allow adequate time for complete drainage of 2l90TEP and refill with manufacturer's specified lube oil. Any components damaged by seawater immersion shall be replaced prior to starting the engine.

079-48.5.13.2 Air Inlet System Flooded. The second type of seawater immersion which can affect gas turbines is engine air inlet system flooded with seawater due to unusual storm conditions. Large gas turbines are fitted with various types of moisture separators and plenum chambers which effectively reduce the probability of this occurrence under usual sea conditions. However, the possibility of seawater flooding is always present and the dangers are indicated in the following paragraphs.

079-48.5.13.2.1 Two separate engine stalls are possible. One occurs because a large mass of seawater will choke off engine air flow and cause flameout. The other occurs when water actually reaches the engine, causing thermal shock and compressor stall.

079-48.5.13.2.2 Both conditions are detrimental to engine life, but the second can cause more extensive damage. Remedial procedures similar to those described in paragraph 079-48.5.13 shall be employed. Commence with a warm, freshwater wash one hour after flameout has occurred. This allows sufficient time for uniform cooling. The wash water shall be mixed with special detergent recommended by the engine manufacturer to flush out possible salt deposits from engine internals.

079-48.5.13.2.3 After water-wash is completed, engine shall be borescoped. Particular attention shall be given to turbine disks and blades to determine if any thermal distortion of the hot section has occurred because of sudden seawater ingestion. This quenching also may result in a material property change.

079-48.5.13.2.4 The lube oil system shall be inspected for the presence of water in the system. If this is detected, lube oil system shall be flushed with fresh oil. The engine may be restarted and allowed to run on a test basis as long as excessive vibration is not detected. If vibration does occur, engine shall be secured and returned to the repair depot as soon as practical.

079-48.5.13.2.5 If excessive vibration is not detected, engine can be allowed to run as long as needed. In-depth borescope inspection of the entire engine shall commence as soon as engine down-time can be scheduled.

079-48.5.14 AUXILIARY HYDRAULIC SYSTEMS. Initially, drain down any accumulators in the system to the hydraulic reservoir or sump. Drain reservoirs or sumps to remove water contamination and refill with clean hydraulic fluid compatible with system fluid to a level above outlets to pumps. As time permits, initiate cleaning and flushing procedures in accordance with MIL-STD-419.

SECTION 49.

GUIDELINES FOR WATCHSTANDERS AND THE ENGINEERING OFFICER OF THE WATCH

079-49.1 CONTROL BY ENGINEERING OFFICER OF THE WATCH

079-49.1.1 WATCH OBJECTIVES. The list of duties and responsibilities of the Engineering Officer of the Watch (EOOW) illustrates the positive control that must be maintained to ensure safe and effective operation of the propulsion plant. The EOOW must maintain control of the entire plant (firerooms, engine rooms, all related systems, and watchstanders) while accomplishing watch objectives.

079-49.1.1.1 The EOOW is responsible for the following:

1. Providing propulsion and other vital services
2. Accomplishing plant maintenance
3. Conducting required plant evolutions.

079-49.1.1.2 Potentially severe incidents can occur when EOOW control is not adequately exercised. This section illustrates how the necessary degree of control can be achieved in practice.

079-49.1.1.3 Key guidelines and a logical approach to EOOW plant control are presented.

NOTE

It is not practical to write strict rules for achieving control; therefore only guidelines are provided and their application must be tempered with common sense.

079-49.1.1.4 Practical examples of application of the guidelines, along with suggestions as to when it is appropriate to seek guidance seek guidance from the Engineer Officer or Commanding Officer before proceeding have been included.

079-49.1.2 EOOW PREREQUISITES. Two important prerequisites based on training and experience as a watch officer must be met by an EOOW before proper control of the propulsion plant can be exercised:

1. A thorough knowledge of the plant systems
2. Sound engineering judgment.

079-49.1.2.1 Knowledge of Plant Systems. A knowledge of all plant systems is gained by a formal study program; this knowledge must be kept current and continually upgraded by continued review of system and procedure changes. System knowledge refers not only to system details, but also to understanding how each system can affect overall plant conditions. Such study will bring about the essential sound understanding of system interrelationships necessary for watch control.

079-49.1.2.2 Sound Engineering Judgment. Sound engineering judgment is the ability to determine which aspects of the total plant situation require attention or action at a given moment. Obviously, even the most capable

EOOW cannot follow everything in detail. The EOOW's function is to monitor indicators that give the best picture of plant performance and can be monitored effectively.

079-49.1.2.2.1 These indicators include everything from communications to plant instrumentation. The number and type of indicators monitored depends on the particular situation (that is, existing plant lineup, complexity of evolution, capability of watchstanders, and so forth) as well as capability of the EOOW to monitor them effectively.

079-49.1.2.2.2 Since a particular plant situation may require any number of concurrent actions, the EOOW's degree of involvement in each action must be apportioned to achieve the best degree of overall plant control within limits of EOOW capabilities. The EOOW's decision in each specific case must be based on an understanding of the present plant status, the watchstanders, and details of the operational situation.

079-49.1.3 EOOW GUIDELINES. There are six general guidelines which together form a systematic approach for the EOOW to maintain plant control during watch. The guidelines can be applied to specific operational situations such as routine, infrequent, or casualty conditions. The EOOW should use these guidelines to formulate a logical pattern of evaluation, analysis, and action for all operational situations in order to achieve and maintain plant control.

079-49.1.3.1 Plant Status Awareness. The EOOW's control of the plant must be based on a full awareness of the current plant status and the evolutions taking place within the plant. This awareness ensures that the plant is being operated according to orders. The EOOW must be prepared to detect and deal promptly with problems as they arise.

079-49.1.3.1.1 Plant awareness must be established before EOOW assumes watch. It is achieved through:

1. Review of plant status logs and records
2. A prewatch plant tour
3. Questioning of the watch being relieved

079-49.1.3.1.2 Each step is essential in preparing the oncoming EOOW to stand watch. The oncoming EOOW first determines overall plant status and objectives of the watch by reviewing pertinent plant documents such as the **Night Order Book and Tagout Log.** Before conducting the tour the EOOW evaluates available logs and records, or present plant conditions, the operations and maintenance evolutions that can be expected to be accomplished during the watch and special conditions that may have to be established to support future plant operations (for example, setting up boiler chemistry for an expected highpower run). This review provides background information which helps the EOOW know what to look for on plant tour.

079-49.1.3.1.3 Objective of the plant tour is to obtain, by first hand observation, a clear understanding of plant conditions and its capability to accomplish planned operations. The prewatch tour should include a detailed inspection of the entire plant, including each piece of equipment, each log, and each valve and switch. Such an approach is impractical. The EOOW should attempt, as a minimum, to verify that plant status is accurately reflected in the documents just reviewed and to observe general condition of the plant. Extent of the plant tour should be determined by the number of changes which have occurred, the time which has elapsed since the EOOW's previous watch, and objectives of the present watch.

079-49.1.3.1.4 A prewatch plant tour in a shipyard situation, where considerable maintenance work may be in progress, must necessarily be more extensive than a prewatch plant tour under steady steaming conditions. Similarly, the EOOW should make a more detailed plant tour if this is this officer's first watch after several days. In all cases, the tour should be sufficiently thorough for the EOOW to become knowledgeable of conditions at each watch station and the watch station's readiness to support plant operations.

079-49.1.3.1.5 The prewatch plant tour should include spot checks of various items such as logs and valve line-ups. In addition to spot checks, the plant tour should include a careful evaluation of items which will be involved in the upcoming watch. Discussions with watchstanders on current or planned operations and condition of equipment can provide valuable insight and supplementary information which may not be evident from reviewing logs or inspecting equipment.

079-49.1.3.1.6 Watch relief is the final step in gaining an understanding of plant status prior to assuming control. During watch relief, the oncoming EOOW must resolve any questions which may have arisen during plant tour.

079-49.1.3.1.7 Watch relief is a formal, controlled evolution. The objective of watch relief is to give the oncoming EOOW a complete understanding of the plant status. If a question cannot be resolved, the Engineer Officer must be consulted before watch is relieved.

079-49.1.3.1.8 Once current plant status is known and watch has been relieved, the EOOW must maintain this awareness by various techniques:

1. Pick out key indications and scan them frequently.
2. Know what normal readings should be and question all abnormal indication, even though they are not at a limiting value.
3. Cross-check indications where possible.

079-49.1.3.1.9 Although key readings are scanned frequently, other plant indications available in Main Engine Control or the Enclosed Operating Station should be checked periodically. The EOOW should be alert to all information available. For example, are there noises that can be expected for this plant condition? Are unusual noises, smells, or vibrations providing early warning of an abnormal condition?

079-49.1.3.1.10 The EOOW should be aware of the status of all evolutions in progress and the activities of watchstanders. When an order has been given to a watchstander to perform an evolution, the EOOW should follow its progress by watching indications and receiving reports from watchstanders. The EOOW should follow the course of evolutions in this manner so problems may be anticipated and so the EOOW is able to provide direction needed to avoid or minimize them. If currently expected indications are not observed during evolution or a report is not received when expected, the EOOW should request a status report from watchstanders.

079-49.1.3.1.11 Plant awareness is fundamental to plant control and must not be displaced by other duties. For example, when it is necessary to carry on a discussion with a watchstander, EOOW shall maintain panels and watchstanders in view and continue to monitor indications frequently. If EOOW is checking a procedure or reviewing other documents, a visual review must be made frequently to monitor indications.

079-49.1.3.2 Advance Planning. The EOOW must know not only current plant status, but must plan in advance for evolutions scheduled on current watch. Planning ahead enables the EOOW to complete evolutions in an efficient, controlled manner and to anticipate potential problems that may occur during evolutions. This enables recognition and quick correction of an abnormality if it occurs.

079-49.1.3.2.1 Planning ahead begins before the watch, when EOOW determines objectives of the watch. At this time, each evolution to be conducted is mentally reviewed. Degree of planning should be based on type of evolution (routine or infrequent), experience level of watchstanders, and other variables that will indicate types of problems that may be encountered.

079-49.1.3.2.2 Infrequent evolutions must be conducted with extreme care and the limitations they place on other plant systems or operations must be considered in advance. Precautions and preparations for such evolutions should be considered before the watch whenever possible. A prewatch briefing of watchstanders is recommended for infrequent procedures. While the EOOW will not always have sufficient advance notice of evolutions to accomplish this degree of preparation, careful advance planning whenever possible will help to avoid many simple errors or misunderstandings which otherwise could contribute to loss of plant control.

079-49.1.3.2.3 The EOOW should consider how changing plant conditions affect the watch and how the evolution being conducted will affect overall plant status. Such things as changes in the ordered bell should be anticipated and how such changes will affect equipment and overall plant operation. The EOOW should be aware of the areas of each evolution which are prone to problems, taking into account limitations of watchstanders and knowledge of any past operational problems experienced by the plant.

079-49.1.3.2.4 In casualty situations it is especially important that while dealing with immediate problems, the EOOW make use of plant knowledge and judgment to anticipate results of orders and watchstanders' actions.

NOTE

Few casualties require instant response. Whenever possible, the EOOW should spend a moment to evaluate the situation. Planning ahead in this manner will help prevent or limit the consequences of various problems which may occur and expedite recovery from casualties.

079-49.1.3.3 Watchstander Understanding. It is important that all watchstanders understand the status of evolutions in progress. Communication systems should be used during watch to inform watchstanders of changes in plant status and to ensure they understand what is happening. Keeping watchstanders informed in this manner helps prevent mistakes and promotes understanding of current plant status and how actions of watchstanders will affect it.

NOTE

It is the responsibility of the EOOW to issue clear and concise orders that can be understood by the operator; to require the operator to acknowledge when order has been received and report back when order has been carried out. The EOOW should be alert for acknowledgements of orders which are hesitant or indicate uncertainty on the part of watchstander. This may imply that watchstander does not have complete understanding of what actions should be. If the EOOW suspects the watchstander misunderstands an order, the evolution should be stopped and the EOOW should rephrase the order.

079-49.1.3.3.1 Orders originating from the EOOW must be sufficiently exact such that the EOOW maintains control of plant at all times. All orders should be phrased so the EOOW retains positive control of when and how an order will be executed. This is particularly important where improper action would immediately result in exceeding an operating limit or alarm set point.

079-49.1.3.3.2 Positive control is achieved by specific orders, or by direct observation by the EOOW, or by the space supervisor in machinery spaces. The EOOW can control an overall plant evolution by giving orders for segments of the evolution which will take the plant through a series of key events. At each key stage of the evolution, the EOOW should verify by reports and observations that plant is in desired intermediate state before proceeding.

079-49.1.3.3.3 Scope of orders is determined by what the particular watch officer judges to be necessary for plant control. The EOOW should recognize, however, that in giving an order which is too broad in scope, ability to determine which evolutions are causing which changes in plant parameters may be relinquished, along with the ability to quickly detect watchstander errors or material failures which may occur.

079-49.1.3.3.4 In short, the broader the scope of the order the less control the EOOW has over watchstanders and plant.

079-49.1.3.3.5 At the other extreme, if scope of orders is too narrow, the EOOW will be involved in controlling every motion of every watchstander, causing distraction from maintaining an awareness of the overall plant condition. Furthermore, this situation could increase the complexity of the evolution, dilute the experience of watchstanders, and create unnecessary difficulties in any special circumstances which may exist (for example, shipyard test program).

079-49.1.3.3.6 For an infrequent evolution, it may be useful for the EOOW to discuss the evolution with watchstanders to verify their understanding before giving formal orders. For watchstanders remote from Main Engine Control, the space supervisor should be used.

NOTE

If the EOOW is uncertain of details and feels that watchstanders are uncertain, the EOOW should not proceed until all watchstanders have a clear and complete understanding of all aspects of the evolution. The Engineer Officer or Commanding Officer should be consulted for additional guidance, if the EOOW remains in doubt.

079-49.1.3.3.7 During casualty situations, the EOOW must place increased reliance on operators' knowledge of necessary immediate actions. In these cases it is particularly important that the EOOW phrase orders clearly, to avoid possible misunderstanding and so maintain control of corrective measures. The EOOW must keep all operators informed of the nature of casualty and recovery actions.

NOTE

Complete understanding by all watchstanders is important. The Engineer Officer and the Commanding Officer shall be kept informed, especially during abnormal evolutions or casualty situation.

079-49.1.3.4 Watchstander Supervision Techniques. Control of the watch necessarily includes control of watchstanders. The EOOW shall actively supervise all watchstanders to maintain awareness of their activities and to ensure that they are operating the plant as expected. Watchstanders in Main Engine Control are supervised directly by the EOOW, while watchstanders outside Main Engine Control are supervised indirectly, with the assistance of the space supervisor.

079-49.1.3.4.1 Proper supervision includes ensuring operator carries out specific evolutions as ordered, performing them correctly and reporting completion or status of evolutions. The EOOW shall not assume that once an order is given it will be carried out without a problem, since any number of occurrences (misunderstanding of orders, equipment failures, inadvertent watchstander actions, and so forth) could result in problems with plant operations.

079-49.1.3.4.2 In most cases, orders will be carried out quickly and effectively because watchstanders are generally well-trained and skilled individuals capable of handling difficult situations. The EOOW cannot completely rely on this capability, however, but must continually check and double check and direct watchstanders as necessary to ensure that problems are either precluded or their effects minimized. Every error in plant operation jeopardizes crew and ship safety; thus every effort must be made to minimize errors.

079-49.1.3.4.3 Proper supervision also involves ensuring operators know the necessary requirements in order to carry out specific evolutions. Watchstanders should be questioned frequently. When an evolution is about to be conducted, operators should be asked to explain the more complicated steps before they attempt to carry them out. This type of supervision will rapidly improve the general knowledge level of operators.

079-49.1.3.4.4 As completion of each major step of an evolution is reported, the EOOW should use indications available in Main Engine Control to verify that it has been performed properly.

079-49.1.3.4.5 The EOOW shall always ensure watch section’s attention is directed entirely towards operation of the plant. Any distraction could cause an order to be misunderstood or an important indication to be missed. Entry into Main Engine Control or to fireroom or engine room control stations must be allowed only for official business and then only if it will not adversely affect control of the plant. The EOOW shall demand that space supervisors reinforce these principles of formality so the entire crew is kept to the business of running the propulsion plant.

079-49.1.3.4.6 Close supervision of watchstanders also provides the EOOW with an understanding of individual capabilities. Such information is important when the EOOW is deciding where to focus attention during plant evolutions.

079-49.1.3.4.7 Throughout any evolution the EOOW should remember to use space supervisors to supervise remote watch stations. At most times the EOOW should remain in Main Engine Control and therefore work through these key watchstanders in carrying out responsibilities as a supervisor.

079-49.1.3.5 Continuing Evaluation of Procedures. Plant control requires active and continuing evaluation by the EOOW, who performs this evaluation frequently by mentally formulating questions that must be answered satisfactorily. For example, **Are correct procedures being used? Is supervision given to key watchstanders appropriate to their experience and complexity of the evolution? Are indications normal?**

NOTE

A questioning attitude is an essential ingredient for proper plant awareness and supervision by the EOOW. It provides an additional level of reliability in plant operation. For example, questioning why a pipe is hot may lead to discovery of an improper valve lineup. Questioning a small but unexplained change in a plant parameter may help to recognize an equipment problem before it causes a failure.

079-49.1.3.5.1 The EOOW's review of paperwork or observation of plant conditions must not be cursory. Even if a detailed review is not possible, a spot check for correctness should be made. If the reason for a particular indication or report is not clear, the problem shall be pursued actively until a complete explanation is obtained. The EOOW must never assume that plant operation is correct, but should confirm actual status by observation, or by requesting verification by watchstanders. The EOOW must use this approach for every function and demand the same approach from watchstanders.

079-49.1.3.6 Maintaining Formality. The EOOW can maintain proper control of the plant only when a precise, formal atmosphere is maintained among watchstanders. Formality on watch promotes safe and efficient operation and ensures more alert and businesslike operators. Formality is best taught by example. The EOOW must demand it and set the standard.

079-49.1.3.6.1 Formality will be promoted by use of proper engineering terminology, strict use of procedures, proper supervisor/watchstander relationships, use of formal communication, proper military alertness and bearing, and maintenance of a businesslike atmosphere at all times.

079-49.1.3.6.2 Inattention to details, mental and physical laziness, and immature attitudes toward the job could lead to loss of plant control. The EOOW should not tolerate inefficiency in any watchstander, such as poor communications, lounging on watch, or careless logkeeping by any watchstander. Prompt correction of lapses when they are observed is the best way to prevent their recurrence.

079-49.2 COMMUNICATIONS

079-49.2.1 OVERVIEW. Basic guidelines ships should follow in establishing formal internal communication procedures for use in the propulsion plant have evolved during years of operations. These procedures have been successful in achieving reliable communications. Although they may seem unnecessarily formal, experience has shown that less formal procedures eventually result in either causing or aggravating plant casualties.

079-49.2.2 FORMAL COMMUNICATIONS. Communication procedures used by a ship generally set the tone for all operations in the ship. If formal and concise communications are used, the ship operates in a similar fashion and fewer adverse incidents occur. Key communications are discussed and analyzed in the following paragraphs to illustrate benefits to be derived from proper, formal communication procedures.

079-49.2.3 SOUND-POWERED TELEPHONE AND ANNOUNCING SYSTEMS. Different ship configurations provide various sound powered phone systems and general or area announcing systems, or both.

NOTE

Overuse of announcing systems creates background noise level and distraction that may cause more confusion than assistance in operating the plant.

079-49.2.3.1 Sound-powered telephone circuits should be used for normal ship control and normal operating evolutions in which only specific propulsion plant stations are involved. Sound-powered telephone circuits are more reliable than announcing circuits and enable messages to be given selectively to the watch station(s) involved in the communication without creating a needless distraction for other watchstanders. This concept is particularly important for communications with watchstanders in the control stations. Unrestricted use of announcing systems which have loudspeakers in control stations can create an atmosphere of confusion.

079-49.2.3.2 Past experience has shown that operators working in such an atmosphere frequently tend to ignore announcing systems, thus failing to pick out emergency and vital messages or both. This situation can be a cause of casualties. For these reasons, announcing systems should be reserved for emergencies, or other situations where a particular message must be passed to several stations simultaneously. For example, all propulsion plant casualties should be announced, even if the necessary corrective action involves only a few watchstanders.

079-49.2.3.3 There are several reasons for this requirement. Watchstanders other than those directly involved with a casualty must be kept aware of plant status in order to respond with consistent corrective action should a concurrent casualty occur at their own watchstations. Additionally, watchstanders may be able to make a constructive contribution to control casualties even though not directly involved in the corrective action, if they are kept informed.

079-49.2.3.4 Other messages of interest which should be announced to all watchstanders are all emergency propulsion orders, such as bringing steam in or securing steam in the engine room, shifting from ship's electric power to shore electric power and back again, lighting boiler fires, or shifting propulsion modes.

079-49.2.3.5 Orders given by the EOOW to watchstanders outside Main Engine Control should be relayed by other watchstanders acting as phone talkers. This is necessary so the EOOW is free to provide overall direction and coordination for propulsion plant operations. This practice is important particularly during complex or emergency situations, but should also be followed at other times so it becomes an instinctive and standard way of EOOW communication.

079-49.2.4 MONITORING SYSTEMS. Many ships have amplifiers and loudspeakers in the Main Engine Control, fireroom, and engine room, which monitor the sound-powered telephone circuits in engineering spaces. This system provides the EOOW or space supervisor with knowledge of all engineering watchstander communications, and the ability to hear, immediately, reports from any watch station. For this reason, the monitoring systems play an important role in keeping the EOOW informed of plant status and provide immediate notification of plant problems.

079-49.2.4.1 During casualty conditions or unusual operating situations when frequent telephone communications are required, however, continued use of the amplifier system may add to background noise level and, in a fashion similar to that discussed for announcing systems, tend to cause or aggravate plant casualties. For this reason a sound-powered telephone headset should be staffed during casualty conditions and the loudspeaker secured as soon as conditions permit.

NOTE

The loudspeaker system is used for initial critical stages when speed of transmitting and receiving reports is vital, but as soon as possible the noise level should be reduced by use of the telephone circuit; that is, the loudspeaker is replaced by a talker staffing a headset.

079-49.2.4.2 A talker who knows the plant can avoid interrupting when the EOOW is receiving vital information from another source and can pass it on later. A talker can also remind the EOOW of the previous message if it appears that the EOOW has forgotten it.

079-49.2.4.3 During casualty conditions or special evolutions, additional personnel should be used as telephone talkers. By using a talker who has no other concurrent duties, the EOOW can avoid distracting the existing watchstanders when they are communicating.

079-49.2.4.4 Use of inexperienced personnel as talkers at key propulsion plant watch stations should be prohibited. They may be confused easily or misled and are likely to pass incorrect or meaningless information to the EOOW. The requirement for a formal qualification for telephone talkers (see Volume 2 of this chapter) will ensure that inexperienced talkers are not used.

079-49.2.5 USAGE BY WATCHSTANDERS. Watchstanders should be trained to recognize priority communications information in various operating situations. For example, requests to perform routine evolutions, such as routine pumping of bilges, should not be made during casualties or training exercises. Casualties can be compounded if vital messages are interrupted or delayed because watchstanders fail to observe this rule.

079-49.2.5.1 Watchstanders should first listen on the telephone circuit to see if it is clear before transmitting a message. If the circuit is in use, watchstanders should normally wait for the circuit to clear before transmitting a message. If the watchstander has an emergency or priority report to make, it is appropriate to cut in by stating, **“Silence on the line,”** and then transmit the message. Stations which were interrupted should fully repeat their incomplete message when the circuit is again clear.

079-49.2.5.2 Communications in the propulsion plant should be addressed to watch stations rather than to names of individuals on watch. Informally-addressed messages lead to an informal atmosphere and to informality in plant operations. The concept of using titles instead of names also is applicable for face-to-face communications, as well as for telephone or loudspeaker communications. In his communications to watchstanders, the EOOW should address order to the Electrical Operator or other appropriately titled watchstanders. In addition to improving formality, this also prevents different but physically adjacent watchstanders from thinking they both are supposed to be carrying out an order.

079-49.2.5.3 A ship should test its ability to communicate when devices such as gas masks are worn. Gas masks, Oxygen Breathing Apparatus (OBA), and other survival support devices make communications difficult. Unless ship’s force practices using these devices, communications may be impossible during emergencies or casualties which require devices to be worn. A ship should not be in the position of determining that it doesn’t have the ability to communicate effectively during a casualty.

079-49.2.5.4 One effective means of a ship’s personnel to ensure its ability to communicate while personnel are wearing survival support devices is to actually use these devices during drills rather than simulate their use.

079-49.2.5.5 It is important that an order be acknowledged and repeated back before that order is carried out. Unless the watchstanding understands the order it can not properly be carried out. By hearing the order repeated back, the originator is assured that the watchstander properly received the order. Obviously the watchstander receiving the order also must understand what the words mean. Use of standard terminology helps avoid misunderstandings. If the order is not understood, or if it appears inconsistent with other plant conditions, the watchstander should request clarification. Normally, the reasons the order appears inconsistent or confusing also should be stated. This will inform the controlling station of the watchstander's basis for questioning an order. If reasons are correct, a casualty probably has been avoided; if the watchstander's reasons were incorrect, a casualty probably would have been caused by lack of understanding.

079-49.2.5.6 When an emergency or special plant condition exists, watchstanders should carry out orders if intent of the orders are clear and consistent with required casualty control actions. After completing an ordered action, watchstander should report this fact to the person who gave the order. Again, this report should be acknowledged to ensure the ordering station has received the report and knows which action was completed.

NOTE

Slang terms of expression and locally-devised code signals should not be used. Such nonstandard communications may not be understood by another watchstander, especially if some recently have reported aboard or qualified. Hand signals and nodding of the head should also be avoided for communication between watchstanders. Such informal communications are too easily misunderstood.

079-49.3 LOGS

079-49.3.1 GENERAL. Ships should follow some basic guidelines in maintaining logs associated with the propulsion plant. Logs should do more than satisfy the requirement of having legal records; they also should provide a ship with the ability to produce a viable record of plant operation and performance which is usable for operating and maintaining the propulsion plant on a day-to-day basis. In the following paragraphs, key guidelines will be discussed and analyzed to describe benefits that can be derived from logs that are used and maintained properly.

079-49.3.2 DEFINITION AND REQUIREMENTS. The following paragraphs, which were taken from a memorandum, define and establish parameters of a log (sometimes referred to as a journal) and stresses importance of accurate records. A log maintained by a naval activity is intended to be as follows:

1. An historical, chronological record of the occurrences in an assigned area
2. A legal record, available on demand to authorized personnel and, in some cases, the general public
3. A sober, objective, and factual account of personnel efforts, communications, occurrences, and observations within a given sphere of interest
4. A tool by which progress and performance may be measured; by which difficulties, incidents, and occurrences may be analyzed and evaluated, reconstructed or accurately demonstrated
5. A means of communication

079-49.3.2.1 A properly kept log provides the following:

1. Gives a written record of memories and pools observations of a vast number of people in one readily available place
2. Minimizes or eliminates need for numerous interviews and costly or perhaps dangerous repetition of efforts, operation, and demonstrations for post facto evaluation or analysis
3. Provides efficient and intelligent continuity to a technical endeavor by immediately making available to supervisory personnel a concise summary of all preceding events

079-49.3.2.2 To achieve its overall intent, a log must be historical, chronological, and current. Entries should be made as they occur. A log written in the last hour of a hectic or eventful watch will probably record only 20 percent of the actual information developed during the time span of the entire watch it is expected to cover.

079-49.3.2.3 Logs must be sober and objective. Expressions of humor, wit, and irony may lighten the day for associates who peruse the record, but can bring only gloom, frustration, anguish, or despair when a literal interpretation is applied in legal proceedings, inquiries, or investigations.

079-49.3.2.4 Logs must be complete, accurate, and informative. Being immune to lapses of memory, a properly kept log should be superior to the collective memories of all foregoing observers. A successor feels more adequately equipped and less confused with the log than with the presence of the predecessor.

079-49.3.2.5 Logs must be written to provide the maximum benefit of combined physical senses and intelligence, without need for interpretation, so a successor is made to feel fully informed.

079-49.3.3 OPERATING LOGS. Operating logs are important because they provide the ship's personnel with a means of ensuring frequent observations of the operating machinery by watchstanders. By its preselection of items to be logged, ship's forces can ensure that adequate parameters are observed on each piece of machinery or on systems in the propulsion plant. This ensures that at least the minimum required observations are being made by the watchstanders.

079-49.3.3.1 Failure Recognition and Analysis. Operating logs provide the basis for performance analysis of equipment, systems, or both. By careful monitoring of the logged readings, the watchstander can determine trends in operating equipment under cognizance and can take corrective action, in many cases before performance of an item deteriorates to an unsatisfactory level. This benefit cannot be obtained if watchstander does not associate one set of log readings with a previous set. Several steps can be taken to aid in associating and analyzing sets of readings. These are discussed in the following paragraphs.

079-49.3.3.2 Maximum/Minimum Parameters. Each log should indicate maximum and minimum readings for each parameter to be recorded. This requirement serves two purposes.

079-49.3.3.2.1 The first benefit is that ship's forces should establish minimum and maximum values for each parameter, using official publications such as the applicable **Propulsion Plant Manual,** component technical manuals, **Ship Information Books,** and other official documents. Personnel should be set so that deviations from normal operating conditions are indicated. For some machinery/systems this requires the ship to establish shutdown limitations as well as operating limits. One set of limits which encompasses both shutdown and operating requirements may not adequately reflect the correct limitations.

079-49.3.3.2.2 The second benefit to be derived by printing minimum/maximum limits on the log sheets is to provide the watchstander with definite limits to compare readings. It becomes apparent that something is abnormal if these values are exceeded. The abnormalities can then be reported, investigated and corrected.

079-49.3.3.3 Unusual Conditions. When a reading falls outside minimum/ maximum readings, or is in some other way unusual, it should be noted in some manner, such as being circled or logged in red. In addition, the EOOW should be notified of any such readings. The question in these circumstances should be: What is unusual?

079-49.3.3.3.1 Examples of unusual conditions would be:

1. An erratic shift in values with no change in operating conditions of the equipment; for example, bearing temperatures on a unit increase by 5°F without a corresponding change in load on the unit
2. A continual increase in temperatures on a component with no noticeable change in load, or similarly, a continual decrease in flow rate through a heat exchanger

079-49.3.3.3.2 Often, these conditions are combined under the heading of trends. Any trend which cannot be explained by a known, expected change in component/system operating conditions should be considered unusual. These trends should be noted and reported to the EOOW.

NOTE

It is essential to recognize that watchstander's responsibility does not end here. It is the watchstander's equipment and the problem should be investigated and analyzed in conjunction with action ordered by the EOOW to determine cause of the abnormal trend so it can be corrected. The watchstander should believe readings are correct until it can be proven otherwise. If changes in parameters are rapid or abrupt, watchstander must take necessary actions to put the plant in a safe condition and report the actions to the EOOW.

079-49.3.4 ENGINEERING LOG. The EOOW should log problems and attempted corrective actions in the Engineering Log. There are several reasons for doing this.

079-49.3.4.1 Watchstander Turnover. First, this helps oncoming EOOW's to have a full picture of problems which occurred on previous watches and which corrective actions were successful or unsuccessful. Passing information by word-of-mouth between EOOW's will never lead to clear understanding of a past problem and its solution if the same problem recurs several months later and it is desired to use the earlier successful corrective action to solve the problem anew.

079-49.3.4.2 Recognizing Problems. Another reason for logging noted readings and corrective action is that the person reviewing the logs, such as the Engineer Officer or Commanding Officer, may recognize certain indications as symptoms of a bigger problem which the EOOW could not recognize. Because of their greater experience in engineering, these more senior officers are expected to be able to recognize potential problems more quickly than the EOOW.

NOTE

This is a valid reason for requiring the Engineer Officer to review the engineering log and to spot-check other logs daily.

079-49.3.4.3 Log Readings. Log readings should not be missed because the ship is at battle stations or has special sea detail stationed. Extra watchstanders posted under these conditions provide increased personnel monitoring of plant conditions and should allow for more rapid detection of major plant problems. Individual monitoring does not, however, help detect trends which indicate an impending problem; these are usually detectable only through a review of operating logs. For this reason all hourly readings should be recorded regardless of the evolutions being performed.

079-49.3.4.4 Hourly Log Readings. Hourly log readings should be taken as close to the hour as possible. This requirement provides a set interval between readings and should aid in analyzing trends. This requirement also precludes watchstanders monitoring some system equipment late for one set of readings and then early for the next set. Unless log readings are taken at specific intervals, a particular piece of equipment may have a pair of readings taken with only a half hour or less interval and the subsequent pair of readings separated by almost two hours. This would not provide adequate monitoring of the equipment/system.

079-49.3.4.4.1 When the EOOW or space supervisor is touring the plant and reviewing the logs, watchstanders should be required to explain various readings on their log sheets. Watchstander's answers to such questions should quickly show whether or not watchstander really understands what is being done and if the job is being accomplished effectively. An effective watchstander should be inquisitive about the watch station and should actively be searching out problems or looking for trends. A few probing questions by the EOOW or supervisor should quickly show the effectiveness of the watchstander. Poor watchstanding procedures noted should be corrected on the spot.

079-49.3.4.5 Periodic Review. Experienced officers should periodically review log sheets covering significant periods of time to evaluate equipment performance and to identify operational trends indicating potential problems. For example, a pump, which over the period of an extended deployment (two months, for example) shows a rise in operating temperatures of -12°F (10°C) under similar load conditions, may indicate a developing problem. This trend may not be detectable through daily log review but may be detectable when log sheets are reviewed over a one- or two-month period. This review may make the difference between overhauling a pump during scheduled maintenance or having the pump later fail while at sea, requiring a more extensive overhaul with only ship spare parts available.

079-49.3.4.5.1 Operating logs provide the ship with a legal record of how a particular ship was operated and the plant maintained. For this reason logs should be neat, legible, correct, and complete. Erasures should be prohibited and where log corrections are necessary, the watchstander who is responsible for its entries should make log corrections.

079-49.3.4.5.2 Operating logs can provide Naval Sea Systems Command (NAVSEA) with a means of analyzing plant equipment operation, which aid in evaluating previous design studies against actual conditions. These records can also assist in developing follow up on systems or equipment.

079-49.3.5 ACCURATE RECORD MAINTENANCE. Accurate records are valuable sources of information for watchstanders, the EOOW, and higher authority. Such a record might be the only available evidence produced that a job had been properly performed.

079-49.4 WATCH RELIEF

079-49.4.1 GENERAL. Certain procedures apply to the conduct of any watch relief in the propulsion plant, whether at initial watch relief or at other times during a watch. In the following paragraphs some of these procedures will be discussed and analyzed to show why they exist and what benefits can be derived by proper application of these procedures.

079-49.4.2 FORMAL TURNOVER. The basic principle involved in watch relief is that the process should be a formal, controlled evolution. Experience has shown that when this basic principle is not followed, a casualty will probably result.

079-49.4.3 WATCHSTANDER RELIEF. Watch relief should not be permitted when plant conditions are changing, or when other conditions exist. Watch reliefs should be permitted only when plant conditions are stable.

079-49.4.3.1 During casualties, the watch should not be relieved. Oncoming watchstanders, in this case, should not attempt to relieve the watch because this will distract watchstanders from their main duty of taking corrective action for the casualty. Oncoming watch can assist the personnel on watch, if so requested by the watch, but it must be clearly established that this assistance shall be controlled by the personnel on watch.

NOTE

Oncoming watch personnel should not take independent action on watch station, but must limit themselves to action requested or directed by watch personnel.

079-49.4.3.2 In some cases it may not be clear to oncoming watch personnel whether conditions are suitable for watch relief; therefore the EOOW should direct watch reliefs.

079-49.4.3.3 The EOOW grants permission to relieve the watch and receives a report back when this has been accomplished. For control station watchstanders, the EOOW should individually permit watch reliefs of each individual watch station. For other watch stations it is permissible for the EOOW to grant permission to the space supervisor for engine room or fireroom watch relief. In this case the space supervisor would control watch reliefs and would report back when all space watches have been relieved. This procedure is advantageous in that repetitious requests to relieve watch are not received by the EOOW, which would distract from the primary duty of monitoring and controlling the propulsion plant. With this procedure, however, watch relief is formally controlled.

079-49.4.3.4 All watch stations in the propulsion plant should be relieved prior to the oncoming EOOW relieving. The watch relief period is a period when watchstander status is rapidly changing. It is logical to have the officer who has the more intimate knowledge of preceding plant history as EOOW. The EOOW in charge of the previous watch should be able to grasp more quickly any changes in plant conditions which occur during the watch relief period and hence should retain the watch until all watch stations have completed the watch relief. In addition, any issue raised at a particular watch station during relief should be resolved by the EOOW who was responsible for the plant during the preceding watch.

079-49.4.3.5 Each watchstander should be required to review the logs associated with the watch station for at least the previous two watches. Since watchstanders normally stand a three-section watch, this review will cover all changes in plant conditions and trends which have occurred since the watchstander was last on watch. If the watchstander has not been standing watches on the particular watch station, a more extensive review of past logs should be made to give a good perspective of plant conditions and problems associated with the watch station.

NOTE

This will require the previous day's logs to be retained on the watch station for at least two watches the following day.

079-49.4.3.6 When the oncoming watch makes this review, it should be done with the offgoing watchstander prior to relieving the watch. The oncoming watchstander should ask the offgoing watchstander questions concerning individual readings or sets of readings. Prior to watch relief, all unusual readings should be discussed, as well as reasons for any questionable entries.

079-49.4.3.7 Oncoming watchstanders should go into precise detail in inspecting the watch station. Oncoming watchstanders should specifically inspect every operating station located in the watch area and should verify and understand the condition and operating mode of all indicators and controls.

079-49.4.3.8 No area on the watch station should be neglected during watchstander inspection. Watchstanders should know in sufficient detail the exact status of all systems, equipment, and their associated control or indicating stations located in the watch area.

079-49.4.4 EOOW WATCH RELIEF. The offgoing EOOW should provide the oncoming EOOW with a summary of current data on plant status and should ensure that plant is in a steady state condition prior to permitting oncoming watch to relieve. The reasons for the latter requirement were discussed in paragraph 079-49.1.3.1.

079-49.4.4.1 A watch relief sheet should be used to provide a written record of information which is not in the **Engineering Log** or on status boards or instruments in Main Engine Control. In addition to simple status items, such as which pumps are running and which are in standby, this sheet provides a suitable format for the offgoing EOOW to indicate trends, evolutions in progress, unexecuted orders, and so forth. The offgoing EOOW should orally brief the oncoming EOOW on these same items, but the watch relief sheet provides a written reminder to the oncoming EOOW which can be used later in the watch.

079-49.4.4.2 The oncoming EOOW's requirements for watch relief include reviews of applicable records, logs, and schedules, and oral discussion with the offgoing EOOW. By an inspection of the engineering plant, the oncoming EOOW becomes aware of plant status, what has happened to the plant in the past watches, and what is expected to occur on the plant during future watches.

079-49.4.4.3 Although the oncoming EOOW cannot inspect each watch station as thoroughly as individual watchstanders, it is necessary that the officer be inquisitive, look behind the gear, and look in spots that are not inspected frequently because they cannot be seen from walkways.

079-49.4.4.4 During the prerelief tour of the engine room lower level, the EOOW should climb outboard or beneath one main condenser and inspect this area; a small steam leak may be located that can not be seen from walkways. In addition, a fire hazard might be detected, such as oily rags which may have dropped from the upper level on hot steam piping. Rapidly deteriorating preservation in this area might be detected.

079-49.4.4.5 During subsequent inspections other areas may be selected for in-depth inspection.

079-49.4.4.6 Another key requirement of EOOW watch relief is the formal relief. The oncoming EOOW should sign the watch relief sheet, noting time of relief. Oncoming EOOW then states, **“I relieve you”** to the offgoing EOOW who acknowledges by stating, **“I stand relieved,”** and announces this relief to watchstanders in Main Engine Control and to space supervisors. The offgoing EOOW also acknowledges the relief by logging it in the **Engineering Log.**

079-49.4.4.7 The EOOW should indicate review of the logs by initialling them. The person on watch at any time should be able to explain any entry on a log, whether it occurred during the watch or previously.

079-49.4.4.8 The oncoming watch must obtain adequate information on the log entries from the offgoing watch prior to watch relief.

079-49.4.4.9 Formal relief is necessary because only one EOOW can be in charge of the plant and it must be clear as to when the EOOW responsibility shifts from the offgoing to the oncoming EOOW.

079-49.5 INSTRUMENT READINGS

079-49.5.1 One of the cardinal rules of good watch standing is, **Believe Your Indications.** Effort and time spent training and qualifying a watchstander to cope with differing plant problems can be wasted if the watchstander does not believe the instruments when they indicate that a problem exists.

079-49.5.2 A watchstander should believe instrument readings and take appropriate action required by the readings.

CAUTION

Operating personnel become accustomed to the plant operating in a normal, reliable manner. As a result, operators may tend to assume that the plant is normal and that abnormal readings are in error. This is incorrect procedure. The operator always should assume the readings are correct. Abnormal readings should be interpreted, reported, and logged as evidence that the plant is not operating in the normal manner.

079-49.5.3 When there is reason to suspect that an instrument is in error, or when inconsistencies between indications develop, it is best to stop the evolution, if possible, and place the plant in a safe condition until the problem is investigated thoroughly. This should always be done when the ship is dockside.

079-49.5.4 The problem of inconsistent indications (for instance, inconsistent readings of the different indicators of steam generator water level) is especially difficult to handle. The operator frequently will be tempted to discount one of the indicators and continue operation, using the one or more remaining indicators believed to be correct.

NOTE

This is a hazardous course of action. It is possible that the one indicator which is thought to be incorrect may be the only indicator that is correct. In cases of inconsistent indications stop and place the plant in safe condition until the inconsistency can be investigated and resolved.

079-49.5.5 A watchstander should use all the indications available. Even though only one meter may give a particular parameter, it is often possible to check values of other parameters to see if they are consistent with the parameter in question, and with the present mode of plant operation. Also, other indications are present in addition to readings which the operator should look for and rely on, just as much as instrument readings. Noises, hot pipes, unexpected water in the bilges, or unexplained behavior of a component or system are all indications which can be used to check plant operation.

079-49.5.6 The operator should use instruments at the watch station where actually located to control an operation. Use of remote or duplicate indicators to monitor plant parameters must be carefully controlled to ensure that watchstanders continue to monitor normally installed local instruments.

079-49.5.7 If an operator who is actually controlling an evolution relies too heavily on reports of readings from other watch stations and neglects to monitor local indications, response time to changes in the parameter controlled by the watch station may be lengthened significantly.

079-49.5.8 One basic principle which underlies all of these points is that a good watchstander should always be suspicious. A watchstander should expect problems. Every abnormality and every unexplainable change, no matter how small it may seem, should be treated as an indication that there is a problem which should be promptly and thoroughly be investigated. If every watchstander adopts this attitude and practices this on a day-to-day basis, many casualties can be prevented.

079-49.6 SUPERVISION AND CONTROL OF TRAINEES

079-49.6.1 TRAINEES. The term trainee applies to the person who has just reported to a ship and who has achieved no watch station qualifications. This term also applies to personnel who have qualified on certain watch stations in the propulsion plant of the ship, but who are now qualifying on different or additional watch stations.

079-49.6.2 TRAINING WATCHSTANDERS. Trainees should be under the constant and direct supervision of a watchstander qualified at the watch station. Trainee does not operate, or cause to be operated, any equipment unless directed to do so by the qualified watchstander and then only in the manner directed by watchstander and only under direct supervision.

079-49.6.2.1 The responsibility requires that the qualified watchstander issue clear and concise instructions to the trainee. For example, trainee should be instructed specifically to **“Open the steam generator vents, SG-13, SG-14, SG-15, and SG-16,”** rather than given the vague instruction, **“Open the vents.”** Improper directions to a trainee can lead the trainee to open the incorrect vents. In addition, all requirements concerning proper repeat of orders and other communications requirements should be closely adhered to in all communication between qualified watchstander and trainee.

079-49.6.2.2 Direct supervision requires the qualified watchstander to accompany the trainee who attempts to follow the instruction given in this paragraph. The qualified watchstander does this for several reasons; first, to make sure the trainee locates and operates the correct valves and, second, during operation of the valves, to provide further instruction to the trainee. This can be done by a series of questions such as, **"Are those valves backseated? Why? Why not? In what sequence are the valves opened? Why? What do you expect to observe as the valves are opened? How long do you expect to observe flow? What time limits do you allow for flow to continue? "**

079-49.6.2.3 Without the timely asking of such questions, the trainee loses much of the value of standing a training watch.

079-49.6.2.4 A third reason for close watchstander supervision is that the qualified operator must be close enough to prevent trainee from either operating the wrong valves, or operating the right valves improperly, and to take over from trainee if an unusual situation occurs which could not have been anticipated.

079-49.6.2.5 The qualified watchstander should not allow the trainee to perform any plant evolution until the qualified watchstander has become certain the trainee understands the evolution and can carry it out properly. For example, in the evolution described above, the trainee should understand why the vents are being opened. In addition, it should be made clear by the watchstander why they are being opened at that particular time during the plant evolution being performed.

079-49.6.2.6 A trainee gets little training from just opening a valve. If this were not true a valve mock-up in a classroom would provide just as much training as standing a training watch. A trainee could open and shut the mockup valve hundreds of times but would not become a competent watchstander capable of performing an integrated procedure on a watch station.

079-49.6.2.7 The trainee should understand the entire evolution that is being performed. The qualified watchstander should ensure the trainee knows enough about the entire evolution to make the need for opening the steam generator vents meaningful to him.

079-49.6.2.8 It is also of value for the operator to learn what the trainee intends to do, so any improper action can be prevented. With a very new trainee, this requirement should be met by having the trainee explain each step in detail before performing it and receiving permission from the operator before performing each individual step. With a trainee who has more experience and is about ready to qualify, this requirement could be met by having the trainee think out loud as he does the operations, but not be required to explain them in detail or receive permission to perform each individual step. If the trainee thinks out loud this should give the operator time to stop any improper action the trainee may be about to take.

079-49.6.2.9 Very few operations on a propulsion plant require instantaneous action by the watchstander. The best training and the best plant operations are achieved if evolutions are carried out in a careful and deliberate manner. The operator should be able to maintain control of a trainee at this pace without difficulty.

079-49.6.3 EOOW RESPONSIBILITY. The EOOW's permission should be obtained for a trainee to be assigned a training watch and the EOOW should be kept informed of which operations are being performed by the trainee. These requirements are based on the fact that trainees can affect the speed with which evolutions are performed and can cause casualties occasionally by their inexperience, or through lack of adequate control by qualified watchstanders.

079-49.6.3.1 The EOOW must have firm control over trainees to properly carry out responsibilities for plant operations. Based on the knowledge and skill level of the trainee, the EOOW may or may not want the trainee to perform certain watch station evolutions. If the EOOW is not kept currently informed of what the trainee is doing or intends to do, this option cannot be exercised.

REAR SECTION

NOTE

TECHNICAL MANUAL DEFICIENCY/EVALUATION EVALUATION REPORT (TMDER) Forms can be found at the bottom of the CD list of books. Click on the TMDER form to display the form.