THROTTLE CONTROL SYSTEM

GENERAL

The throttle control system consists of the mechanism used to control the flow of steam for ahead or astern propulsion. The Control Setting Diagram shows the arrangement of the system as well as information on the setting of the mechanism.

AHEAD STEAM CONTROL VALVES

The ahead steam control valves (see drawing) are located in the steam chest of the high-pressure turbine. The valves are arranged in a split beam in such a manner that the valves will lift off their seats in a specific sequence when the beam is raised by the lift rods. The valves open or close in response to the movement of the ahead operating cylinder piston. Valve stem packing leakoffs are provided where the lift rods pass through the bushings in the valve chest cover.

In case of failure of the control oil system, the valves may be operated by other means in order to control the movement of the ship. Refer to Emergency Operation of Steam Control Valves, Section 3.

Maintenance of the Ahead Valves

It should not be necessary to inspect the valves and seats or the lift rod bushings between regular overhaul or inspection periods. The mechanism should be kept clean, and lubricated in those places specified in the illustration. One spring is furnished as a spare part. If it becomes necessary to replace a spring, slowly back off the nut on the upper spring plate. The spring stud has sufficient length so that the compression of the spring will be relieved before the nut is removed.

ASTERN STEAM CONTROL VALVE

The astern steam control valve (see drawing) is assembled on the end of the steam chest of the high-pressure turbine. The valve opens or closes in response to the movement of the astern operating cylinder piston. A valve stem packing leakoff is located between the valve stem bushings. A needle valve is incorporated in the design of the valve chamber for the purpose of adjusting the steam unbalance on the valve disc.

In case of failure of the control oil system, the valve may be operated by other means in order to control the movement of the ship. Refer to Emergency Operation of Steam Control Valves, Section 3.

Maintenance of the Astern Valve

It should not be necessary to inspect the interior of the valve between regular overhaul or inspection periods. The mechanism should be kept clean, and lubricated in those places specified in the illustration. One spring is fur-

nished as a spare part. If it becomes necessary to replace a spring, slowly back off the nut on the upper spring plate. The spring stud has sufficient length so that the compression of the spring will be relieved before the nut is removed.

ASTERN GUARD VALVE

An astern guard valve is installed in the steam line between the astern steam control valve and the inlet to the low-pressure turbine. This valve is used as an additional means of preventing steam flow to the reversing element during normal ahead operation.

This valve is not manufactured by the General Electric Company. When this valve is furnished by the General Electric Company a drawing of the valve and a parts list is included in Section 6, Accessory Equipment. If accessories are not furnished by the General Electric Company, Section 6 will not be included in this manual.

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DESIGN CONDITIONS AND OPERATING LIMITATIONS

RATED STEAM CONDITIONS

Inlet to the high-pressure turbine	845 psig
	905 FTT
	1.5 in. Hg. Abs.

AHEAD POWER AND SPEED

Maximum rated horsepower	30,000 shp
Speeds at maximum rated horsepower	
H.P. Turbine	6,700 rpm
L.P. Turbine	3,418 rpm
Propeller	128 rpm
Maximum allowable propeller Speed	132 rpm

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Ahead Limitations

During ahead operation DO NOT EXCEED the maximum ALLOWABLE propeller speed. When operating at rated horsepower, the propeller speed must not exceed the maximum ALLOWABLE propeller speed when it is necessary to accommodate such conditions as propeller variations, light draft, etc.

ASTERN POWER AND SPEED

When operating astern, the turbine-gear set can develop 80 percent torque at 50 percent speed relative to maximum ahead power.

Astern Speed Limitations

When operating astern, the turbine-gear set may be operated continuously NOT IN EXCESS of 68 percent of ahead speed at 2.5 inches Hg. Absolute.

ALLOWABLE PRESSURE VARIATIONS

The steam pressure at the turbine throttle valve inlet flange must average not more than rated pressure over any 12-month operating period. In maintaining this average, the steam pressure shall not exceed 110 percent of rated pressure, except during abnormal conditions when the steam pressure may swing momentarily to 120 percent of rated value. However, the aggregate duration of such swings shall not exceed 12 hours per 12-month operating period.

ALLOWABLE TEMPERATURE VARIATIONS

The steam temperature at the turbine throttle inlet flange, and at the reheat inlet flange when included in the design, must average not more than rated temperature over any 12-month operating period. In maintaining this average, the temperature must not exceed rated temperature plus 15°F except during abnormal conditions. The temperature must not exceed rated temperature plus 25°F for operating periods of not more than 400 hours per 12-month operating period nor rated temperature plus 50°F for swings of fifteen minutes duration or less, aggregating not more than 80 hours per 12-month operating period.

EXHAUST PRESSURE LIMITATIONS

When operating ahead or astern the exhaust pressure should never be 1.5 inches Hg. Abs. poorer than that specified above under RATED STEAM CONDITIONS and Astern Speed Limitations.

LIMITATION OF TURBINE OPERATION WITH EXTRACTION LINES CLOSED

Turbines may be operated with feedwater heater extraction lines closed subject to the following limitations.

1. All extraction lines may be closed provided that the turbine-gear output does not exceed the maximum rated horsepower specified above.

2. One or more nonadjacent extraction lines may be closed provided that the turbine-gear output does not exceed the maximum rated horsepower specified above.

3. If adjacent extraction lines are closed, all extractions at higher pressures must also be closed and the turbine-gear output must not exceed the maximum rated horsepower specified above.

LIMITATIONS DURING SINGLE TURBINE OPERATION

During emergency operation when operating the high-pressure turbine only (low-pressure turbine out of service) the first stage shell pressure must be limited to 308 psig.

When operating the low-pressure turbine only (high-pressure turbine out of service) the inlet steam temperature should be limited to 750°F.

PREPARATION FOR GETTING UNDERWAY

START UP OF LUBE OIL SYSTEM

The procedure for starting up the lube oil system is as follows:

1. Make sure that all ahead and astern steam supply and control valves are in the closed position.

2. Check valve positions in lube piping.

   (a) Open all main line valves so that oil flow is not interrupted to the bearings.

   (b) Open all valves in pressure and temperature sensing devices.

   (c) Open all gage valves.

   (d) Make sure that water is available to the oil coolers.

   (e) Open oil cooler isolating valves.

3. Check the quantity and temperature of the oil in the supply tank. The temperature of the oil should not be less than 90 F at the time of getting underway.

4. Check the bearing-oil pressure at the most remote bearing and compare with the pressure shown on the Lube Diagram.

5. Check all sight flows to make sure that there is oil flow to each bearing.

TURNING-GEAR OPERATION AND START UP OF VACUUM SYSTEM

Turning-Gear Operation

At least thirty (30) minutes before steam spinning, perform the following:

1. Check the propeller shaft and line shaft bearings, and seals, to make sure they are in condition for operating.

2. Check the shafting (turbine, gear, and propeller) to make sure all is clear for turning-gear operation.

3. Recheck for correct bearing-oil pressure at the most remote bearing. Recheck all sight flows to make sure that the oil flow to the bearings has not been interrupted.

4. Start the turning-gear operation.

5. Check the operation of the turbine-gear set; listen for any unusual noises. If any unusual noises develop, shut down the turning-gear and refer to the Trouble Analysis Guide.

Start Up of Vacuum System

1. Open shut-off valves to gages and alarm switches.

2. For orifice type continuous drains,

   (a) Open all shut-off valves.

   (b) Close atmospheric drains if used.

3. For trap drains,

   (a) Open trap discharge valves to proper destination.

   (b) Close by-pass lines on traps, and close atmospheric vents.

   (c) Open trap inlet valves when used.

4. For traps that are pressurized, briefly blow down the strainer.

5. Close the shut-off valve ahead of the steam seal regulator.

6. Pressurize the supply line to the steam-seal regulator, and blow down until the line is warmed, using atmospheric vents and trap by-passes.

7. Start the main condenser in accordance with the procedure outlined in the main condenser manual.

8. Start the air removal equipment (air ejectors, vacuum pumps, etc.).

9. As soon as the vacuum has started to rise, start the gland exhauster system.

Start Up of Gland Exhauster System

1. Check the supply line to the steam-seal regulator to be sure the line is dry by briefly blowing down the steam-seal regulator header drain line.

2. Open the shut-off valve ahead of the steam-seal regulator. The steam-seal header pressure should come up to between 2 and 4 psig. It can be expected that over the range of load conditions the pressure setting will vary due to inherent regulation of the control system. As long as the pressure is positive, and steam is not blowing from the glands, the regulator is working satisfactorily.

NOTE: If the steam-seal regulator does not come up to between 2 and 4 psig in the gland seal lines, or the regulator hunts, refer to the Trouble Analysis Guide.

3. Check the packing boxes at the ends of the casings to make sure there is no steam blow. If there is steam blow, recheck the steam-seal header pressure (step 2, above) and the operation of the gland evacuator to make sure all settings have been properly carried out. Also check the drain lines from the gland vent connections.

4. Recheck the steam-seal manifold drains to make sure they are operating properly.

5. Check the vacuum gage to make sure that the vacuum is rising steadily.

FINAL CHECK-OUT OF SYSTEMS

1. Recheck the lube and control oil system; bearing oil pressure, control oil pressure, and sight flows. Make sure that the supply tank temperature is above 90 F.

2. Make sure that the turning-gear operation is continuing properly.

3. Make sure the main condenser vacuum is 10 inches and rising.

4. Recheck the drains, and gage lines, to make sure they are lined up properly.

5. Make sure that the oil temperature to the bearings is held between 110 F and 120 F by proper adjustment of the oil cooling system.

CHECK OF AHEAD AND ASTERN STEAM CONTROL VALVES

1. Make sure that the main turbine header valve is closed, and there is no pressure in the line between this valve and the turbine steam chest.

2. Operate the ahead and astern steam control valves through full stroke to ensure they are functioning properly.

3. Close the ahead and astern steam control valves.

4. Pressurize the main steam supply line to the ahead and astern steam control valves. Be sure the drains are operating properly so as not to build up water in this line, or in the turbine valve chest.

5. Blow down the main steam strainer.

OPERATION OF THE TURBINES

WARMING UP THE TURBINES

Before starting this operation it should be determined that there is no intereference around the propeller, and the personnel have been warned that steam spinning of the rotors is about to begin.

NOTE: Make sure there is no steam blow from the packing boxes at the ends of the casings. This type of operation could result in increased maintenance.

1. Open the astern guard valve.

2. Take the unit off turning gear.

3. Within one minute after step 2 spin the rotors alternately ahead and astern in the following manner:

   (a) Open the ahead throttle and bring the speed of the shaft up to no more than five to ten percent of ahead speed. Then,

   (b) close the ahead throttle and open the astern throttle and bring the astern speed up to no more than five to ten percent of ahead speed. Then,

   (c) close the astern throttle and open the ahead throttle to repeat the (a) and (b) cycle which should take approximately one minute.

4. Continue this mode of operation for thirty-five (35) or forty (40) minutes. During this operation, listen for unusual noises, check all oil pressures, and gland seal pressures.

5. After the time established in step 4 has elapsed, close the ahead and astern valves.

The propulsion unit is now ready for the UNDERWAY signal.

NOTE: Do not allow the turbine rotors to remain stationary any longer than one minute after coastdown from step 5. If the time for getting underway has been extended, it is necessary to maintain an even temperature in the turbines, and prevent bowing of the shafts. This is done by applying either ahead or astern steam, at least once a minute, to rotate the shafts at no more than five to ten percent of rated ahead speed. Close the throttle when this speed is reached.

EXTENDED STANDBY

If the departure time is delayed more than one hour, return the set to turning-gear operation. However, during this period take the set off turning gear once every half hour and steam-spin the rotors alternately ahead and astern for 5 minutes; then return to turning-gear operation. Also during this period, vacuum should be kept up and sealing steam maintained.

At any time the set may be taken off turning gear and immediately answer the UNDERWAY signal.

UNDERWAY (Normal Conditions)

It is recommended that full power should be built up gradually over a period of ten to twenty minutes. However, if it is necessary to answer bells calling for greater than half speed during this interval, listen for unusual sounds and vibration. If unusual operation is detected, reduce speed until the condition clears.

After warm-up, there is no restriction on the speed with which the ahead and astern valves may be operated. However, the operator should be aware of boiler conditions to avoid water slugs entering the turbines.

Ahead and astern valves may be operated simultaneously during very rapid transients to reverse rotation of the shaft as this type of operation tends to reduce sudden demands on the boiler. However, both valves should not be open simultaneously for more than one minute.

1. Check the oil temperature to the bearings. The temperature should be held between 110 F and 120 F by proper adjustment of the oil cooling system. The temperature of the oil at any bearing discharge should not exceed 180 F. The temperature rise of the oil passing through any bearing should not exceed 50 F.

2. Test the Overspeed Relays at the first opportunity when operating at speeds above 90 percent of normal rated speed.

UNDERWAY (Emergency Conditions)

Under emergency conditions it may be necessary to get underway very quickly. Under this type of operation, the warm-up procedure may be bypassed, the set taken off turning-gear operation, and within one minute answer UNDERWAY signals up to 40 percent speed.

When operating under these conditions, the turbines should not be brought to more than 60 percent speed in less than 40 minutes, or to full power in less than one hour.

Since this is an unusual mode of operation, the turbines should be constantly monitored for vibration or unusual noises. If vibration or noise is detected, the speed should be reduced until the condition clears.

This method of getting underway is not desirable, and if practiced frequently could result in increased maintenance on the turbines.

STEADY STEAMING TO MANEUVERING

Before going into a maneuvering mode the steam control valves (ahead, astern, and astern guarding) should be exercised to make sure there is no deposit on the valve stems that will prevent them from functioning properly. This check should be made sufficiently ahead of the maneuvering mode so that corrective action can be taken to make sure the valves will be in good operating condition.

When the operation is to change from steady steaming to maneuvering, OPEN THE ASTERN GUARD VALVE.

After the guard valve is open, check the following, preferably before going into the maneuvering mode.

1. See that steam drains are operating properly. Hand operated drains should be open. (See MONITORING TABLE 3-1). If a drain is found to be plugged, avoid large rapid load changes, if possible, until the drain is corrected.

2. See that the circulating water for the main condenser is lined up for maneuvering operation.

NOTE: During the maneuvering mode do not allow the turbine rotors to remain stationary any longer than one minute. It is necessary to maintain an even temperature in the turbines and prevent bowing of the rotors. Apply ahead or astern steam at least once a minute, or keep the rotors turning slowly if the maneuvering condition permits this type of operation.

There is no restriction on the speed with which the ahead and astern valves may be operated. However, the operator should be aware of boiler conditions to avoid water slugs entering the turbines.

Ahead and astern valves may be operated simultaneously during very rapid transients to reverse rotation of the shaft as this type of operation tends to reduce sudden demands on the boiler. However, both valves should not be open simultaneously for more than one minute.

SECURING THE TURBINES

1. Check to be sure that ahead and astern steam inlet valves and the astern guard valve are closed.

2. As soon as the shaft has stopped turning start the turning-gear operation. Make sure that oil is flowing freely to all bearings.

SECURING THE SYSTEMS

After the turbines have been on turning-gear operation for thirty (30) minutes, the vacuum and steam seal systems should be secured. The valves in the drain systems should be lined up in accord-

ance with shipboard procedure. Do not secure the lubrication system until after the turning-gear operation has been completed.

Vacuum System

Secure the air removal equipment (air ejectors, vacuum pumps, etc.) in order to reduce vacuum.

Gland Exhauster System

After the vacuum has dropped to 5" Hg,

1. Close the valve in the supply line to the steam-seal regulator.

2. Shut off the gland exhauster system.

3. Close the main steam line valve to isolate the turbines from boiler pressure.

Lubrication System

1. Leave the turbines on turning gear until the temperature of the oil leaving the bearings is within 15 F of the oil entering the bearings.

2. When the condition in step 1 has been met, stop the turning-gear operation.

3. Shut down the lube system.

4. Secure the water to the lube oil cooler.

There is no need to rotate the shafts of the propulsion machinery after it has been secured, unless it is desirable to do so to prevent build-up on the propeller shaft. In this case the oil system should be put in operation, and the turbines put on turning gear. The oil should not be heated in order to prevent condensation within the machinery casings.

Once a month, circulate oil to the turbines and gears; however, do not heat the oil in order to prevent condensation within the machinery casings.

MONITORING WHILE UNDERWAY

The propulsion machinery should be monitored so that any malfunctioning of the equipment will be evident before serious damage can occur. The table below shows what should be checked, how often, and the frequency of logging the information.

Items designated as ESSENTIAL should be connected to alarms. These items require constant attention as they affect the immediate operation of the ship. Items designated as DIAGNOSTIC do not require such constant monitoring, and the observation periods and logging intervals vary with the items.

TABLE 3-1

MONITORING

ITEM	OBSERVE	LOG
ESSENTIAL		
Oil pressure at most remote bearing Oil level in supply tank Main steam temperature Vibration Exhaust pressure - vacuum High hot-well level (only with axial flow condensers)	Once a watch and during changes in operating mode ↓	Once a watch and during changes in operating mode ↓
DIAGNOSTIC		
Oil discharge - flow to bearings Oil temperature - discharge from bearings	Once a watch ↓	Once a day ↓
Rotor position indicator	At the beginning and end of each watch	Once a voyage - at startup and steady steaming ↓
Steam pressure at turbine inlet Stage pressure and temperature Steam-seal pressure	Once a voyage ↓	
Oil contamination	At startup and once a week	
Drains working properly	Not more than one day ahead of starting a maneuvering mode	

EMERGENCY OPERATION USING ONE TURBINE

PREPARATION

If either the high-pressure or low-pressure turbine becomes inoperative for any reason, the piping of the crossunder assembly must be changed to permit continued operation on the remaining turbine. The arrangement of the crossunder piping for normal operation, and for operating either the high-pressure or low-pressure turbine only, is shown on the Outline Drawing.

The rotor of the disabled turbine must be uncoupled from the reduction gear and the turbine rotor secured to keep it from rotating or moving axially because of sea conditions (see Step 4 below).

Before uncoupling the rotor, close the ahead and astern handwheels and lock them closed. It is further recommended that the steam inlet valves to the turbine be mechanically secured to prevent them from being opened.

If possible, do not secure the oil flow through the bearings in order to uncouple the turbine until the temperature of the oil leaving the bearings is within 15 F of the oil entering the bearings.

UNCOUPLING THE ROTOR

To uncouple the rotor of the disabled turbine from the reduction gear proceed as follows:

1. Secure the lube system to the bearings.

2. Remove the upper-half coupling guard on the first reduction pinion.

3. Remove the aft bearing cap of the turbine.

4. Remove the upper-half aft journal bearing and lay a clean piece of 1/32 inch gasket paper over the top half of the journal.

5. Replace and bolt down the upper-half journal bearing. The gasket paper will cause a pinch fit between the bearing and shaft and will prevent the shaft from moving.

6. Unbolt the coupling sleeves from the pinion and turbine rotor and lift out the sleeves and the distance piece. Preserve these parts to prevent rusting and damage.

7. Replace the bearing cap and the upper-half coupling guard.

8. Resume oil circulation through the bearings.

NOTE: A CAUTION tag should be attached to the aft bearing cap noting that gasket material is under the upper-half bearing and must be removed before returning the turbine to service.

RESUMING OPERATION

CAUTION: See Design Conditions and Operating Limitations for steam