Appendix-5

Periodic Inspection Procedure for Boiler and Turbine

Appendix-5 Periodic Inspection Procedure for Boiler and Turbine

- Contents -

1. Periodic boiler inspection procedure

(1) Boiler

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
a. Boiler drum	1. Remove a required number of steam separators in the inspection, and conduct visual inspection inside the drum and liquid penetrating test of the weld line inside the drum. 2. If the nozzle stub internal surface weld zone is not provided with smoothing, remove a required number of steam separators in the inspection, and conduct visual inspection and liquid penetrating test of the nozzle stub internal surface weld zone. If the ends of the internals installation weld zone are not machined to have curvatures, conduct visual inspection and liquid penetrating test of that section. If the nozzle stub internal surface weld zone is provided with smoothing, mount the steam separator and perform the test. The weld zone must be subjected to liquid penetrating test if it can be inspected at all.	1. During disassembling (1) Deposits and adhered substances a) Positions (distribution) b) Color (external appearance) c) Thickness or volume d) Composition (sampling, chemical analysis) (2) Corrosion and erosion Measure the volume of corrosion on the test piece if there is any. (3) Installation condition of internals and other parts a) Inspect bolts and packings. b) Inspect installation of the feed water internal tube penetrations. 2. After cleaning and adjustment (1) Cracks, corrosion and erosion a) weld lines and weld zones b) Man holes c) Water level gauge, pressure gauge d) Nozzle stub and feed water internal tube penetrations e) Tube expansions f) Around the drain hole g) Around the water level for normal operation (2) Checking the tube for closure or clogging a) Communication tubes for water level gauge and pressure gauge b) Drain and blow tube c) Chemicals supply tube d) Feed water internal tube (3) Sealing of internals seat surface Cracks, corrosion, erosion on the installation weld position (4) Damage on man hole sheet surfaces 3. During assembling and after completion (1) Make a final confirmation to see if there is any defect in connections.	1. Disassembling (1) Open the man hole. Replace the packings. (2) Man hole Mount the dust proof wire netting (about 120 meshes) or sheet to prevent dust from entering. (3) Measure oxygen concentration (to protect against oxygen shortage) (4) Use of safety work light Use a guarded low voltage electric light (5) Protecting the tube openings Mount the molded ion plate or spreading sheets below the drum. (6) Disassembling the planned internals 2. Cleaning and adjustment (1) When entering the interior, use clean working uniform and footwear. Take care not to drop things into the tube and tube. (2) Take only a minimum number of required tools with you when you enter inside. Do not drop or leave them in the tube or tube. (3) Clean inside using a nylon brush and rags. (4) Do not damage the bright black oxidized film. (5) Do not dent the metallic surface. (6) Use a vacuum cleaner for finish cleaning of the interior. Do not use water unless absolutely essential. (7) After cleaning the inside, normally keep the cover closed. (8) Internals a) Take care not to damage the bolts and nuts to be removed. Count the number of these bolts and nuts. b) Adjust the sheet surface and clean the tube hole of the internals to remove clogging. c) To prevent them from being rusty, dry the internals immediately after they are removed. If necessary, clean them with a nylon brush, warm water or compressed air. After drying, cover them with sheet and keep them in storage. d) Finish the man hole sheet surface with a scraper and sand paper as required.	1. Operation items and cautions (1) Record the details of deposits and adhered substances, as well as the position and dimensions of corrosion and erosion if any. If necessary, take a photograph of them to provide a guideline information for the secular change or next periodic inspection. (2) Put the composition of deposits and adhered substances to chemical analysis as required, and arrange the results of analysis in chronological order to provide information for treatment of feed water and boiler water. (3) Record the positions and dimensions of the cracks and corrosions, and check them against the previous records to confirm their development, thereby providing information to determine the scope of the next disassembly and inspection or to take some other measures. For example, the position of the drum weld zone suspected of having cracks as a result of liquid penetrating test must be subjected to magnetic particle test. Take appropriate actions as required. (4) Liquid penetrating test or precision test implementation procedure a) Remove the internals on a planned basis in the inspection, and conduct liquid penetrating test of the weld zone. b) Conduct a magnetic field test if any failure has been detected in liquid penetrating test, operation has been performed for 100,000 hours or more or some other needs have arisen. For the joints of different metals, it is preferred to make a precision test such as microstructure test. c) After completion of liquid penetrating test, wipe off the liquid immediately. (5) To check irregularities over an extensive range on the internal surface of the drum, apply light in the longitudinal direction from both ends of the drum, and confirm changes in shape. (6) If corrosion, erosion and other progressive defects have been found in dimensional inspection record, prepare a specified inspection sheet whenever required, and determine a fixed point; record the inspection result and observe the secular change on the continuous basis. (7) Check the outer surface of the heat insulated portions at the of heat insulation repair. 2. Secular change and reference items (1) Pitting or grooving is likely to occur at the positions close to drum water line, bottom or weld zone due to poor water quality. (2) Cracks may occur to the weld zone in the drum due to low-cycle fatigue caused by thermal stress. (3) Cracks are likely to occur to the nozzle stub inner surface corners of the downcomer and feed water tube, the weld zones of the inner and outer surfaces (longitudinal joint and circumferential joint), support fittings and internals installation weld zones due to low-cycle fatigue caused by thermal stress.

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
			3. Assembling and recovery (1) Determine the procedures to install the internals. Install them firmly according to the specified sequence. Do not use seizure preventive agent. (2) Take adequate corrosion preventive measures as required. (3) Use extreme care to assemble the air-tight section of the parts to be installed. (4) Check the tools and bolts for quantity before going inside. Take care not to drop things into the opening of the water tube. (5) Replace packings with new ones, and use the internals installation bolts and nuts which are carefully kept under satisfactory conditions. (6) Carefully confirm that the interior is free of foreign substances or things left behind.	(4) Pitting and cracks due to corrosion and fatigue are likely to occur to the inner surfaces of the drum feed water hole and downcomer nozzle stub. (5) Stress corrosion and cracks due to tube reaction are likely occur to the safety valve and feed water nozzle stub, and cracks due to friction or thermal fatigue are likely to occur to the lifting lug. (6) When such defects as cracks, corrosion and erosion have been found, record them accurately, check them for causes and take appropriate measures to avoid progress of the defects. a) Remove pitting by the grinder immediately to avoid progress. b) Remove fine cracks by the grinder if possible. 3. Special precision test The following special precision test must be conducted: (1) Select representative positions from the weld zones on the nozzle stub outer surface, longitudinal joint and circumferential joint, and conduct magnetic particle test. (2) Remove a required number of the internals installed by welding, and conduct magnetic particle test of the weld zones of the nozzle stub inner surface.
b. Header (Furnace, economizer, supercharger, reheater)	1. The following inspection must be conducted at the time of the inspection: (1) Inspect the appearance of the header and lifting hook. (The heat insulating materials need not be removed.) (2) Select representative positions and conduct liquid penetrating test of the nozzle stub weld zone and support fittings weld zone. (The items to be tested are those having been used for about six years after commencement of commercial operation.) (3) Select representative positions including other headers to check inside. (4) Inspect the appearance of the header and lifting hook. (The heat insulating materials need not be removed.)	1. When disassembling: (1) Deposits and adhered substances a) Position (distribution) b) Color (external appearance) c) Thickness or volume d) Composition (sampling, chemical analysis) (2) Faults of inspection hole cover and sheet (3) Damage or deformation of the header and support/lifting hook (Check the appearance.) (4) Leakage from weld zones 2. After cleaning and adjustment (1) Cracks, corrosion, erosion (2) Leakage from weld zones (3) Damage of inspection hole sheet	1. Disassembling (1) Releasing the inspection hole a) Grind the weld zone of the hand wheel seal. b) When cutting the inspection hole nipple, cut off the central portion of the weld padding. (2) To prevent foreign substances from entering the inspection hole after cutting, seal the hole with tape or similar material. (3) When checking inside, use a electric lamp with wire netting or an inspection mirror. Check the details carefully. 2. Cleaning and adjustment (1) To clean inside the header, follow the boiler drum cleaning procedure, and use the cleaner whenever required. (2) When the inspection hole nipple is cut off by gas, use the magnet or similar tools to remove all the residues which have entered inside. (3) Clean the sheet surface of the inspection hole or the like, using a scraper or similar tool. (4) Take care not to allow the metallic surface to be dented. After cleaning inside, close it normally except when it must be opened.	1. Operation items and cautions (1) Intervals for header internal inspection a) Some boilers have particularly a great number of headers of the supercharger and economizer, depending on the type and structure of the boilers. In the case of such boilers, it is preferred to select the representative positions to be opened, depending on operating conditions and the quality of feed water and boiler water, on the basis of inspection experience, and to make an internal checkup of all items in every 100,000 hours. b) For the boilers of the same type, same age and same specifications, it may be allowed to inspect one of them, depending on the experience with several periodic inspections and operating conditions, and to omit the inspection of the others, except for the lower header. c) When opening inspection holes, it must be so planned as to ensure easy inspection with illumination by opening both ends of more than two holes at one time. d) When the water tube and supercharger have been cut off, check the header interior whenever required. e) Check the outside of the heat insulated portion when repairing heat insulations. (2) Select representative positions to inspect the weld zone for installation of the header, nozzle stub and lug, by considering the positions which have been subjected to troubles or the positions subjected to severe thermal stress. It is preferred to check them carefully in liquid penetrating test. (3) Observing the cracks, corrosion and erosion. After the inspection, record the conditions of the tested positions and check the records against the previous ones. These records, together with the result of chemical analysis of deposits and adhered substances, will be used to provide guiding information for the next disassembly and inspection, evaluation of the scope of inspection and treatment of boiler feed water.

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
		3. During and after assembly (1) Make sure that welding is complete and there are no defects as pinholes and undercuts. (2) In the hydraulic test, make sure that there is no leakage.	3. Assembling and recovery (1) Check to see that there is no foreign substance. (2) Replace the packings in inspection holes and the like with new ones, and tighten them uniformly and carefully. (3) For the butt welding, conduct welding groove inspection. Welding must be performed carefully (by qualified personnel).	2. Secular change and reference cases (1) Cracks are likely to occur to the headers of the furnace, supercharger and reheater due to low-cycle fatigue caused by thermal stress and high temperature creep. (2) Cracks are likely to occur to the weld zone of the nozzle stub of the furnace, supercharger and reheater due to low-cycle fatigue caused by thermal stress. (3) Cracks are likely to occur to the weld zones of the support fittings of the furnace, supercharger and reheater due to low-cycle fatigue caused by thermal stress and tube reaction. (4) Cracks are likely to occur the lower header on the side of the furnace, surface of the furnace, supercharger tube header, tube hole of the inner surface and outlet nozzle stub weld zone due to heat cycle fatigue. (5) Cracks are likely to occur to the inner surface of the lower header of the economizer and the like due to corrosion fatigue caused by deposition of sludge and dissolved oxygen. (6) The inner surfaces of the furnace, supercharger and reheater headers are likely to be corroded due to poor water quality and stagnant drain during storage. (7) The outer surfaces of nozzle stubs of the furnace, supercharger and reheater headers, as well as the support fitting weld zone, are subjected to low temperature corrosion by corrosive thermal gas. (8) It is recommended to diagnose the remaining service life of the header and header nozzle stub after 100,000 hours of cumulative operation time or 2500 cumulative starts. 3. Special precision inspection Select the representative weld zones on the outer surface of the longitudinal joint and circumferential joint of the header, and conduct the magnetic particle test.
c. Tube (a) Furnace tube	1. In the inspection, build a scaffold up to the necessary level, and conduct the following test: (1) Visually check the tube. (2) Select the representative position of the weld zone of the metallic substance attached to the tube, and perform liquid penetrating test. (3) Measure the wall thickness	1. Disassembling (1) Deposits and adhered substances on the surfaces inside and outside the tube a) Position (distribution) b) Color (external appearance) c) Thickness or volume d) Composition (sampling, chemical analysis) (2) The effect of the soot blower and damage by diffusion (3) Leakage from the weld zone cracks, corrosion and erosion (4) Disarrangement and swelling of tubes	1. Disassembling (1) Install the scaffold with sufficient consideration given to safety and workability based on the Industrial Safety and Health Law. (2) When building (or disassembling) the scaffold, take care not to damage the water tube. (3) Put on the safety hat, protective goggles, safety helmet, dust preventive mask and lifeline. (4) Ensure effective ventilation, and measure oxygen concentration to protect against oxygen shortage as required. (5) Prepare the hammer and other required tools, and perform precise inspection under effective illumination.	1. Operation items and cautions (1) It is preferred to select the test positions of the tube and to conduct a tube sampling test and non-destructive test, giving consideration to thermal load and other conditions. (2) Tube sampling test and intervals of the test Select the position of the tube on the burner level which has a great thermal load and has been found to be abnormal in the appearance and wall thickness test, and conduct a tube sampling test. Check the thickness of the deposits and adhered substances, properties, corrosion and metallic structure, thereby providing data for evaluation of chemical cleaning, water treatment and tube updating. It is recommended to sample and inspect the test tube every two years and to check the internal conditions. However, it is preferred to make inspection very year until the trend of scale deposition is known after commencement of commercial operation (3) In the visual inspection of the tube, check for cracks, corrosion, wear and disarrangement of the bank of tubes. Record the results of inspection using qualitatively and quantitatively objective methods such as photographing, drawing and analysis, thereby providing a guiding information for repair, modification, and the next periodic inspection.

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
		(5) Burnout and deformation of the distance pieces and support fittings (6) Furnace materials and refractories (7) Check inside the water tube through the boiler drum interior and the header inspection hole wherever possible. 2. After cleaning and repair (1) Cracks, corrosion and erosion (2) Disarrangement, curvature and swelling of the tubes (3) Weld zones and tube expansions (4) Burnout, deformation or cracks of the fin, seal fittings, distance piece, screen tube hanging lug and support fittings (5) Wear or damage due to jet flow of the soot blower (6) Damage of the protector (7) Furnace materials and refractories (8) Elongation (9) Measurement of wall thickness (checking the secular changes of reduced wall thickness) (10) Sampling test by cutting off the tube a) Scale deposit by photographs showing thickness, amount and composition analysis b) Inspection of metal structure and mechanical strength of the material as required c) Measurement of outer diameter and wall thickness d) Scale chemical washing dissolution test (11) Non-destructive test of the required positions 3. During and after assembly (1) Make sure that welding and repair are perfectly completed. a) Check for such defects as pinholes and undercuts. b) Liquid penetrating test c) Radiographic test as required (2) Check if there is any curvature. (3) Check to see that all specified positions have been repaired. (4) In the hydraulic test, confirm that there is no leakage.	2. Cleaning and adjustment (1) Cleaning the tube outer surfaces Depending on hardness and deposition of ash, clean the tube outer surfaces using the scraper, wire brush or compressed air. In the case of heavy oil fired boilers, consider use of warm water or steam washing for cleaning. (2) Cleaning the tube inner surfaces Cleaning the tube inner surfaces by hot water jet washing, tube cleaner or chemical washing, depending on the conditions of deposits and adhered substances. (3) Carefully clean the positions which have been found faulty as a result of the test. Precision inspection must be conducted. (4) Measuring the wall thickness Completely remove deposits from the positions to be measured. Careful finishing and accurate measurement must be provided according to the specified measuring procedure. (5) Tube sampling test a) Remove the outer casing heat insulator. b) Remove the skin casing. c) Cut off the tube. Use a cutter or file to cut it off. Ensure that chips can be easily discharged by washing with water. Do not use gas. Take care not to allow the foreign substances to be dropped inside the tube. Carefully handle the cut tube so that scale will not be peeled off. Enclose both ends with tape. d) Finish the welding groove to specified dimensions. e) Carefully weld the new tubes. Use the acid creared tubes. f) For the high pressure boiler, radiographic test must be conducted to evaluate acceptance or rejection. g) Test the sampling tubes. 3. Assembling and recovery (1) Welding in repair work must be performed carefully (by qualified personnel). (2) Take a sufficient care not to allow entry of foreign substances.	(4) In the inspection of corrosion and erosion, priority must be placed on the inspection of the baffle hearth and its surrounding area as well as tube penetration areas of the castable. The penetration area with the refractories, the water tube at the furnace internal corners in particular, is likely to absorb moisture. After cleaning, take care to keep it dry and prevent it from being wet. (5) The water-cooled wall tube in the furnace (especially the position close to the burner with high thermal load) must be checked for cracks, corrosion, wear, local overheat and swelling. Conduct non-destructive test such as liquid penetrating test, radiographic test or ultrasonic test, as required. (6) Measure the wall thickness on a continuous basis in conformity to the structure and type of the boiler. Compare the results with those of previous measurements, thereby to provide guiding information for the subsequent requirements. (7) Regarding the frequency of chemical washing, type of fuels and water treatment method, check the amount of scale in the tube sampling test and the properties of the scale, and work out the test schedule and testing method, with consideration given to the tube wall temperature and operation time during operation. Chemical cleaning should preferably be determined according to the permissible amount of the scale deposited on the inner side of the furnace. Before determining it, carefully consider the chemical factors related to the thermal factor of the permissible amount of the scale and generation of the scale and the result of tube sampling test. 2. Secular change and reference cases (1) Cracks are likely to occur to the weld zones of the fitting attached to the tube and steam generating tube due to low-cycle fatigue caused by thermal stress. (2) Cracks may occur due to corrosive fatigue caused by alkali corrosion, hydrogen attach and oxygen corrosion at the high temperature loaded section. (3) Overheat swelling may be caused by a rise in metal temperature due to scale deposition at the high temperature loaded section, and by overheat due to resultant reduction of creep service life of the tube or reduced water level and clogging of foreign substances and film boiling at the time of startup. (4) Overheat caused by deposition of the scale on the inner surface of the deflection arch tube and creep rupture may occur. (5) Thermal fatigue rupture is likely to be caused by differences in temperatures between the root of the tube bend fin for the soot blower lancing hole, installation frame at the burner/wind box interface (connection), and steam generating tube. (6) Stress corrosion cracks are likely occur inside the furnace tube. (7) Rupture by jetting may be caused by a combination of ash cut and tube bend wall scratch. (8) Damage by mechanical fatigue may be caused by vibration during the operation of the soot blower including the screen tube hanging lug. (9) Cracks may occur due to low cycle fatigue by thermal heat.

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
				(10) It is recommended to diagnose the remaining service life of the tubes having a temperature exceeding the design temperature of 450 degrees Celsius, after 100,000 hours of cumulative operation time or 2500 cumulative starts.
(b) Superheater, reheater and economizer tubes	1. At the time of inspection, perform the following: (1) Visually inspect the superheater, reheater and economizer tubes. (2) Select the representative points of superheater, reheater and economizer tubes and measures the wall thicknesses (3) Select the representative points of the different material joints not using the Inconel based welding rod, and conduct liquid penetrating test. (4) Select the representative points of the weld zones of the fitting attached to the tube, and conduct liquid penetrating test.	1. During disassembling (1) Deposits and adhered substances on the surfaces inside and outside the tube a) Position (distribution) b) Color (external appearance) c) Thickness or volume d) Composition (sampling, chemical analysis) (2) The effect of the soot blower (3) Leakage from the weld zone, and cracks, corrosion and erosion 2. After cleaning and repair (1) Check Cracks, corrosion and erosion Check especially for vanadium attach. (2) Disarrangement, curvature and swelling of the bank of tubes (3) Leakage from weld zones (4) Burnout and deformation of the fin, distance piece and support fittings, and such defects as blow-holes and undercuts on fin weld zones (5) Burnout of the fin and seal fittings (6) Wear or damage due to jet flow of the ash and soot blower (7) Damage of the protector (8) Such defects as corrosion and elongation of ceiling penetrations and lifting hook (9) Burnout of refractories (10) Burnout of eddy current protective plate (11) Measurement of wall thickness and outer diameter (checking the secular changes of reduced wall thickness) (12) Sampling test by cutting off the tube a) Scale deposit inspection (thickness, amount and composition analysis) b) Inspection of metal structure and mechanical strength of the material as required c) Measurement of outer diameter and wall thickness	1. Disassembling (1) Check if repair, cleaning or inspection is required. Also determine the scope of the building the scaffold, depending on the degree of necessity. (2) Install the scaffold with sufficient consideration given to safety and workability since the work is to be done at elevated positions. (3) Take care not to damage the outer surface of the tube. (4) Put on the safety helmet, protective goggles, dust preventive mask and lifeline. (5) Prepare the hammer and other required tools, and perform precise inspection under effective illumination. 2. Cleaning and adjustment (1) Cleaning the tube outer surfaces a) Checking the steam temperature before stop and the frequency of using the soot blower, and determine how far cleaning is required. b) Depending on hardness and deposition of ash, clean the tube outer surfaces using the scraper, wire brush or compressed air. c) In the case of heavy oil fired boilers, consider use of warm water or steam washing for cleaning. Scrape the missing portions of the refractory sufficiently and replace it with new ones. (3) check the damaged position for the cause, and provide a build-up welding or replace the tube and accessories on that portion. (4) The portion exposed to high temperature for design and the tube having discolored surfaces must be checked carefully for deposition of SUS scale, overheat and degree of wall thickness. [SUS scale inspection procedure] a) Measure the thickness of the scale deposition at the lowest position of the bend by radiographic test. b) When the scale has deposited to 50 percent or more of the inner diameter, remove the scale by free blowing outside the steam system or by cutting of the tube. (5) Measurement of wall thickness Completely remove the deposits and adhered substances from the position to be measured, and provide adequate finishing carefully in conformity to the specified method. The measure the wall thickness accurately.	1. Operation items and cautions (1) To prevent corrosion due to high temperature in the heavy oil fired boiler, it is preferred to provide chemical analysis of deposits and adhered substances on the outer surface as required, and to conduct non-destructive test such as measurement of the wall thickness. (2) The portion where the tube penetrates through the refectories must be carefully checked for corrosion or allowance for expansion. (3) To prevent superheater tube from being disarranged, carefully check the sliding with the support or the function of the slide base. In the base of a suspended type supercharger, check the U-bend carefully. (4) The positions likely to be subjected to corrosion due to stress such as weld zones and distance pieces must be checked on a priority basis. (5) Record the positions and details of cracks, corrosion and wall thickness (by photographs), and arrange the records in a chronological order to provide reference information for the next inspection and repair schedule. (6) If any abnormality is found in the amount and properties of the scale and the scale deposited on the turbine blade, study the boiler water quality, de-superheater spray water quality, and the requirements and method of chemical cleaning, and work out appropriate measures. 2. Secular deterioration and reference cases (1) Austenite based stainless steel used for the superheater and reheater is likely to be corroded by the carbide segregated onto the grain boundary during the long-time use. Accordingly, abnormal intrusion of Na, Cl and Po4 salts, if condensed in the element, may results in stress corrosion cracks. (2) When steam temperature is 540 degrees Co or more and the tube wall temperature is 620 degrees Co or more, scale is likely to occur on the inner surface of the stainless steel tube due to steam oxidization. It may peel and deposit at the time of start and stop, resulting in overheat and creep rupture. (3) When much V, Na and S are contained in the fuel in the case of high temperature tube and attached metal, corrosive composite salts having a comparatively low melting point may be generated by the combustion gas, and the wall thickness may be reduced by so-called high temperature corrosion. To prevent this, external wear and loss must be checked. (4) Reduction in wall thickness and rupture by jetting may be caused by ash cut. Check the outer surface for wear and measure the wall thickness. (5) Broken holes may occur due to welding defects such as the blow hole of the build-up weld zone. (6) Low-cycle fatigue cracks are likely to occur to the surface on the side of the flame of the foremost tube of the plate type reheater, and cracks may occur to the distance piece and weld zone due to liquid phase corrosion and stress concentration due to thermal stress.

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
		3. During and after assembly (1) Make sure that welding and repair are perfectly completed. a) Check for such defects as pinholes and undercuts. b) Check the weld zone of the slide spacer. c) Conduct liquid penetrating test of the weld zone. (2) Check if there is any curvature. (3) Make sure that all positions are perfectly repaired. (4) In the hydraulic test, make sure that there is no leakage.	(6) Tube sampling test Same as the test for water tube and steam generating tube 3. Assembling and recovery (1) Repair of the damaged portion, welding work in particular, must be performed by qualified personnel. (2) Carefully repair each portion, and dry the refractories and insulating materials.	(7) Cracks are likely to occur to the final outlet tube T piece of the superheater and reheater, caused by low cycle fatigue and high temperature creep due to tube reaction and thermal reaction. (8) Material deterioration may be caused by a long-term use, so pick out the sample and confirm the strength deterioration. (9) Wear, erosion, corrosion and cracks may occur due to leakage of drain from the soot blower. (10) The inner surface of the economizer tube is like to be corroded by poor water quality. (11) Low cycle fatigue cracks are likely to occur to the Inconel based welding rod which does not use the weld zone of the dissimilar material joint. (12) Low cycle fatigue cracks are likely to occur to the fitting attached to the tube due to thermal stress. (13) It is recommended to diagnose the remaining service life of the superheater and reheater after 100,000 hours of cumulative operation time or 2500 cumulative starts
d. Safety valve (Steam drum, supercharger, reheater, pressure relief unit and startup bypass)	In the inspection, disassemble and inspect the valve and conduct the operation test after assembling.	1. Inspection item during disassembling (1) Inclusion of foreign substances, and damage of the valve body and valve seat (2) Cracks on weld zones of the valve casing and valve installation tube seat (3) Curvature of the valve rod, seizure at the top end, wear and clearance (4) Seizure, wear and clearance of the slide portion and adjust ring (5) Defects of the spring, adjust screw and bolt 2. Inspection item after cleaning and adjustment (1) Inclusion of foreign substances, damage of the valve body and valve seat, and cracks of molten metal (2) Defect of the valve casing and cracks of the weld zone (3) Curvature of the valve rod, seizure at the top end, wear and clearance (4) Wear and clearance of the slide portion and adjust ring (5) Defects of the spring, adjust screw and bolt (6) Corrosion and damage of the silencer 3. During and after assembling (1) Make sure that the interior is free of foreign substances or things left behind. (2) Check the lift for clearance.	1. Disassembling (1) Check each part after disassembling. When disassembling put matching marks to the position of the adjust ring. (2) Record the set dimensions. 2. Cleaning and adjustment (1) Use the rags and detergent to wipe the valve casing, and use compressed air to clean it. (2) The valve body and valve seat must be subjected to liquid penetrating test and adjustment by fitting, as required. (3) Check the valve body and seat for allowance after fitting. (4) Clean the drain hole adjust ring of the valve seat and valve casing with special care. (5) Clean the rain water drain hole of the exhaust tube. 3. Assembling and recovery (1) Assembling must be done according to the set dimensions at the time of disassembly and position of the adjust ring. (2) Apply grease to the positions between the top end of the valve rod and the disk, and between the lower panel rest and blow-out pressure adjust screw. (3) Take extreme care not to damage the seat surface.	1. Operation items and cautions (1) Take particular care in checking inclination of the seat surface and eccentricity of each part. (2) It is preferred to check the valve casing and spring by magnetic particle test and liquid penetrating test as required. (3) Conduct operation test when the safety valve has been disassembled. Use the hydraulic jack for operation test. 2. Secular deterioration and reference cases (1) Operation failure of the safety valve may be caused by defects of the tube on the exhaust side, in addition to inclination and wear of the seat surface, defects of the assembly dimension, the clearance defect of the sliding part and adjust ring, and the damage of the seat air tightness. (2) Leakage is often caused by cracks of molten metal on the valve and valve seat due to thermal impact, as well as by the damage of the air tight surface due to scale foreign substances at the time of blow-out. (3) When operation failure is caused by the secular deterioration, replace or repair parts, or replace the valve. (4) Cracks may occur to the valve casing, valve body and valve seat due to the low cycle fatigue caused by thermal stress.

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
		(3) To start the boiler, perform operation test of the blow-out pressure, closing pressure and blow down pressure of each valve, and make sure that accurate operation is obtained at the specified pressure.		
e. Main valve (with the valve body and valve seat seriously damaged)	Disassemble and check the valves for inspection.	1. During disassembling (1) Deposits and adhered substances in the valve body and valve casing (2) Damage of the packing and seal ring (3) Defect of the bolt and nut (4) Lubrication of the shaft and gear of the drive mechanism, and contamination of gear box (5) Deterioration of lubricating oil (6) Inspection of de-superheater a) Cracks, corrosion, erosion and damage of the nozzle and mixing chamber, and defects of the weld zone b) Damage of the liner and support plate c) Cracks, corrosion and erosion on the inner and outer surfaces of the element condensate replacement type 2. After Defects cleaning and adjustment (1) inside the tube and weld zone (2) Cracks of valve casing and damage by erosion (3) Damage and contact of valve body and valve seat (4) Cracks, curvature, wear and corrosion of valve rod (5) Contact of guide (6) Loss of the packing, seal ring and flange surfaces (7) Defects of bolt and nut (8) Contact and wear of shaft, gear and bearing of the drive mechanism (9) Defects of the connections with pneumatic operation mechanism 3. During assembling and after completion (1) Confirm that the interior is free of foreign substances or things left behind. (2) Check the assembly state for any defect.	1. Disassembling (1) Disassemble the valve and check each part. Put the matching mark as required. (2) Take care not to damage the valve body, valve seat and bolt. 2. Cleaning and adjustment (1) Use the rags and detergent to wipe the valve casing, and use compressed air and vacuum cleaner to clean it. (2) The valve body and valve seat must be fitted and adjusted as required. Adjust the contact and check the function. (3) Use detergent to wash the shaft, bearing, gear and gear box, and use oil-proof sponge to clean it. (4) Adjust the contact of the packing and seal ring. (5) Adjust the bolt and nut. (6) Check, adjust and repair the de-superheater spray nozzle. 3. Assembling and recovery (1) Carefully assemble it, taking care not to allow foreign substance to enter. (2) Check the retainer lock around the valve. (3) Tighten the high temperature bolt to give specified elongation. (4) Replace the gland packings with new ones. (5) Check the power and pneumatically driven parts for assembling and functions. (6) Conduct the on-off test.	1. Operation items and cautions (1) Check the valves of all systems for external appearance before shutdown, and confirm their functions. Check for leakage and other defects, and determine the valves which must be disassembled and inspected. (2) Disassemble and inspect the main steam check valves and major valves of the main body for every periodic inspection, if their valve bodies and valve seats are considerably worn. Disassembling, inspection and adjustment must be done, giving attention to the following major points: a) Valves whose operations are suspended due to leakage b) Valves which must be closed when repairing the equipment during operation c) Valves which may cause serious accidents through leakage d) Valves frequently used, with their valve bodies, valve rods and gland packings likely to be damaged e) Valves which may be subjected to frequent leakage, according to the experience f) Valves having been subjected to defects and troubles such as cracks, and likely to be affected by such troubles again (3) Check the main valve of the major tube system once in two to three years or when accompanying equipment are to be inspected. Other valves mounted on the main body, which have leaked before periodic inspection and have been found to be free of defects by inspection of each part, must be disassembled and inspected once in four to six years on a planned basis (4) Disassemble and inspect the de-superheater nozzle and spray water chamber once in four to eight years. Before disassembling and inspecting, It is necessary to determine if spare parts must be provided or not, and if application of welding inspection is required or not. (5) To check for cracks, use liquid penetrating test for the inner side, and magnetic field test for the outer side. Use radiographic test as required. (6) Inspect the outer side of the valve, whenever required or when repairing the heat insulations. 2. Secular deterioration and reference cases (1) The valve body and valve seat are often subjected to leakage by erosion. Cracks have been caused by thermal impact of the deposited metal. (2) Low cycle fatigue cracks may occur to the valve casing, valve body and valve seat.

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
		(3) Check on-off operations (including manual operations), strokes and operation smoothness. (4) On-off test of the power driven valve Check to confirm the operations of the limit switch and torque switch. Measurement (record) at on-off operation (5) On-off test of pneumatically operated valve Record the operation pressure and valve lift. (6) Leakage an other defects in hydraulic test		(3) Damage of the valve rod due to stress concentration and vibration, cracks due to irregular walls thicknesses, cracks on the valve casing surface, wear and damage of the valve rod, and damage of the valve body have occurred.
f. Furnace (except for pressure part) (a) Furnace interior, ceiling, nose, furnace bottom (b) Furnace opening, manhole, inspection sight, burner nozzle, soot blower	1. Inspect each part during periodic inspection.	1. During disassembling (1) Deposits and adhered substances on the clinker (distribution and amount) (2) Burnout and missing of furnace wall refractories and insulating materials (3) Gas leakage and other defects 2. After cleaning and adjustment [Furnace interior] (1) Gas leakage, burnout and sealing of the casing (2) Sealing of the penetrations of tubes and tubes through furnace walls (3) Deformation, cracks and discoloration of skin casing	1. Disassembling (1) Open the furnace manhole and inspection sight. (2) Build scaffolds to ensure improved safety and workability since the work is to be done at elevated positions. (3) Take care to ensure effective ventilation, and wear required protective goods. (4) Prepare the hammer and other required tools, and perform precise inspection under effective illumination. 2. Cleaning and adjustment [Furnace interior] (1) Check for discolored and degenerated positions under effective illumination. (2) Use the test hammer to check for looseness. (3) Check or leakage.	1. Operation items and cautions (1) Check the corner and tube penetrations on a priority basis. (2) Take special care to check for burnout of fin weld zones such as the burner tile nozzles, and deposition of clinker. (3) Check for furnace wall opening seal air and nozzle clogging and corrosion.

(2) Feed water pump

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
a. Feed water pump body including booster pump	1. In inspection, check the pump for defects by measuring pressure, flow rate and bearing temperature.	1. During disassembling (1) Deposits and adhered substances a) Positions (distribution) b) Color (external appearance) c) Thickness or volume d) Composition 2. After cleaning and adjustment (1) Foreign substances, seizure and damage of the rotary parts (2) Corrosion and cracks of each part (3) Shaft curvature (4) Looseness at fit sections of the impeller (5) Clearance of each part (6) Defects of bolt and nut (7) Bearing clearance (8) Damage of white metal due to contact (9) Journal damage (10) Gland defect (11) Wear of balance disk seat 3. During assembling and after completion (1) Measure the clearance of each part in assembling, and record the value. (2) In the case of the flexible coupling, check the center ring and the rubber for bolts. (3) In the case of the gear coupling, confirm the center ring, and check the gear for wear. (4) Use the wire brush to treat the threaded parts of the bolts.	1. During disassembling (1) Measure the center ring and shaft movements. (2) Use wire brush or rags, vacuum cleaner and honing to remove deposits and adhered substances. (3) Use emery cloth and scraper to finish the machined surface. (4) Wash the fit parts and journals with detergent, and finish them with oil stone.	1. Operation items and cautions (1) Disassemble and inspect them on a planned basis according to the result of the tests which allow pump defects to be checked by measuring pressure, flow rate and bearing temperature, or the inspection on patrol. (2) When not disassembling them, be sure to conduct tests which allow pump defects to be checked by measuring pressure, flow rate and bearing temperature. (3) Disassemble and inspect two or more of them in the initial periodic inspection, and open and inspect them at intervals of four years thereafter. (4) It is preferred to conduct liquid penetreting test of the gear tooth face. (5) Low cycle fatigue cracks by thermal stress may occur to the casing inner face and runner. (6) Corrosion and wear are likely to occur to the casing inner face and runner, and must be checked carefully. (7) When the pump is assembled, measure the clearance of each part and record the result.

(3) Heat exchanger

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
a. Steam evaporator (a) Main body	1. Check each part during periodic inspection. 2. Disassemble and inspect them once two to four years.	1. During disassembling (1) Damage, deformation and deposits on the steam chest cover (2) Damage, deformation and deposits on the tube plate (3) Damage and deposits on the heating tube (4) Pitting inside the drum (5) Deposits and adhered substances inside the drum (6) Damage of packing	1. During disassembling (1) Open the cover. (2) Take out the heating tube bundle and clean it. (3) Repair the packing seat. (4) Conduct hydraulic test (pump cut-off pressure).	
(b) Deaerator		(wear and damage of tray and spray nozzle) 1. Follow the procedure for the main body given in (a).	Same as left	
(c) Drain cooler		1. Follow the procedure for the main body given in (a).	Same as left	
(d) Feed water pump		1. After disassembling (1) Wear and corrosion of the runner and casing (2) Shaft curvature (3) Runner clearance (4) Contact and clearance of the bearing (5) Balancing disk defect (6) Gland defect	1. During disassembling (1) Take out the runner. (2) Measure the shaft runout. (3) Measure the clearance. (4) Measure the balance disk runout. (5) Center ring (6) Replace the gland packing. (7) Replace lubricating oil.	
(e) Feed water tank		1. When opening: (1) Deposits and adhered substances (2) Corrosion	1. Cleaning and adjustment (1) Open the manhole. (2) Drain water and clean.	

(4) Draft system

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
a. Draft fan (induced draft fan, forced-draft fan, gas recirculation draft fan and gas-mixed draft fan) (a) Draft fan	1. Conduct the tests which allow the defect of the draft fan to be checked by measuring air pressure and bearing temperature during inspection A.	1. After disassembling Draft fan [Draft fan] (1) Deposits and adhered substances (2) Wear, missing and looseness of bolts and rivets (3) Wear of dampers and vanes, and defect of the drive mechanism (4) rotor vibration and balance (5) Corrosion, wear and damage of casing, plate and boss liner [Bearing] (1) Damage by foreign substances and seizure (2) Clearance of each part (3) Shaft curvature (4) Bearing contact and wear	1. Cleaning and adjustment [Draft fan] (1) Use the wire brush and scraper to clean it. (2) In the case of oil-fired combustion system, remove deposits and adhered substances from the runner, vane,damper and casing of the induced draft fan by water flushing. [Bearing] (1) Use detergent to wash the journal, bearing, sealed part and oil sump, and use oil stone, compressed air and rags to clean them. (2) Center ring	1. Operation items and cautions (1) Disassemble and inspect them on a planned basis according to the record of the tests which allow the draft fan defect to be checked by measuring wind pressure and bearing temperature, or the inspection on patrol. (2) It is preferred to open and inspect them at intervals of two years. (3) Conduct magnetic particle test as required. (4) In the case of oil-fired combustion system, check the induced draft fan for corrosion in particular.
(b) Lubrication unit	1. Disassemble and inspect it in the inspection.	1. After disassembling (1) Deterioration of lubricating oil (2) Deposition of sludge inside the system, and clogging of the strainer (3) Defect in each part of the oil pump (4) Cooler defect	1. Cleaning and adjustment (1) Wash the pump interior with detergent, and clean it with compressed air.	
b. Air duct and gas duct	1. In the inspection, open the manhole and inspect the interior.	1. After disassembling (1) Deposits and adhered substances (2) Corrosion, absence and damage of the lining (3) Leakage of air and gas (4) Wear and corrosion inside the duct (5) Cracks and damage of the expansion joint, stay and baffle plate (6) Deformation and damage of the vane and damper (7) Damage of the vane and damper operation mechanism (8) Manhole clamping bolt (9) On/off state of the water drain valve for water flushing	1. Cleaning and adjustment (1) Remove ashes from the inside, and clean the inside by water flushing.	1. Operation items and cautions (1) In the case of oil-fired combustion system, check the gas duct for corrosion in particular.

(5) Air preheater

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
a. Rotating regenerative air preheater (a) Main body	1. In the inspection, conduct the test which allows the air preheater defect to be checked by measuring the differences in temperatures and pressures between air inlet and outlet.	1. During disassembling (1) Gas leakage or other defects of the main body and rotor protrusions (2) Adherence of soot on the element and clogging, as required 2. After cleaning and adjustment [Element] (1) Corrosion and wear (Carefully check the plate wall thickness.) (2) Corrosion, wear, crack or absence of reinforcements (3) Loose and uneven conditions (4) Measurement of plate thickness and weight, as required Sealed parts [Rotor seal, circumferential seal and radial seal] (1) Corrosion and wear (2) Check installation and measure clearance. (3) Loose condition, damage or absence of installation bolts [Rotor] (1) Conduct liquid penetrating test for cracks and corrosion of the rotor weld zone, and the rotor post and diaphragm weld zone, as required. (2) Measure the contact and wear of the pin and rack. (3) Defect of the installation bolt [Housing] (1) Corrosion (2) Measure the level and inclination as required Bearing (1) Inspect and measure the bearing clearance. (2) Contact (3) Replace the lubricating oil. [Rotor balance] (1) Adjustment of rotor weight as required 3. Make final confirmation t see if there is any defect in the installation part and seal. (1) Make a final confirmation to see if there is any defect in installations and seals	1. Disassembling (1) Open the manhole and inspection sight. (2) Change air and inspect it under effective illumination. (3) Check the rotor racing preventive brake carefully. 2. Cleaning and adjustment [Element] (1) Perform water flushing. Washing and drainage must be done at the exhaust gas temperature of 100 oC or less until the pH value reaches 0.5 or more. (2) The elements on the low temperature side may be reversed and replaced in the initial inspection, depending on corrosion and wear. [Sealing] (1) Re-tighten the installation bolt or replace them. (2) Replace them with new ones if much corroded. [Rotor balance] (1) To install the weight, weld it onto the rotor outer plate. 3. Assembling and recovery (1) Clean the seat surfaces of the manhole and inspection sight, and replace the packings. (2) Confirm that the interior is free of things left behind.	1. Operation items and cautions (1) Open and inspect them on a planned basis according to the result of the test which allows the air preheater defect to be checked by measuring the differences in temperatures and pressures between air inlet and outlet, or the inspection on patrol. (2) It is preferred to inspect the heat transfer surface at intervals of two years. (3) Take out and inspect the low temperature element to provide guiding information to determine the replacement time, if required, depending on the record of the weight and plate thickness, comparison with new ones and the low temperature section element. (4) Conduct chemical analysis of deposits and adhered substances on the element as required, to provide reference information for operation. (5) The low temperature section of the rotating regenerative preheater is exposed to sulfur attach, while the high temperature section is exposed to the combustion exhaust gas; the operating conditions are very server. Accordingly, extreme care should be used to inspect them when disassembling and inspecting them. (6) Check each seal for contact and leakage during the test operation after disassembly and inspection. To check for leakage, measure the amount of O2 before and after the air preheater. (7) Take actions to prevent the tool kit from falling.

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
(b) Drive unit i. Speed reducer	In the inspection, check each part.	1. After disassembling (1) Contact of gears (2) Oil seal (3) Bearing contact (4) Check if the anchor bolt is loose. (5) Wear of coupling bushing (6) Lubricating oil, need of its replacement	1. Cleaning and adjustment (1) Open the cover. Make sure that the interior is free of foreign substances. (2) Use treated oil or compressed air to remove contaminations.	
ii. Air motor	1. Disassemble and inspect	1. After disassembling (1) Contact of gears (2) Oil seal (3) Bearing contact (4) Wear of bearing bushing (5) Defect of air strainer	1. Cleaning and adjustment (1) Clean the air motor blade with compressed air and rags. (2) Wash the air strainer with detergent.	

(6) Firing equipment

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
a. Oil firing equipment (a) Oil pump i. Heavy crude oil pump (screw type, centrifugal type) ii. Light oil pump	1. In the inspection, conduct the test which allows the pump to be checked by measuring pressure and electric current.	1. After disassembling (1) Water and crack of each part of the rotor (2) Shaft, bearing and mechanical seal (3) Wear of oil seal and other parts (4) clearance of each part (5) Relief valve operation	1. After disassembling (1) Open the casing. (2) Take out the rotor. (3) Measure the wear and curvature. (4) Center ring	1. Operation items and cautions (1) Check the safety device of the gas detector of the oil firing equipment, and the grounding wire of the tube and equipment. (2) It is preferred to disassemble and inspect it at intervals of four years.
(b) Heavy oil heater	1. Inspect each part.	1. After opening (1) Corrosion and erosion of the main body and piping (2) Cracks and damages of the tube expansions (3) Cracks and damages of the tube plate and diaphragm (4) Tube leakage test (5) Relief valve operation test	1. Cleaning and adjustment (1) Open the cover. (2) Take out and clean the heating tube bundle. (3) Replace the packing.	
(c) Piping and valves	1. Inspect each part. 2. Disassemble and inspect valves.	1. After disassembling (1) Defects, deposits and adhered substances of the strainer (2) Leakage from valves (3) Damage of the valve, coupling and flexible tube (4) Wear and erosion of the shut-off valve, control valve and drain trap (5) Wear and damage of the drive mechanism (automatic strainer alone)	1. Cleaning and adjustment (1) Clean tubes and valves using the detergent, rags and compressed air. (2) Fit the valve seat surfaces as required.	
(d) Burners (main burner and firing burner)	Disassemble and inspect them in the inspection.	1. After disassembling (1) Wear and damage of burner tip and nozzle (2) Burnout and deformation of the diffuser cone and protective tube (3) Burnout of register damper (4) Defect in each part of the operation equipment (5) Head valve, flexible tube and universal joint (6) Operation test	1. Cleaning and adjustment (1) Clean the burner using the wire brush, rags and compressor air. (2) Fit the tip.	[Burners] (1) Sufficient adjustment must be made to ensure that burner refractories and diffusers can be used for three years. (2) After completing the assembling, check how the burner is set for the furnace. (3) After completing the assembling of the firing burner, conduct the spark test to confirm that there is no trouble.

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
(e) Ventilators (burner seal fan, frame motor cooling fan, pressure fan, ventilation fan, igniter booster fan)	1. Disassemble and inspect them.	1. After opening (1) Wear, corrosion and damage of shaft, bearing, liner and casing (2) Damage of damper, bearing, blade and movable parts (3) Contamination of strainer	1. Cleaning and adjustment (1) Disassemble, inspect and adjust the fan proper. (2) Clean the strainer.	
(f) Additive feed device	1. Disassemble and inspect them.	1. After assembling (1) Damage of the control valve, float, etc. (2) Agitator (3) Pump shaft, bearing and diaphragm	1. Cleaning and adjustment (1) Clean the strainer using treated oil, rags and compressed air. (2) Clean the pump and control valve using treated oil and rags.	
b. Gas firing equipment (a) Burner	1. Disassemble and inspect them in the inspection.	1. After disassembling (1) Clogging, wear and damage of the nozzle (2) Burnout and deformation of protective tubes (3) Burnout of register damper (4) Defect of the operating equipment (5) Valves and flexible tubes (6) Operating test	1. Cleaning and adjustment (1) Clean the nozzle using rags and compressed air.	1. Operation items and cautions (1) Check the safety device with specific care. (2) Carefully check for gas leakage in daily inspection.
(b) Gas piping and valves	Disassemble and inspect valves.	1. After disassembling (1) Check for gas leakage around the piping, valves, burners (2) Check the relief valve and release valve. (3) Shut-off valve a) Check for operation. b) Check fore leakage.		

(7) Soot blower

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
a. Injection tubes (lance tube, feed pipe)	1. Inspect each part. 2. Inspect the nozzle, lance tube and feed pipe.	1. During disassembling (1) Check the injection angle and direction of the nozzle from inside the furnace, and positional relationship with tube group (2) Also check the tube group within the nozzle injection range for damage. (3) Check the nozzle for clogging. 2. After cleaning and adjustment (1) Corrosion, wear, cracks and absence of the nozzle (2) Damage, corrosion, wear, curvature and burnout of the lance tube and feed pipe (3) Clogging of the drain hole (4) Corrosion and damage of the gland 3. During and after assembling (1) Make sure that that they are installed to the specified dimensions. Also confirm the positional relationship with the tube wall. (2) Check the injection angle and direction of the nozzle, and positional relationship with tube group. (3) After assembling, confirm vibration and injection start position from inside the furnace without feed steam.	1. Disassembling (1) Build scaffolds and wear protective goods since the work is to be done at elevated positions in some cases. (2) When pulling out the lance tube, take care not to damage the tube groups nearby. (3) Put tally marks (such as positional relationship) to required positions. 2. Cleaning and adjustment (1) Clean the nozzle and lance tube using the wire brush and rags. (2) Clean the feed tube taking care not to damage it. (3) Repair light curvatures and nozzle wear. 3. Assembling and recovery (1) Take care not to damage the boiler tube. (2) Put the specified marks and tally marks to required positions.	1. Operation items and cautions (1) The intervals for disassembly and inspection may be extended according to the daily operation management and operating conditions. (2) Inspect the sealing of the portion of the furnace wall penetrating the soot blower, by checking the ash and gas blow during the operation. (3) The damaged topper may cause the water tube to be damaged, so it must be repaired. (4) When inspection, take a sufficient care to the drain cut of the tube group due to the stopper blower.
b. Head valve	Disassemble and inspect.	1. After disassembling (1) Cracks ad erosion of the valve casing, valve body and valve rod (2) Contact of valve seat and spring (3) Erosion and seizure of pressure adjust ring	1. Cleaning and adjustment (1) Clean the valve casing interior, valve body and rags using the rags. (2) Fit the valves which have poor seat surface contact and are damaged. (3) Replace the gland packing.	1. Operation items and cautions (1) The intervals for disassembly and inspection may be extended according to the daily operation management and operating conditions.
c. Sealing device	1. Inspect each part. 2. Inspect inside the wall box.	1. During disassembling (1) Deposits and adhered substances inside the wall box (2) Wear of the brush and sleeve (3) Corrosion and wear of the scraper plate, wall end plate (4) Clogging and damage of the seal air and aspirate air pipe (5) Corrosion and damage of the gland and gland retainer (6) Damage of the wall box installation refractories	1. Cleaning and adjustment (1) Remove the seal air and aspirate air nozzle which are clogged. (2) Using the scraper, wire brush and compressed air, remove the ash deposited and heaped inside the wall box. (3) Replace the gland packing.	1. Operation items and cautions (1) The intervals for disassembly and inspection may be extended according to the daily operation management and operating conditions. (2) Leakage from the head valve may erode the refractories inside the wall box and furnace wall tube as well. To prevent this, a sufficient care must be taken to check leakage from the head valve and defects of seal parts during disassembly and inspection as well as in the daily inspection.

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
d. Drive mechanism	1. Inspect each part. 2. Disassemble and inspect the air moor and gear box.	1. After disassembling (1) Wear and damage of the air motor blade (2) Contamination of the gear box (3) Wear of the gear, bearing, chain and roller shaft brake shoe (4) Deterioration of lubricating oil	1. Cleaning and adjustment (1) Clean the air motor blade using the rags and compressor air. (2) Use detergent to wash the gear box interior, gear, bearing, chain and roller drive shaft, and use the oil-proof sponge to clean them.	1. Operation items and cautions (1) The intervals for disassembly and inspection may be extended according to the daily operation management and operating conditions.

(8) Steam pipe, Feed water pipe and Steam receiver

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
a. Steam pipe and feed water pipe	1. Inspect each part. 2. Check the pipe internal surfaces when you have cut off the pipe in disassembling or removing the valve. 3. Check the pipe external surfaces when you have repaired insulations.	1. When opening (1) Deposits and adhered substances a) Positions (distribution) b) Color (external appearance) c) Thickness or volume d) Composition (2) Corrosion and cracks (weld zones in particular) (3) Damages on the flange surface (4) Defects of bolt and nut (5) Defects of the tube hanger, support, restraint and other support tools. (6) Defects of reduced or curved parts. As required, measure the wall thickness of the feed water tube in particular.	1. Cleaning and adjustment (1) Use the vacuum cleaner and rags to clean the pipe internal surface as required. (2) Use the wire brush, emery cloth and special scraper to clean the flange seat surface. (3) Confirm that the interior is free of foreign substances or other things left behind. 2. Assembly and recovery (1) Use the scraper and emery cloth to finish the pipe flange surface, and replace the packing. (2) Re-tighten the high temperature tube flange after ventilation.	1. Operation items and cautions (1) When you have cut off the pipe, install a suitable shield plate to prevent foreign substances from entering the pipe. (2) Make chemical analysis of the deposits and adhered substances as required, thereby providing information for the treatment of feed water and boiler water. (3) One year after start of use in particular. Check the support points of the large diameter pipes against the records taken during operation to make sure that expansion and contraction have been made as designed. (4) Record the positions of the cracks and corrosions, and check them against the previous records. The operation record will be used as reference information to determine the time and scope of the next disassembly and inspection. For example, conduct liquid penetrating test and magnetic particle test, and observe secular deterioration on a planned basis; then take measures as appropriate. (5) The piping of the reduced part before and after the feed water control valve in particular may be eroded. To prevent this, measure the wall thickness at specified times, and observe secular changes to take appropriate measures. (6) It is recommended to conduct precision inspection of the pipe hanger and support accessories as required.
b. Steam receiver	1. Open the manhole and check inside.	1. When opening (1) Deposits and adhered substances a) Positions (distribution) b) Color (external appearance) c) Thickness or volume 2. Cleaning and adjustment (1) Cracks, corrosion and erosion a) Weld line and weld zone b) Manhole c) Nozzle stub and drain hole, and their surrounding (2) Damage of the manhole seat surface (3) Conduct liquid penetrating test of the weld zone as required. 3. During and after assembling (1) Make sure that that tools or similar objects are not left behind inside, and drain holes are not clogged.	1. Disassembly (1) Open the manhole. (2) Measure the oxygen concentration (to void oxygen shortage) (3) Use the safety work lamp. (Use an electric lamp with a low voltage provided with guard.) 2. Cleaning and adjustment (1) When you are inside the manhole, wear a clean working uniform and footwear, and take only the minimum of tools and other required parts with you. Be careful not to leave them behind when you get outside. (2) Clean the inside with nylon brush and rags. (3) Take care not to allow the metal surface to be damaged or dented. (4) Use the vacuum cleaner to finish cleaning of the inside. (5) After cleaning the inside, take care not to allow foreign substances or moisture to enter. Close it tightly when there is no need to open it. 3. Assembly and recovery (1) Use the scraper and emery cloth to finish cleaning of the manhole seat surface, and replace the packing. (2) Re-tighten the high temperature pipe flange after ventilation.	1. Operation items and cautions (1) Make chemical analysis of the deposits and adhered substances as required, thereby providing information for the treatment of feed water and boiler water. (2) Record the positions of the cracks and corrosions, and check them against the previous records. The operation record will be used as reference information to determine the time of the next disassembly and inspection. For example, conduct liquid penetrating test and magnetic particle test, and observe secular deterioration on a planned basis; then take measures as appropriate.

(9) Air source

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
a. Air compressor	1. Disassemble and inspect the air compressor.	1. During disassembling (1) Check for clearances before disassembling. 2. Cleaning and adjustment (1) Suction valve and delivery valve a) Wear, crack and damage of the valve plate, valve seat and valve spring Replace the valve plate and spring. b) Valve seat surface Fit the surface as required. c) Wear of the valve guide d) Defect of the unloader mechanism (2) Piston and cylinder a) Wear, crack and damage of the sliding surface b) Clearance between the piston and cylinder c) Looseness of cylinder top nut d) Defect of the gland Replace the defective metallic packing, gland packing and ring. e) Wear and crack of the piston cylinder f) Contamination of cylinder jacket g) Measure the dimensions. Cylinder liner, piston, piston rod, piston ring groove, piston ring, metallic packing, spring h) Measure the piston rod warp. i) Measure the clearance. (3) Cross head, crank shaft and connecting rod a) Wear and crack b) Measure the clearance. c) Contact and wear of the bearing Measure the dimensions as required. d) Peeling of the white metal e) Looseness of installation bolts (4) Oil pump, lubricator and oil cooler a) Tooth contact and damage b) Measure the dimensions of the oiler pin and oiler sleeve as required. c) Contamination of the oil filter and replacement of the felt d) Defect of the lubricator e) Defect of the oil cooling tube f) Defect of the relief valve	1. Disassembling (1) The cylinder cover and piston are heavy, and should be handled carefully. Build scaffolds to ensure safety. (2) When disassembling, take sufficient care not to damage to the parts. (3) Put tally marks to required positions to indicate the relational position and other information. 2. Cleaning and adjustment (1) Use the emery cloth, detergent and compressed air to clean the parts as required. (2) Using appropriate tools, remove contamination and dust inside the cylinder jacket. (3) To repair the shaft rod, use oil stone to finish it. (4) Use the scraper to finish the bearing and white metal. (5) To clean inside the crank case, use the detergent, rags and compressed air. (6) To clean, the inter-cooler and after-cooler, pull out the cooling tube and flush the tube and outer cylinder with water. Clean them with the brush and rags. (7) Clean the inside of the drain separator. Clean the air filter with the detergent and compressed air, taking care not to damage the element. 3. Assembly and recovery (1) To confirm the clearance, use the lead line and thickness gauge. (2) Make sure that the interior is free of foreign substances (bolts, set screws, etc.). (3) Manually operate it before test operation and check the sliding part.	1. Operation items and cautions (1) Measure and record the dimensions (wear, etc.) of the parts as required, and inspect the clearance of the sliding parts. Replace the parts or determine the time of repair by studying in comparison with the repair standards recommended by the manufacturer. (Standard dimensions of each part and limits of use to be compared with each other) (2) It is recommended to check the suction valve and delivery valve on a periodic basis at shorter intervals. (3) Warming up contact damage and accident may be caused by poor clearances of the air compressor. Adjust the clearances to the specified dimensions.

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
		(5) Crank case a) Deterioration and replacement of lubricating oil. Analysis as required. (6) Inter-cooler and after-cooler a) Deposits, adhered substances and damage of the cooling tube b) Deposits, adhered substances and damage of the outer cylinder c) Defect of the safety valve drain trap d) Defect of the drain separator (7) Air filter a) Contamination, deposits, adhered substances and damage 3. During and after assembling (1) Make sure that it is installed according to the specified dimensions (clearance, etc.) and tally marks. (2) Conduct hydraulic test of the oil cooler, inter-cooler and after-cooler after assembling. (3) Conduct operation test of the safety valve and related equipment.		
b. Air receiver	1. Open the manhole and inspect the inside.	1. When opening: (1) Deposits and adhered substances (2) Cracks and corrosion a) Rust on the inner side b) Weld line and weld zone c) Nozzle stub, drain hole and their surrounding area d) Conduct liquid penetrating test of the weld zone as required. (3) Damage of the manhole and seat surface (4) Check the safety valve and drain trap for defects.	2. Cleaning and adjustment (1) Using the wire brush and rags, remove deposits and adhered substances. (2) Finish the manhole and seat surface with the scraper and emery cloth, and replace the packing. (3) Make sure that that tools or similar objects are not left behind inside, and drain holes are not clogged.	1. Operation items and cautions (1) For the periodic voluntary test and repair. (2) Record the result of the voluntary inspection according to the rule, and keep it.
c. Dehumidifier	1. Open it and inspect the interior.	1. During disassembling (1) Reduction in the amount of the dehumidifying agent (silica gel, active alumina) (2) Clogging of the filter (3) Wear and damage of the filter 2. After cleaning and adjustment (1) Reduction in the amount of the dehumidifying agent (silica gel, active alumina), and its grain size (2) Heater insulation and electric conduction	1. Disassembly (1) Open the cover of the dehumidifier cylinder. (2) The upper cover is heavy, and should be handled carefully. Build scaffolds to ensure safety. 2. Cleaning and adjustment (1) Replace the older dehumidifying agent with the new one. (2) Clean the filter by compressed air. (3) Clean the operation valve body and sliding parts.	1. Operation items and cautions (1) Defective dehumidifier may cause measuring instrument control failure, and may result in freezing accident in winter. This requires careful inspection during daily operation management and periodic inspection. (2) Pull out all the dehumidifying agents and inspect them during daily management and at the specified time as required. (3) Check each operation after completion.

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
		(3) Wear and damage of the sliding part of operation valve 3. During and after assembling (1) Check that the specified amount of dehumidifying agent is supplied. (2) Measure the dew point of dehumidified air.	3. Assembly and recovery (1) Use the scraper and emery cloth to finish cleaning of the cover and seat surface, and replace the packings with new ones.	

(10) Other piping and valves

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
a. Adjust valve (including piston)	1. Inspect each part. 2. Disassembly and inspect it.	1. After disassembling (1) Measure the wear and wall thickness of the body internal wall. (2) Fit the contact of the interval valve and valve seat as required, and conduct liquid penetrating test. (3) Weld zone 2. After assembling (1) Air tight test (2) Operation test	1. Disassembling (1) Put tally marks before disassembling, without (2) Handle each part taking care not to damage it. 2. Assembling (1) Replace the gland packing and gasket packing with new ones. (2) Full the gland with lubricating agent. (3) Tighten the bolts and nuts firmly.	1. Operation items and cautions (1) Inspect the valve for use, leakage and operation at intervals of one to two years. (2) Make external inspection of the actuator. When used in an especially poor environment, it is recommended to check it at intervals of two to four years. 2. Reference information (1) Since a stellite layer is normally laid to a thickness of about 1 to 2 mm, it must be repaired when erosion has reached half that thickness.
b. Safety valve	1. Inspect each part. 2. Disassembly and inspect it.	1. After disassembling (1) Check the body for corrosion, damage and cracks. (2) Fit the contact surfaces of the nozzle and disk and conduct liquid penetrating test as required. (3) Check for spindle curvature and wear. (4) Check the spring for defects. 2. After assembling (1) Conduct operation test.	1. Disassembling (1) Make sure that there is no foreign substance inside. (2) Handle each part taking care not to damage it.	1. Operation items and cautions (1) Test the operation at intervals of one to two years. (2) Carefully clean the connection tube on the safety valve side. (3) Uniformly tighten the inlet connection flange bolts and studs.
c. Reducing valve	1. Inspect each part. 2. Disassembly and inspect it.	1. After disassembling (1) Check the valve body for corrosion, damage and cracks. (2) Check the valve seat for contact. (3) Check the sliding part for wear.	1. Disassembling (1) Make sure that there is no foreign substance inside. 2. Assembling (1) Replace the gasket packings with new ones.	1. Operation items and cautions (1) Test the operation at intervals of one to two years.
d. Other general pipings and valves (a) Valves	1. Disassembly and inspect them.	1. Disassembling (1) Check the valve body for corrosion, damage and cracks. (2) Check the valve seat for contact. (3) Check the valve rod for crack, curvature, wear and corrosion. (4) Check the seal ring, packing and flange surfaces. (5) Check the bolts and nuts.	1. Disassembling (1) Confirm that the interior is free of foreign substances. (2) Take care not to damage the valve rod, valve seat or bolt. (3) Fit the valve and valve seat as required. (4) Replace the gland packings with new ones.	1. Operation items and cautions (1) Check the system valve for the external appearance before stopping, and check the function. Carefully check the valve for leakage and other observable defects in particular. (2) Disassemble and adjust the following valves: a) Valves stopped by leakage b) Valves which stop when equipment are repaired during operation c) Valves likely to be subjected to serious accidents by leakage d) Valves and valve seats likely to be damaged e) Valves subjected to frequent leakage according to experience (3) Inspect cracks using liquid penetrating test. Conduct magnetic particle test as required. (4) Inspect outside the valve as required or during repair of the insulation. (5) Check for specifications of the pressure and temperature when replacing the gland packing.

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
(b) General piping (Steam and feed water pipe)	1. Inspect accessories such as pipe hanger and suppor at intervals of two to four years.	1. Follow the procedure given in "8. a. Steam pipe and feed water tube" in this Volume.	Same as left	1. Operation items and cautions (1) When you have cut off the tube, provide a stopper or other suitable materials to prevent foreign substances from entering the pipe. (2) Check the separations of smaller pipe and pipe for cracks. (3) Since erosion may occur to the pipe at reduced positions, measure the wall thickness and check for secular changes. (4) Inspect inside the surface wherever possible when you haveremoved the valve or cut off the pipe. (5) Inspect inside or outside the pipe when you have repaired the insulation.

(11) Chemicals feeder

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
a. Chemicals reservoir	1. Inspect each part. 2. Open and inspect it.	1. After opening and adjustment (1) Check the bottom plate and side plate for deformation, cracks and corrosion. (2) Internal paint and lining (3) Check the nozzle and drainage for corrosion and cracks (4) Check atmosphere tube and liquid level gauge for clogging and corrosion.	1. Cleaning and adjustment (1) Measure the oxygen concentration (to void oxygen shortage) as required. (2) Clean the inside by water flushing, and remove deposits and adhered substances by wire brush and wags. (3) Measure the wall thickness of the bottom plate and side plate. 2. Assembly and recovery Replace the packings with new ones.	1. Operation items and cautions (1) When discharging chemicals, take appropriate measures such as neutralization. (2) Before entering the chemicals reservoir, wash it by water flushing carefully and make sure that there is no danger.
b. Chemicals feed pump	1. Inspect each part. 2. Disassembly and inspect it.	1. After assembling and adjustment (1) Wear and damage of the cylinder (2) Damage of the crank shaft (3) Wear and damage of the piston, piston ring and oil ring (4) Rod, pin and bearing (5) Wear and damage of the diaphragm and ball valve (6) Gear contact (7) Lubricating oil 2. During and after assembling (1) Clearance (2) Operation of the relief valve and pressure adjustment device (3) Vibration and noise (4) Delivery pressure	1. Cleaning and adjustment (1) Wash each part with detergent and clean it with compressed air. (2) Use the wire brush to clean threaded parts of the bolts. (3) Replace the bearing, piston ring, oil ring and diaphragm as required. 2. Assembly and recovery (1) Replace the lubricant oil. (2) Measure the clearance. (3) Measure the volume of delivery for stroke.	

2. Periodic inspection procedure for steam turbine

(1) Turbine proper

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
a. Turbine proper	1. In the inspection, remove the upper half turbine casing, and inspect the turbine with the diaphragm and labyrinth packing installed. Select the position with high stress level as required, and conduct the magnetic particle test.	1. During disassembling (1) Centering (2) Relational position and dimensions of the axle, Casing and bearing stand (3) Major clearance for each part a) Clearance of thrust bearing and journal bearing b) Clearance between rotating blade and stationary blade or diaphragm c) Moving blade tip clearance d) Gland and dummy seals e) Oil thrower and oil seal f) Other major parts (4) Alignment (5) Level of each part (6) Deposits and adhered substances (7) Discoloration and rust (8) Foreign substances (9) Crack, damage, dent, deformation and curvature (10) Contact between rotary and stationary parts (11) Corrosion and erosion (12) Wear (13) Steam leakage (14) Loosened bolts 2. During adjustment and assembling Repeat the inspection items implemented during disassembling as required. Furthermore, check the following as required: (1) Deterioration of bolts and nuts (2) Extensible parts and sliding parts	1. Disassembling (1) When disassembling, pay attention to metal temperature and its falling speed to ensure that the casing and rotor will not deform. (2) When opening it, take care to minimize damage of heat insulations. (3) To check the conditions as accurately as possible immediately after disassembly, take care not to contaminate or damage the parts. (4) When starting the work, wear a clean working uniform. Wear the soft rubber bottomed footwear not to damage machined surfaces or slip. (5) When measuring the centering, also record the measuring conditions such as the casing temperature, room temperature, time after stop, and hot well water level (spring support system). When measuring outdoor type centering, avoid direct sunshine. (6) To lift the heavy objects such as the casing and rotor, confirm the rope safety load and lifting angle in advance. (7) After opening, enclose the opening with a temporary cover. (8) When you enter inside, take only the minimum of tools and other required parts with you. Be careful not to let them fall or leave them behind when you get outside. (9) Cover them with the protective sheet and plate as required, until you complete turbine assembling. (10) Store the disassembled parts in a specified vessel to ensure that they will not be lost or mixed with others. 2. Adjustment and assembling (1) Remove the deposits and adhered substances by the wire brush, sand paper and buffing, and use the vacuum cleaner and compressed air for cleaning. Provide honing and shot blasting if required. (2) Use fine emery cloth, scraper and oil stone to adjust the machined surfaces of the flange and similar parts. (3) Use the oil stone to finish precision machined parts such as fitted parts and journals. (4) Use the wire brush to treat the threaded parts of the bolts. (5) When making adjustment, take care not to damage the lustrous black protective film. (6) Remove fine cracks by the grinder whenever possible. If not, give punch marks or open stop holes.	1. Operation items and cautions (1) For inspection, it is recommended to take out Rotor every four to eight years, and to remove the diaphragm and labyrinth packing including the lower half turbine casing. (2) It is recommended to open the steam turbine every four to six years and to inspect it. (3) In the initial inspection, disassemble and inspect it whenever possible and check for initial defects; then take appropriate measures. (4) Before starting inspection, check for the history and operation record since construction. Record each part in details. (5) The relative associated treatment such as centering, alignment and level before and after periodic inspection will affect the operation status at the time of operation startup. So their conditions and treatment must be made clear during the operation. (6) Conduct chemical analysis of the deposits and adhered substances as required, and arrange the data in chronological order to provide reference information for water treatment. (7) If there are deposits, adhered substances, corrosion and erosion, record the positions and dimensions, and take their photograph if required, thereby providing reference information for secular changes and the next periodic inspection. (8) Record the position of the cracks, and confirm their progress by checking the results with the previous record. This will be used as reference information to determine the time and scope of the next disassembly and inspection. 2. Secular change and precision inspection (1) The reliability of the equipment will be reduced if used for a longer period of time, so precision inspection is essential. The positions of high temperature and high pressure in particular require inspection of the secular change including the microstructure test. (2) It is recommended to select the appropriate positions at the following intervals and to conduct precision inspection: a) After 80,000 times for the first time b) Every eight years or after 60,000 to 80,000 hours for the second time and thereafter (3) It is recommended to select the appropriate positions of the equipment used for a long time (cumulative operation hours exceeding 100,000 or cumulative numbers of starts exceeding 2,500), and to diagnose the remaining service life.

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
			(7) Apply the seizure preventive agent and lubricating oil to the sliding parts, fit parts and threaded parts. (8) Apply sealing agent to the air tight section. (9) Replace all the consumable parts with new ones.	
b. Turbine casing	1. Do as follows in the inspection. a. Remove the upper half turbine casing, and inspect the turbine with the diaphragm and labyrinth packing installed. b. Do as follows as required: (a) Liquid penetrating test (b) Warpage measurement (horizontal joints)	1. During disassembling (1) Positional relationship in the turbine casing (2) Internal deposits and adhered substances (3) Erosion and corrosion of each part (4) Air tight conditions Steam leakage and contact of joint surface and air tight ring (5) Cracks and blowholes Especially check the steam inlets and flanges, inner and outer radius-machined parts, corners, reinforcement ribs, complicated forms and weld zones (6) Upper and lower horizontal joint surfaces (7) Fit parts (8) Contact (9) Internal parts (10) Sliding parts (11) Looseness Tightened and staked parts (12) Cracks, wear and seizure of bolts and nuts (13) Cracks and damages of washers (14) Contact, wear, curvature and erosion of the fin 2. During adjustment and disassembly Repeat the inspection items implemented during disassembling as required. Furthermore, check the following: (1) Clearance and contact of upper and lower horizontal joints (2) Levelness of upper and lower horizontal joints (3) Deformation and displacement of the casing	1. Disassembling (1) Remove the parts after confirming the tally marks. (2) Supply screws and fit parts with penetrating oil. (3) When heating the bolt and loosening it, take care not to overheat it. (4) Take care not to apply excessive force when disassembling and removing. To lift the upper turbine casing, measure the height at four corners using the appropriate guide. While measuring it, lift it until there is no contact between parts and no excessive force is applied to related parts. (5) Put the temporary cover on opened areas to ensure that foreign substances will not enter these areas. 2. Adjustment and assembly (1) Remove deposits and adhered substances from inside the turbine casing by sand paper, wire brush or buffing, clean it with a vacuum cleaner and compressed air. Use honing or shot blasting as required. (2) Use fine emery cloth, scraper and oil stone to treat the machined surfaces of the flange and similar parts. (3) Correct scoring on the fit parts by the scraper and grinder. (4) Use the wire brush to treat the threaded parts of the bolts. Especially the broken threads must be machined again. (5) When making adjustment, take care not to damage the lustrous black protective film. (6) Remove fine cracks by the grinder whenever possible. If not, give punch marks or open stop holes. (7) Repair the fin using oil stone or scraper. (8) Apply the seizure preventive agent and lubricating oil to the sliding parts, fit parts and threaded parts. (9) Apply sealing agent to the air tight section. (10) Carefully remove oil and grease by wiping. (11) Replace all the consumable parts with new ones. (12) Tighten the bolts, leaving a specified elongation. When tightening it by heat, take care not to overheat it. (13) Check for the tally mark, assembling accuracy, clearance and position, and record them.	1. Operation items and cautions (1) It is recommended to inspect it by removing the diaphragm and labyrinth packing including the lower half turbine casing every four to eight years. (2) It is recommended to open the barrel type steam turbine and inspect it every four to six years. 2. Secular change (1) Inspection of the inner and outer surfaces of the turbine casing of high and intermediate pressure for cracks. Check the steam flow paths, thermal stress concentrated area and weld zone on the inner and outer surfaces (high temperature side) of the turbine casing of high and intermediate pressure due to thermal fatigue, high temperature creep and casting defects on a priority basis. Treat the damaged cracks with skin cutting, scraping, providing stop holes or local repair. Round off the edges. (2) Inspection of the short tube weld zone in the external turbine casing of high and intermediate pressure Same as the above step (1) (3) Inspection of steam chest weld zone and inner and outer surfaces Same as the above step (1) (4) Inspection of main steam inlet expansion tube sealing When the clearance due to wear or erosion exceeds the tolerance, replace the seal ring with a new one. (5) Inspection of secular changes, major fit parts and air tight portions of the casing a) Measure the levelness, perpendicularity, thickness, displacement and through-center of the assembly section related to enter ring support, and evaluate the impact on the internal core. Adjust the center or offset it as required. b) If erosion, deformation or steam leakage is found on the contact and fit surfaces, repeat the contact or weld. c) Cracks due to low cycle fatigue are likely to occur to the nozzle fit part and structural corner. Check the radius-machined parts, and conduct precision inspection. (6) Inspection of high temperature bolts Perform visual inspection and measure the hardness. Bolts with deteriorated strength and toughness must be annealed again or replaced with new ones. Bolts with cracks due to high temperature creep must also be replaced with new ones. (7) Countermeasures against wear and erosion of the radial fin in the internal turbine casing Determine the repair and adjustment method according to the clearance value on the right, left, top and bottom, erosion and changes in heat consumption rate. To get back to appropriate thickness, replace the fin with the molded fin.

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
			(14) Do as follows as required: a) Conduct liquid penetrating test, measure the warpage of horizontal joint surfaces. b) Select the position of high stress level in the initial periodic inspection and the periodic inspection after long-term use, and conduct magnetic particle test.	(8) It is recommended to diagnose the service life after 100,000 hours of cumulative operations or cumulative 2,500 starts. For details, see the description of Operation Procedure (Appendix 3) "Guideline of the diagnosis of the remaining service life". (9) It is recommended to perform special precision inspection at the following intervals: a) After 80,000 times for the first time b) Every eight years or after 60,000 to 80,000 hours for the second time and thereafter
c. Diaphragm, nozzle and stationary blade	1. Do as follows in the periodic inspection: (1) Check the nozzle of the 1st stage of high and intermediate pressure. (2) Check the diaphragm installed in the turbine casing. (3) Conduct the following test as required: a) Liquid penetrating test b) Clearance measurement c) Throat measurement	1. During disassembling, adjustment and assembling (1) Deposits and adhered substances (2) Corrosion and erosion (3) Contact (4) Damage due to foreign substances (5) Cracks and blow hole (6) Fit parts (7) Cast parts and weld zone of the nozzle (8) Seal ring (9) Horizontal joint surface Steam leakage and contact (10) Deformation (11) Wear, damage and contact of the pin (12) Key, key groove and pin contact (13) Spring deterioration (14) Looseness of installation bolts and cracks (15) Clearance with shaft	1. Disassembling, adjustment and assembling (1) Remove the deposits and adhered substances by liquid honing, wire brush or emery cloth. Use the vacuum cleaner and compressed air for cleaning. (2) Use emery cloth and scraper to treat the horizontal surface. (3) Treat the fin with oil stone or scraper. (4) When fitting them into the casing, adjust the tally marks. (5) Apply lubricating oil, seizure preventive agent or sealing agent to the fit part with the casing and horizontal joint surface. (6) Tighten the horizontal joint bolt to give specified elongation.	1. Operation items and cautions (1) It is recommended to inspect it by removing the diaphragm every four to eight years. 2. Secular deterioration and reference cases (1) Inspection of nozzle box defect Cracks due to high temperature creep and low cycle fatigue are likely to occur to the structural welded corner, so check the radius-machined parts and conduct the precision inspection. If any defect is found out, remove defects by grinding if the wall thickness is within tolerance. If the tolerance is exceeded, repair it by welding. (2) Measurement of diaphragm deformation Occurrence and progress of deformation of the diaphragm by creep. Repair the diaphragm by machining if reduction for clearance during installation has reached below the tolerance. (3) Erosion test for the nozzle hole in the first stage of high and intermediate pressure. Erosion is likely to be caused by solid particles at the nozzle hole plate in the first stage of high and intermediate pressure. Check if erosion mitigation measures have been taken, and conduct precision inspection. When erosion and defects have been found, remove them by cutting back. If the tolerance is exceeded, repair it by welding. (4) Measures against wear and erosion of the radial fin Same as step 2 (7) for turbine casing. (5) Countermeasures against wear or erosion of the radial spindle strip Same as step 2 (7) for turbine casing (6) Countermeasures against wear or erosion of the diaphragm packing Same as step 2 (7) for turbine casing
d. Rotating blade	1. Do as follows in the inspection: (1) Gently rotate the shaft without removing it, and inspect the following: a) Blades and installations b) Shroud and lacing wire (2) Conduct liquid penetrating test as required.	1. During disassembling, adjustment and assembling (1) Deposits and adhered substances (2) Damage by foreign substances (3) Corrosion and erosion (4) Contact (5) Cracks and blow holes (6) Stopper blade Check the stopper blade for lift and the stopper for looseness.	1. Disassembling, adjustment and assembling (1) Remove deposits and adhered substances by liquid honing, wire brush and emery cloth. Use the vacuum cleaner and compressed air for cleaning. (2) Correct the cutter edge with the scraper and oil stone, and replace the severely damaged fins. (3) Replace the air tight fin if its clearance is not proper. (4) Remove oil and grease by wiping carefully when assembling. (5) Conduct liquid penetrating test as required.	1. Operation items and cautions (1) It is recommended to inspect the shaft by taking it out every four to eight years. (2) Measure the natural frequency of the blade as required. (3) Check each part for looseness by the sound produced in tapping. Measurement of the natural frequency of the blade will make it easier to find out defects. 2. Secular change and precision inspection (1) Countermeasures against nozzle profile erosion If erosion occurs to the profile trailing edge, performance will deteriorate, resulting in excessive stress produced in the impact stage. Replace the nozzle with a new one if it is close to the critical limit.

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
		(7) Inserted blade Check the inserted blade for inclination, looseness and gap with adjacent blade. (8) Shroud Check the shroud and tenon for lift and erosion. (9) Peeling and breaking of lacing wire, damping wire and silver soldered zone (10) Peeling, crack and erosion of the stellite, strip and silver soldered zone (11) Sealing (12) Contact, wear, discoloration, burr, crack,and corrosion of the air tight fin (13) Fit parts, clearance (14) Blade clearance (15) Inspection of dove tail hook		(2) Inspection of the 1st stage blade of high and intermediate pressure and dove tail hook Check for lift caused by cracks and deformation of the double tail hook due to high temperature creep. Conduct ultrasonic test as required. If any defect is found out, the blades must be subjected to sampling test. (3) Countermeasures against wear of radial clearance on the blade b) Same as step 2 (7) for turbine room (4) Inspection of the Rotating blade stellite in the final stage of low pressure Detects caused by SCC (stress corrosion crack) are likely to occur to the Rotating blade stellite in the final stage of low pressure. Check if measures have been taken to prevent sensitivity from being reduced. a) Silver soldered stellite If indications having a length of 3.2 mm or more are found on the boundary between the stellite section and silver solder, conduct ultrasonic test to see if the it is peeled or not. If peeling is detected, replace the stellite with the new one. b) Welding type stellite If any defect is found out by liquid penetrating test, remove the defect by grinding. Skin-cut the stellite surface layer of all other blades as required, and prevent stress corrosion crack by shot peeling. (5) Countermeasures against blade surface erosion Check the blades for erosions, deposits and adhered substances and notches on the 1st stage blade of high and intermediate pressure and large blade, dent on trailing edge, cracks on corroded and pitted sections, the shroud of fit parts, and magnetization of moistened areas. Replace the blades by new ones if they are close to the critical limit. (6) Countermeasures against erosion in the final stage of low pressure and large Rotating blade When erosion has progressed considerably due to water drops, cut off or grind the blade surface from the viewpoint of performance and strength. (7) Damping of the large Rotating blade of low pressure Inspect the lacing wires and installations. Also inspect to see if the damping and lacing wires due to vibration of the blade end and erosion, and installations are subjected to SCC (stress corrosion stress) and damage. (8) Inspection of the Rotating blade tenon of high and intermediate pressure. The blade tenons of the 2nd stage of high pressure and 1st and 2nd stages of intermediate pressure are likely to be subjected to erosion due to solid particle. Check how sunk tenons are used, and conduct precision inspection (9) Inspection of the rotating blade fork pin in the final step of low pressure. Check to see if the rotating blade fork pin on the final stage of low pressure is subjected to defects caused by SCC (stress corrosion crack).

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
				(10) Inspection of shroud ring Check to see if the shroud ring in the initial periodic inspection is subjected to damage due to high cycle fatigue. (11) It is recommended to diagnose the service life after 100,000 hours of cumulative operations or cumulative 2,500 starts. For details, see the description of Operation Procedure (Appendix 3) "Guideline of the diagnosis of the remaining service life". (12) It is recommended to perform special precision inspection at the following intervals: a) After 80,000 times for the first time b) Every eight years or after 60,000 to 80,000 hours for the second time and thereafter
a. Rotor and disk	1. Do as follows in the inspection: (1) Gently rotate the shaft without removing it, and inspect the following: a) Rotor b) Disk c) Balancing weight installation (2) Conduct liquid penetrating test as required.	1. During disassembling (1) Centering (2) Rotor position (3) Alignment (4) Rotor runout (5) Rotor level (6) Deposits and adhered substances (7) Corrosion and erosion (8) Contact (9) Heat group and labyrinth group (10) Journal and thrust collar (11) Core hole (12) Rotor ground system (13) Fit parts 2. During adjustment and assembly Repeat the inspection items implemented during disassembling as required. Furthermore, check the following: (1) Clearance of the blades and gaps and contact of upper and lower horizontal joints (2) Presence of oil in center hole	1. Disassembling (1) When lifting or lower them, adjust the level using a beam. In this case, take care not to damage the shaft and blade by contact. When placing the shaft on the support rest, put the lead plate and teflon under the support rest. 2. Adjustment and assembly (1) After treating the journal and thrust collar with oil stone, apply rust preventive agent , and protect it with tape. (2) Remove deposits and adhered substances and rust using wire brush or emery cloth. Use compressed air for cleaning. If required, provide liquid honing uniformly, leaving behind the protective film as it is. (3) Perform liquid penetrating test if required.	1. Operation items and cautions (1) It is recommended to inspect the shaft by removing it every four to eight years. (2) Carefully inspect the blade stage subjected to severe temperature and stress conditions. (3) It is recommended to adjust the balance of the shaft, or the shafts which exhibit considerable run out due to operation for eight to ten years, though vibration is not very big. (4) Replace the fin as required if the shaft packing is considerably worn or eroded. 2. Secular change and precision inspection (1) Inspection of rotor core hole Check if cracks have occurred in the rotor core hole due to high temperature creep. When any defect is found out, remove it by expanding the center bore or local grinding if considered as necessary. (2) Inspection of cracks at rotor disk base Cracks are likely to occur to the rotor disk base due to low cycle fatigue. Check how heat group is formed, and conduct precision inspection. If cracks are found out, skin-cut the rounded position. (3) Inspection of shrink fit parts of the thrust collar If any trouble is found out, take out the thrust collar and skin-cut the shrink fit part of the shaft. Remove fretting corrosion completely, and replace the thrust collar with a new one. (4) It is recommended to diagnose the service life after 100,000 hours of cumulative operations or cumulative 2,500 starts. For details, see the description of Operation Procedure (Appendix 3) "Guideline of the diagnosis of the remaining service life". (5) It is recommended to perform special precision inspection at the following intervals: a) After 80,000 times for the first time b) every eight years or after 60,000 to 80,000 hours for the second time and thereafter

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
f. Shaft coupling	1. In the inspection, check for external appearance.	1. During disassembly, adjustment and assembly (1) Runout of the coupling (2) Elongation of the coupling bolt (3) Centering (4) Coupling bolt and hole (5) Burr, damage and contact of coupling surface and spigot (6) Spacer fit parts (7) Turning gear (8) Shrink fit parts (9) Bolt cover retainer screw (10) Flexible joints Adhesion of oil contaminants, wear and seizure of the matching parts, and tooth damage (11) Cracks and galvanic corrosion	1. Disassembling (1) Before turning the rotor for runout or centering, fill the bearing with a sufficient amount of cylinder oil. Start measurement after oil film has fit with the surrounding area. (2) Check for the centering by turning together. (3) Disconnect the coupling spigot using a jack bolt. (4) Push out the reamer bolt with a jack, taking care to ensure that seizure will not occur. (5) Check bolts and nuts for tally marks, and keep them in store. 2. Adjustment and assembly (1) Use fine emery cloth or oil stone to treat the coupling flange surface and spigot. (2) Wash bolts and nuts in treated oil. (3) Set the tally marks of the bolts and tighten them to a specified elongation. (4) For flexible coupling, meshing is carried out by one set of gears.	1. Operation items and cautions (1) It is recommended to inspect it every four to eight years. 2. Secular change and precision inspection (1) The fixed coupling used for a long time should be checked for displacement of the coupling bolts and secular change of the spigot. Measure the service life of the gear coupling.
g. Steam gland	1. In the inspection, gently rotate the shaft without removing it.	1. During disassembling (1) Check if the inserted fin is damaged or loosened. (2) Check the fin cutter blade for contact, discoloration, absence, burr, wear and corrosion. (3) Check the sinking comb for wear, curvature, cutting loss and crack. (4) Damage of the retainer ring (5) Air tightness of the battery case, and fit parts (6) Packing clearance (7) Check if the clamping ring is damaged or loosened. (8) Cracks, damage, fatigue and elasticity of the spring (spring back method) (9) Fit parts of the rotary and fixed parts, and air tight ring (Barrel type steam turbine radial packing) 2. During adjustment and assembly Repeat the inspection items implemented during disassembling as required. Furthermore, check the following: (1) Spring tension (spring back method) (2) Movable amount (radial packing method)	1. Disassembling (1) Paying attention to the tally mark and stage, start disassembling. In this case, take care not to damage the fin. (2) When measuring the clearance, note the labyrinth position. Bend the lead line according to the undulations of the rotor groove, and bend both ends into segments to hold each other, so that it will not be disengaged. 2. Adjustment and assembly (1) Use the wire brush, sand paper and compressed air for cleaning. (2) Repair the contact trace at the tooth top sharply with a scraper. The severely damaged fin must be replaced.	1. Operation items and cautions (1) It is recommended to disassemble and inspect it every four to eight years. 2. Secular change and precision inspection (1) Countermeasures against wear and erosion of the gland and shaft packing Same as step 2 (7) for turbine casing

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
h. Bearing	1. In the inspection, check the bearing for external appearance.	1. During assembling (1) Rotor direction of the shaft (at zero point) (2) Oil gap of the bearing (3) Contact with turbine Rotor, contact width and surfaces under pressure (4) Scratch, discoloration, burnout, crack, peeling, lift, foreign substances and blow hole of the babbitt (5) Parallelism with the journal (6) Thrust gap (7) Contact surface of the thrust bearing pad, and pivot (8) Gap of the back face (9) Contact, dent and gap of bearing, adjust ring and spherical seat (10) Contact of bearing position adjusting pad (11) Galvanic corrosion (12) Loosened bearing (13) Deposits and adhered substances in oil path (14) Foreign substances, rust and oil leakage inside the bearing block (15) Contact, wear, deformation, deposits and adhered substances of the oil thrower 2. Adjustment and assembly Repeat the inspection items implemented during disassembling as required. Furthermore, check the following: (1) Bearing arc rate (2) Correction of white metal (3) Fitness and clamping allowance of the insert bushing (4) Bearing position adjust pad and assembly shim (5) Bearing retainer tightening torque (6) Levelness of the horizontal joint of the bearing stand (7) Misalignment due to foundation behavior (8) Loosened anchor bolt	1. Disassembly (1) Keep the bearing center ring adjust liner and shim in store by specifying their position and combination. (2) When measuring the bearing oil gap with the lead line, the diameter of the lead line must be 1.5 times or less that of the oil gap. (3) Measure thrust gap by moving the Rotor in the lateral direction. (4) For the oil thrower fin, pay attention to the labyrinth pattern. (5) Put plugs on the lubrication port and oil drain port after removing the bearing. 2. Adjustment and assembly (1) Use the scraper and oil stone to beat the horizontal and vertical joint surfaces and fit parts of the bearing block and bearing, adjust ring. (2) Use the scraper to remove foreign substances and scratches from the babbitt surfaces, and to make fine adjustment of the contact. In this case, adjustment must be kept minimum. (3) Babbitt surfaces are subject to damage. When handling them, take care not to damage them. Electric welding must not be carried out close to the bearing in particular. (4) Clean the bearing with treated oil, vacuum cleaner and compressed air. Use the oil proof sponge when treated oil is utilized. (5) Completely clean the oil path to the bearing. (6) When the axle is placed in the bearing, apply highly viscous cylinder oil to the journal, thereby providing for rotation of the axles for centering. (7) Confirm the tally mark of the metal, adjust ring and position adjust pad, and assemble it, paying attention to the direction and rotational direction. (8) Use the polished bronze plate polished steel plate and stainless steel for bearing liner adjustment. (9) Replace the sheet packing with a new one.	1. Operation items and cautions (1) Inspection must be conducted in conformity to intervals of removing the rotor. (2) Use the torque wrench to manage the tightening torque of the bearing retainer clamping bolts. (3) It is recommended to measure the metal loads when the bearing alignment has been corrected to a great extent. 2. Secular change and precision inspection (1) Confirmation of bearing arc rate The arc rate of the metal babbitt will deteriorate in conformity to the shaft by a long-time use, so check for arc rate, and correct the curvature rate if required. (2) Sliding of the bearing block Check the following to see if smooth sliding is ensured: a) Behavior and clearance of the bearing block guide b) Penetration of grease on the sliding plate c) Effective connections (interfaces) between turbine casing and bearing block Defects caused by piping force must be corrected on the piping side. (3) Secular changes on the foundation system, deformation of the sole plate and sliding failure and misalignment of bearing block must be inspected. (4) Inspection of metal babbitt a) Metal babbitt temperature rise b) Manufacturing fault c) Bearing load d) Entry of foreign substances into lubricating oil e) Shaft voltage

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
i. Turning gear	1. In the inspection, check the turning gear for external appearance. In the initial periodic inspection, disassemble and inspect it.	1. During disassembly [Mechanical system] (1) Clogging and presence of foreign substances in oil path (2) Wear and elongation of the drive chain or V-belt (3) Wear and play of the bearing and bushing (4) Wear, chipping, crack and tooth contact of the gear [Hydraulic system] (1) Presence of foreign substances in oil path (2) Crack and erosion of nozzle and nozzle box (3) Crack, wear and looseness of the blade in the turbine wheel 2. Adjustment and assembly Repeat the inspection items implemented during disassembling as required. Furthermore, check the following: [Mechanical system] (1) Gear tooth contact and backlash (2) Bearing gap (3) Drive chain deflection (4) Around the shaft (5) Tooth top clearance of clutch section [Hydraulic system] (1) Contact of joint surface with Rotor (2) Starting kick lever operation (3) Clearance nozzle and turbine wheel (4) Kick force	1. Disassembling [Mechanical system] (1) In disassembling, take care not to allow excessive force to be applied to the gear. [Hydraulic system] (1) If the blade has disengaged from the fit part of the spigot, lift it out, taking care not to allow it to contact the nozzle box. 2. Adjustment and assembly [Mechanical system] (1) Treat the scratches on the gear with the scraper, fine emery and oil stone. (2) Wash the shaft, bearing, gear and gear box in treated oil using the oil proof sponge, and clean them with compressed air. [Hydraulic system] (1) Wash the nozzle box interior in treated oil, and clean it with compressed air. (2) Use the scraper and oil stone to treat the turbine wheel joint surface and spigot.	1. Operation items and cautions (1) It is recommended to disassemble and inspect it every four to eight years. (2) Check for current value (mechanical) during the operation, kicking force at the time of startup and the number of rotations (hydraulic). 2. Secular change and precision inspection (1) In the plant featuring frequent starts and stops, conduct precision inspection on the following items every four to six years: [Mechanical system] Pitching and crack of the gear, wear and play of the bearing bushing, wear and elongation of the chain [Hydraulic system] Erosion of the blade

(2) Major valves

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
(Major steam stop valve, reheat stop valve, intercept valve, and oil barrel)	1. Do as follows in the inspection: (1) Disassemble the valve and check the strainer, valve body, valve seat and valve rod. (2) Conduct the following test as required: a) Liquid penetrating test b) Clearance measurement c) Curvature measurement	1. During disassembling (1) Contact of the valve, valve seat, valve rod and back seat (2) Cracks, erosion, wear and seizure of the valve rod (3) Deposits and adhered substances of valve rod and bushing (4) Wear and erosion of gland packing and bushing sleeve (5) Seizure and wear of high temperature sliding part (6) Loosened fit parts (7) Crack, erosion and blow hole of such casting as the valve casing Carefully check the drain hole, corner and weld zone in particular. (8) Crack and erosion of the weld zone and stellite parts (9) Steam leakage from the air tight portion and flange, and erosion (10) Crack, wear, fatigue and brittleness of bolts and nuts (11) Looseness, crack, erosion and wear of the baffle and pin (12) Connections (13) Crack and fatigue of the spring (14) Scratch and wear of the oil barrel piston and cylinder (15) Scratch and wear of the servo motor and pilot valve (16) Contact and wear of pin joint (17) Backlash and wear of the lever link mechanism (18) Cam, cam shaft, cross head and bearing 2. Adjustment and assembly Repeat the inspection items implemented during disassembling as required. Furthermore, check the following: (1) Gap between valve rod and bushing (2) Curvature and hardness of valve rod (3) Fatigue and elongation of high temperature bolt (4) Compression of packings (5) Tightened amount of the valve cover (6) Assembly-related dimensions of each part, clearance and position (7) Operation and characteristics	1. Disassembly (1) After confirming that there is no residual pressure, start disassembling. (2) Removal of the insulations must be kept minimum. The shape of the formed ones must be damaged. (3) Remove parts after confirming the tally mark. (4) Fill threads and fit parts with penetrating oil. (5) When disassembling, pay attention to the tightness and looseness of the bolts and nuts. When loosening the bolts by heating, taking care not to overheat it. (6) Take care not to allow excessive force to be applied to each part. Careful handling is required to ensure that scratch or curvature will not occur to the valve rod, valve body and air tight ring in particular. (7) Protect the valve seat with tape. (8) After removing, close the opening with a temporary cover. (9) When disassembling the oil barrel, uniformly loosen the bolts until the spring is completely released. 2. Adjustment and assembly (1) Remove the scale of the valve rod with oil stone and sand paper. If the valve rod runout is excessive, adjust the runout or repair the valve. If the valve rod is found to be eroded, replace the valve rod with a new one in principle. Remove scale inside the bushing by fine emery cloth, grinding or honing. (2) If scratches are found on the valve bod, valve seat surface and valve rod back seat surfaces, or their contact is not satisfactory, fit them properly. Use sand paper or oil stone to remove the scale from the valve body and seat surfaces. (3) Use the wire brush and buff to remove the scale from inside the valve casing, oxidized film or rust. Use the vacuum cleaner for cleaning. (4) Treat the air tight portion and fit parts with fine emery, oil stone or scraper. (5) Use the wire brush to treat the threaded parts of the bolts and nuts, and remove the scale. (6) Apply seizure preventive agent to the sliding parts, fit parts, air tight ring, and threaded parts. (7) Replace all consumables with new ones. (8) Apply sealant to the joint surfaces which must be kept air tight. (9) Confirm the tally marks and assembly related dimensions of each part, clearance and position, and record them. (10) Conduct liquid penetrating test of the strainer, valve body, valve seat and valve rod as required, and measure the clearance and curvature.	1. Operation items and cautions (1) It is recommended to disassemble and inspect valves every four to six years. (2) If the operation of the hydraulic operation mechanism is free of defect, it is not necessary to disassemble and inspect it for each periodic inspection. (3) After assembling, conduct on-off test, confirm operations and measure the lift. Also check the operation of protective devices. 2. Secular change and precision inspection (1) Inspection of high temperature bolts Same as step 2 (6) for turbine casing (2) Inspection inside and outside the valve body a) Check if cracks have been caused by casting defects inside and outside the valve body. Cracked and damaged portions must be subjected to skin-cutting, scraping, hole stopping or local repair. The edged portion must be rounded off. b) The structural welded corner is subject to low cycle fatigue, so check radius-machined parts and conduct precision inspection. (3) Inspection of hydraulic cylinder and piston For the unit which has been used for a long time, confirm the damages caused by foreign substances on the inner and outer diameters of the cylinder piston. Replace the piston ring if defective. (4) Inspection of the pilot valve, relay damp valve and bushing For the unit which has been used for a long time, confirm the foreign substances and damages. If faulty, provide fitting or similar treatment. (5) Replacement of the sheet packings for all the hydraulic equipment To prevent leakage resulting from faults of the packing due to deterioration, replace the packings of the unit which has been used for a long time. (6) Inspection of valve rod stellite In the event of failure, provide build-up welding in the factory or replace the valve rod with a new one. (7) Inspection of the main valves, valve rods and bushings The vibration of the valve rod will be increased by expansion in clearance with the valve rod. This will result in cutting loss and reduced efficiency. If the clearance with the valve rod is 0.2 to 0.5 or more, consider replacement of the valve rod bushing. a) Check if erosion has been caused by the solid particle of the valve body seat. b) Especially the auxiliary valve of the main steam stop valve is likely to be eroded by solid particles. Check if erosion mitigation measures have been taken, and conduct precision inspection. c) Check if erosion, crack and increase in clearance has occurred to the valve rod for the following reasons: (a) Solid particle (b) Vibration (c) High cycle fatigue

(3) Governor

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
(Governor, emergency stopper, extraction pressure governor and control related equipment)	1. In periodic inspection, inspect the governor link mechanism and emergency governor trip mechanism for external appearance, and check the operations of the emergency governor and auxiliary oil pump.	1. During disassembling, adjustment and assembling [Governor] (1) Fatigue, crack and deformation of the bellows and diaphragm (2) Sludge and foreign substances in oil orifice, strainer and pole check (3) Scratch and wear on the sliding surfaces of the servo motor, pilot bushing and valve (4) Wear of levers, wear and burr of the pin and piston tops, and conditions of the baffle (5) Wear, deformation and damage of the sprig and bearing (6) Assembly related dimensions of each part, clearance and position (7) Loosened parts [Emergency governor] (1) Wear, burr, deformation and clearance of the jumping fitting tip latch, and wear of pawls and links (2) Trip lever pin and lock bolt (3) Spring fatigue and deformation (4) Scratch and corrosion of the sliding parts of the spindle and bushing (5) Loosened spring and adjust screw (6) Assembly related dimensions of each part, clearance and position [Extraction pressure governor] (1) Wear and looseness of the pin and set screw (2) Wear, burr and sliding of the piston and cylinder of the hydraulic mechanism (3) Oil leakage (4) Foreign substances, deposits and adhered substances (5) Assembly related dimensions of each part, clearance and position [Control related devices] (1) Wear and deformation of the connection pin, bearing, baffle and split pin (2) Sliding and wear of the servo motor and pilot (3) Friction of levers and links (4) Loosened lever and cam mechanism	1. Disassembling (1) Disassembling must be made to enable checking of the parts which are subject to wear and seizure. (2) Carefully check the constantly used positions for wear, deformation and seizure. (3) Put tally marks to the required positions before disassembling and record the dimensions so that adjustment will not be affected in assembling. 2. Adjustment and assembly (1) Wash the disassembled parts with detergent, and clean them with compressed air. Use the oil proof sponge to wipe off oil and sludge. (2) Remove burrs with oil stone. Do not round off the sharp edge such as the corner of the oil pot. (3) Readjust the items having the wear and clearance beyond the specified values. (4) When opening, extreme care must be taken not to allow dust particles to enter. (5) Before reassembling, carefully clean them so that dust and soil will not remain. (6) Based on the assembly drawing, assembly and installation record and adjustment record, reassemble them according to the procedure when disassembling. (7) Record all adjustments made since disassembling, including change of the setups. (8) For reassembling, operate each of the rotary units and sliding parts and make them break in by using common oil. Make sure that the operation is smooth and easy.	1. Operation items and cautions (1) It is recommended to inspect the following every four to eight years: a) Check the lever and link mechanism for wear and rust. b) Check the servo valve and solenoid valve for entry of foreign substances and wear. c) Check the hydraulically operated equipment for wear. 2. Secular change and precision inspection The units having been used for six to eight years must be subjected to precision inspection for the following items: (1) Confirm the hydraulic pressure to check for such defects due to secular changes as hysteresis, backlash, deviation from the setvalue, and reproducibility. (2) Disassemble such control governors as load limiter, governor, hydraulic governor, oil trip equipment and bellows, and check the sliding part, pin joint, lever mechanism and fixed pin for accuracy, break-in, contact, backlash, wear and presence of sludge and foreign substances in details. (3) Disassemble the servo motor and pilot valve, and check the pilot valve, sleeve, piston, cylinder, pin joint, connection lever, spring, thrust metal, righting cam and guide of the high speed rotary unit for thickness of fit parts, break-in, wear and contact in details. (4) Check for the backlash or adhesion caused by the wear and rust of the lever link mechanism. (5) Check the electrohydraulic governor for scratch or backlash due to entry of foreign substances into the servo valve and solenoid valve in particular. (6) In the case of high pressure electrohydraulic governor, pay attention to flushing of control oil.

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
		(5) Degeneration of rolling and seal packing (6) Assembly related dimensions of each part, clearance and position [Electrohydraulic system] (1) Check the servo valve for the amount of oil. (2) Check for dynamic and static characteristics (3) Others are based on the above description.		

(4) Oil hydraulic system

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
a. Oil	1. Inspect the oil every one to two years.	1. Oil properties and deterioration (1) All oxidization (2) Dynamic viscosity (3) Hue (4) Others	1. Sampling of the oil must be made at one position in chronological order for the purpose of comparative study of the oil returned from bearing and that in the oil reservoir.	1. Operation items and cautions (1) The vessel in which oil is transferred must be carefully cleaned by the common oil. When filling with oil, remove water and foreign substances by passing it through oil purifier. (2) Since oil is deteriorated by long-time use, analyze the oil properties with the passage of time to determine the time for oil replenishment and replacement. (3) The amount of oil to be replenished must be 5 percent or less. 2. Secular change and precision inspection (1) Replace the deteriorated oil with new one. (2) Temporary install manometers on the bearing stand and oil Tank, and confirm the negative pressure effect.
b. Oil Tank	1. In the inspections, remove oil and conduct inspection.	1. During disassembling, adjustment and assembling (1) Type and amount of the sediments at bottom (2) Peeling of internal painting, deterioration and rust (3) Loosened clamping bolt inside the Tank (4) Deterioration and wear of packings (5) Foreign substances passing through the strainer, rust and damage (6) Warpage and deformation of the on-off door for inspection (7) Oil level gauge (8) Air tightness in the Tank	1. Disassembling, adjustment and assembling (1) Drain and discard the contaminated oil remaining in the Tank bottom. (2) When working in the oil Tnak, blow in compressed air into the Tank to improve circulation of air. Enter the Tank barefoot. (3) To clean inside, impregnate deer skin or oil proof sponge with treated oil, and wipe inside the Tank all the way from end to end. Do not use rags. (4) Apply the rust preventive paint again to the position in the oil Tank where rust preventive paint is peeled off or is rusty. Dry it sufficiently. (5) The strainer for returned oil must be washed in treated oil. Use compressed air to blow off the foreign substances. (6) Take care to ensure air tightness of the on-off door of the Tank.	
c. Oil cooler	1. In the inspections, open the oil cooler and inspect it.	1. During disassembling, adjustment and assembling (1) Water chamber a) Type and amount of contaminants, deposits and adhered substances b) Crack, corrosion and erosion c) Crack on the diaphragm base d) Peeling of the inner wall coating (2) Cooling small tubes and tube plate a) Type and amount of clogging, deposits and adhered substances inside and outside the cooling tube b) Erosion and corrosion c) Crack of the expanded parts (3) Packing (4) Consumption of corrosion proof zinc plate	1. Disassembly (1) To drain oil, connect the hose to the piping, and transfer oil to the catch pan; then transfer it into the houser and drum can through the film press. (2) When lifting the tube bundle, take care not to allow the tube bundle baffle to contact the cooler inner cylinder. When lowering the tube bundle, use a wooden frame not to damage the cooler tube or tube plate. 2. Adjustment and assembly (1) Use the brush or compressed air to clean the inner side of the cooling tube. Wash the outer side of the cooling tube with the proper solvent. Use compressed air for cleaning. (2) Repair the eroded parts of the air tight section. (3) Repair the wall in the water chamber if coating is peeled off. (4) Replace the packing with a new one. (5) After assembling, conduct water pressure or hydraulic test, and make sure that there is no leakage.	1. Operation items and cautions (1) Whenever the coolant is considered to be leaking, inspect for leakage. 2. Secular change (1) Conduct eddy current inspection of the cooling small tube to check for the degree of corrosion and reduced wall thickness. It is also necessary to predict the service life with consideration given to remaining performance allowance.

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
d. Oil pump	1. Disassemble and inspect the main oil pump and its fan, and periodic inspection. Disassemble and inspect other pumps every four to eight years.	1. During disassembling (1) Centering (2) Contact, corrosion, erosion, wear and crack of the impeller and runner (3) Friction of the mouth ring and bushing (4) Damage and wear of the gland packing (5) Shaft runout, friction and wear (6) Bearing contact and wear (7) Damage on the inner surface of the casing (8) Gear pump tooth contact and wear, damage of the piston, cylinder and rod (9) Coupling (10) Looseness and fretting of fit parts (11) Flange surface (12) Contamination and clogging of the oil path (13) Galvanic corrosion of each part 2. Adjustment and assembly Repeat the inspection items implemented during disassembling as required. Furthermore, check the following: (1) Clearance of the impeller, liner and casing (2) Gas between the mouth ring and bushing (3) Shaft runout (4) Bearing gap (5) Thrust gap (6) Clearance of labyrinth packing (7) Fit parts (8) Centering	1. Disassembling (1) Check each part for tally marks before disassembling. (2) When removing the rotary parts, take care not to allow excessive force to be applied to the bearing, mouth ring and busing. (3) Taking care not given dents, apply oil to the disassembled parts to prevent rust from growing. Cover them with vinyl to prevent dust from attaching to them, and keep them in store. 2. Adjustment and assembly (1) Use the fine file and scraper to smoothen the main shaft journal, mouth ring and bushing, and use emery cloth to finish them. (2) Finish the bearing metal with the scraper. (3) Wash such parts as bearing, oil path and casing with treated oil, and clean them with compressed air. (4) Finish the casing joint surface with oil stone. (5) Remove old sealing agent from the flange surface with the scraper and oil stone. (6) Be sure to replace the consumables with new ones. (7) Check for tally marks, and assemble the parts while measuring clearance of each part. (8) After reassembling, be sure to turn it manually, and confirm that it is free of troubles.	1. Operation items and cautions (1) Disassemble and inspect the main oil pump and the paper fan in the periodic inspection. Disassemble and inspect other pumps every four to eight years, if there is no trouble during the operation. When cleaning the oil Tank, remove the suction strainer and check only the runner. (2) In the periodic inspection, perform the following operation test: a) Automatic startup test for auxiliary oil pump b) Automatic startup test for emergency oil pump 2. Secular deterioration and reference cases (1) Check the main oil pump, governor impeller, bushing and shaft for fretting and corrosion. Also check for clearance. If required, repair the inner and outer diameters and replace parts. (2) For the condensate turbine, galvanic corrosion may occur to the main oil pump bearing depending on the operating conditions. If galvanic corrosion is found out, take appropriate measures.
e. Hauzeur	1. Disassemble and inspect it once in one to two years.	1. During disassembling, adjustment and assembling (1) Deposits and adhered substances in each chamber (2) Contamination of the filter bag and cartridge filter (3) Deterioration of lubricating oil (4) Contamination, deposits and adhered substances (5) Leakage of lubricating oil	1. During disassembling, adjustment and assembling (1) Feed oil into the batch tank or drum can using the filter press. (2) The oil left in the sedimentation chamber is much contaminated and is mixed with leaked water, so discard about 50 liters. (3) Replace the bag filter once in one or two years. Wash the dirty bag with proper liquid and dry it completely; then it can be used again. (4) Disassemble and replace the cartridge filter which has reached the specified differential pressure.	

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
f. Other hydraulic circuit and related equipment	1. To be determined according to the operating conditions	1. During disassembling, adjustment and assembling (1) Foreign substances and damage of each strainer (2) Sludge in the piping lines and loosened joints (3) Deterioration of packing (4) Operation and wear of check valve (5) Crack, wear and seizure inside the selector valve (6) Hydraulic pressure adjust unit (7) Inspection from the viewpoint of fire prevention (8) Hydraulic pressure adjustment value	1. Disassembling, adjustment and assembling (1) Wash the strainer and filter in treated oil, and clean them with compressed air. (2) If required, fit the valve seat surfaces and replace the gland packing. (3) Replace all joint packings with new ones. (4) To prevent fire, parts subject to oil leakage must be provided with a catch pan.	
g. Oil flushing	1. Oil flushing must be performed in inspections.	1. Flushing (1) After re-assembling the oil circuit and related equipment, keep oil flowing, and check that the system interior is cleaned. Check the following points for foreign substances: a) Bearing lubrication strainer b) Tank return oil strainer c) Other strainers (2) Oil properties on completion of flushing (3) Check that the operation can be made.	1. Preparation for flushing (1) Dissemble and remove the hydraulic adjustment orifice in the circuit and easily reassembled parts. If the parts cannot be removed, fully open such positions and operate them. (2) Incorporate the flushing strainer in the strainer box. (3) Use the oil for operation. 2. Oil flushing (1) Using the oil pump, keep a maximum amount of oil flowing, so that the equipment in the system (bearing stand and servo motor) are not overflowed, and the motor is not overloaded. (2) For shaft strainers, check for the amount and contents of the recovered foreign substances every four hours or when the differential pressure before and after the strainer has reached 0.5 kg/cm^2. Remove other filters and strainers as required, and inspect and clean them. (3) Make sure that the oil level in the oil reservoir reaches the standard level when the pump is operating. (4) Oil must have a normal temperature. Oil temperature is adjusted by oil cooler to ensure that it will not exceed 60 degrees Celsius even if it is raised by the operation of the oil pump. (5) To increase the cleaning effect, study the possibility of performing flushing in two parts by opening and closing the oil feed line. (6) Use the oil cleaner at all times during flushing to ensure circulation of clean oil. (7) Carefully watch oil temperature, pressure, current and oil level in the Tank during flushing, and record the results on a periodic basis. (8) Perform flushing until there are no more foreign substances in the system.	1. Operation items and cautions If oil is found to be deteriorated or contaminated, remove the equipment and branch tubes which can be disassembled. Check if foreign substances are contained in the system and if rust grows in the tube. Perform flushing thoroughly. To do so, flushing may be divided into two parts; the primary and secondary flushing, if required.

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
			3. Reassembly after flushing Completely reassemble the positions set up for flushing and the parts removed for flushing, and recover the original state. Make sure that they are ready for operation.	

(5) Condenser

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
a. Condenser shell	1. In the inspection, open and check the condenser shell.	1. During disassembling (1) Corrosion, deposits and adhered substances on the outer surfaces of the small condenser tube (2) deformation, corrosion and erosion on the following positions: a) Shell plate b) Stay tube c) Expansion joint d) Baffle plate e) Tube support plate f) Strainer g) Support spring 2. After cleaning and adjustment (1) Cracks of the shell plate, tube, drain intake nozzle stub expansion joint and stay installation welds, general corrosion and erosion (2) Damage of drain intake nozzle stub structures (3) Loosened bolts for connection with intermediate shell (4) Damage due to vibration of the condenser tube of the tube support plate (5) Ammonia attack on the air cooling zone condenser tube (6) Erosion of the condenser tube due to drain inflow (drain from the boiler startup bypass system)	1. Operation items and cautions (1) Countermeasures against oxygen shortage a) Ventilation b) Measure oxygen concentration. (oxygen shortage) (2) Use of safety work light a) Use of low voltage illumination (24 volt) b) Use of cabtire cable (3) Opening the manhole a) Take care not to damage the gasket. b) When cleaning, take care not to damage the inside. Use the rubber-soled shoes when working. 2. Cleaning and adjustment (1) Wash out deposits and adhered substances in water and perform cleaning. (2) When reassembling, confirm that the interior is free of foreign substances or things left behind.	1. Operation items and cautions (1) Conduct chemical analysis of deposits and adhered substances if required, in order to provide information of water treatment. (2) To inspect the baffle plate, especially check the drain inlet for erosion, and the air outlet for corrosion. (3) Also check the piping such as the gland steam tube installed inside for corrosion and wear. (4) Perform visual inspection and liquid penetrating test of the shell plate drain intake nozzle stub. (5) When the belt type rubber expansion joint is used for five years or more, check for damage, and measure the rubber hardness. The service life is considered to be about ten years. It is recommended to replace it with a new one after the lapse of ten years.

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
b. Water chamber and tube plate	1. In inspection, open the chamber for inspection.	1. During disassembling (1) Deposits and adhered substances in water chamber and tube plate 2. After cleaning and adjustment (1) Peeling and damage of the rust preventive coating and lining (2) Corrosion of the diaphragm (3) Wear of the corrosion-proof zinc plate (4) Defects of cathodic protection equipment a) Cathodic protection electrode b) Segregation by overcurrent c) Insulation resistance (5) Defects of tube plate installation bolts	1. Operation items and cautions (1) See the description of the condenser and condenser shell. (It is slippery inside the water chamber, so build a scaffold or take other safety measures.) (2) Opening the cover of the water chamber a) Make sure that the water chamber contains no water. b) Take care not to damage the cover gasket surfaces 2. Cleaning and adjustment (1) Use a brush to remove rust, deposits and adhered substances from the water chamber and tube plate, and use water to wash them. (2) When cleaning, take care not to damage the metal surface and lining. (3) To put on the cover, tighten it uniformly to prevent uneven tightening.	1. Operation items and cautions (1) To clean inside the water chamber, take care not to damage the lining. (2) Inspect corrosion and erosion on the tube plate on the inner surface of the water chamber and tube end (galvanic attack on the titanium tube inserted position). (3) When sea water is used, open and inspect them according to periodic inspection.
c. Condenser tube	1. In the inspection, open the water chamber and check the condenser tube. Perform the following test as required: (1) Condenser tube leakage test (2) Eddy current inspection of the condenser tube	1. During disassembling (1) Defect of the tube end (2) Foreign substances, deposits and adhered substances on the tube inner surface 2. After cleaning and adjustment (1) Corrosion and erosion on the tube inner surface (2) Defect of the tube expansions (3) Defect of the stopper 3. After assembling (1) Fill the shell side with water and check for leakage.	1. Cleaning and adjustment (1) Take care not to damage the protective film of the aluminum plumb tube. (2) Use the nylon and brush rubber to clean the tube inner surface with compressed air and pressurized water. (3) Check the number of the brushes before and after cleaning, and make sure there is no brush left behind inside the tube.	1. Operation items and cautions (1) Sample the test tube according to the conditions, and check for corrosion. (2) Inspection records are used as reference for observation of the secular change, and to provide a guide for repair and modification. (3) If required, conduct eddy current inspection to check for deposit and inlet attack. (4) If the tube wall thickness is reduced to 1/2 or the variation equivalent to 1/2 of the wall thickness as a result of the eddy current inspection, consider the feasibility of replacing the tube with a new one. (5) When sea water is used, it is recommended to inspect them according to periodic inspection.
d. Condenser cleaning equipment	1. Open the condenser cleaning equipment in inspections.	1. During disassembling (1) Brush cleaning a) Damage of the basket b) Wear of the cleaning brush (2) Ball cleaning a) Ball collector b) Valve related to the collector operating portion c) Damage if provided with rust preventive treatment	1. Operation items and cautions (1) In the case of brush cleaning, see the description of the water chamber and tube plate. (2) In the case of ball cleaning: a) See the description of the water chamber and tube plate. b) Make sure that water is not contained in the tube. 2. Repair and cleaning See the description of the water chamber and tube plate.	1. Operation items and cautions (1) When sea water is used in ball cleaning method: a) It is recommended to disassemble and inspect the ball circulating pump collector piping in the initial inspection. b) Determine the time period for disassembling according to the result of the above inspection.

(6) Heat exchanger attached to the steam turbine

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
a. Feed water heater	1. In inspection, open the water chamber, and check inside the chamber as well as the small condenser tube. Test leakage on the feed water side as required.	1. During disassembling (1) Deposits and adhered substances in the water chamber flow adjusting cylinder (2) Discoloration and rust (3) Damage, corrosion and erosion (4) Loosened bolts, and leakage from the diaphragm gasket seal 2. After cleaning and adjustment (1) Corrosion and erosion in the water chamber (2) Cracks of radius-machined parts in the water chamber, radius-machined parts of the diaphragm, the water chamber partition plate, the water chamber welds (3) Leakage from the tube mount (4) Damage of the tube plate surface and tube end (5) Tube stopper (6) Damage caused by steam drain of heating condenser tube outer surface (7) Damage of the heater tube protective cover (8) Damage caused by ammonia attack (low pressure feed water heater) 3. After assembling (1) Conduct hydraulic test to confirm that there is no leakage.	1. Operation items and cautions (1) Completely remove drain before disassembling and make sure that there is no pressure inside. (2) Open the water chamber. 2. Cleaning and adjustment (1) Clean the water chamber using the wire brush, scraper, emery cloth and vacuum cleaner. (2) When wiping, do not use the cloth which is likely to produce lint. (3) Use scraper and wire brush to treat the flange surface, bolt and nut; then apply specified compound to them. (4) Replace the gasket which has been used once. (5) Clean inside the tube by brushing, water flushing and compressed air. (6) Record the position where the stopper test tube is handled. (7) Make sure there is no foreign substance or other thing left behind inside. (8) Apply water pressure from the feed water side and check for leakage.	1. Operation items and cautions (1) When pressure is applied to the feed water side after shutting down the turbine during periodic inspection, check the drain water level for changes, and make sure there is leakage inside. (2) Conduct chemical analysis of deposits and adhered substances as required, to provide information for water quality control. (3) Conduct liquid penetrating test of the heater tube welds and similar positions which are subject to cracks. (4) To clean the tube, use water jet cleaning or brush cleaning, depending on the degree of contamination and form of the tube. (5) Conduct eddy current inspection whenever possible, and check the degree of damages chronologically. (6) Check for inlet attack due to feed water eddy flow or solid materials and others in feed water. (7) Check the water chamber partition plate for cracks caused by increased differential pressure on the feed water side. (8) Check the radius machined parts of the water chamber for cracks due to low cycle fatigue.
b. Air ejector	1. Inspect the air ejector every four years.	1. During disassembling (1) Corrosion and erosion of the nozzle diffuser (2) Deposits, adhered substances, discoloration and rust (3) Check the tube plate and water chamber for corrosion, erosion and cracks. 2. After cleaning and adjustment (1) Foreign substances and erosion inside the tube (2) Defects of the tube expansions (3) Clogging and damage of the strainer (4) Damage of the condenser tube by ammonia attack 3. After assembling (1) Conduct hydraulic pressure or pneumatic pressure to make sure that there is no leakage.	1. Cleaning and adjustment (1) Use emery cloth to treat the nozzle diffuser. (2) Use the wire brush to clean inside the small tube. (3) Use the nylon brush to clean inside the small tube. (4) Flush the small tube outer surface with water as required. (5) Use the scraper or wire brush to finish the joint surface, bolt and nut. (6) Use soft copper wire to remove the foreign substances clogged in the nozzle. (7) Using hydraulic pressure or pneumatic pressure, check the small tube and valves on the vacuum side for leakage. (8) Apply pressure to either the inter-cooler or after-cooler to check for leakage.	1. Operation items and cautions (1) Apply water pressure after shutting down the turbine, check the air ejector and cooler for leakage according to the drain water level. (2) Take care not to damage the nozzle inner surface. (3) Inspect the nozzle diffuser for wear, and the nozzle mount for looseness every four to six years. (4) Check the valves for leakage every four to six years.

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
c. Gland steam condenser (a) Main body	1. Inspect the gland steam condenser every two to four years.	1. After disassembling (1) Deposits and adhered substances in the cooling tube of the water chamber (2) Damage and leakage in tube expansions (3) Defects of the spring, valve rod and guide of the bypass valve in the water chamber (4) Corrosion and erosion of the small cooling tube 2. After assembling (1) Conduct hydraulic test to make sure that there is no leakage.	1. Operation items and cautions (1) Completely remove drain before disassembling. (Make sure that it is empty) 2. Open the water chamber cover. 3. Repair and cleaning (1) After water flushing, jet cleaning and brushing, determine the cleaning method, depending on the degree of contamination. (2) When wiping, do not use the cloth which is likely to produce lint. (3) In the case of hydraulic pressure, gradually increase the pressure to the specified value and hold it for the specified time. (4) Replace gaskets with new ones. (5) Make sure there is no foreign substance or other thing left behind inside. Then recover them.	1. Operation items and cautions (1) When the turbine is shut down, check the condensate pressure to see if there is any leakage. (2) If there is no contamination, part of the work may be omitted. (3) If water pressure cannot be applied for the structural reason, actual fluid may be used to apply pressure. (4) Check the bypass valves by liquid penetrating test.
(b) Gland steam exhauster	1. Inspect the gland steam exhauster every two to four years.	1. After disassembling (1) Shaft runout, wear and friction (2) Contact wear, erosion and crack of the impeller runner (3) Bushing friction and wear (4) Bearing defects (5) Damage on the inner surface of the casing (6) Damage and wear of gland packing	1. Operation items and cautions (1) When disassembling the rotary parts, take care not to allow excessive force to be applied. 2. Repair and cleaning (1) Use the sand paper, treated oil and rags to treat disassembled parts. (2) Replace the defective bearings according to the inspection result. 3. Assembly and recovery (1) Replace lubricating oil. (2) Measure vibration.	
d. Deaerator	1. Open and disassemble the deaerator in inspections.	1. During disassembling (1) Deposits and adhered substances (2) Deformation, corrosion and erosion a) Inner surfaces of the reservoir and deaerator b) Piping inside the deaerator and feed water piping c) Distributor, baffle plate, diaphragm, tray and tray support plate d) Nozzle hole, injection valve and valve seat 2. After cleaning and adjustment (1) Damages such as corrosion, erosion and crack (2) Defects of the nozzle hole, injection valve, valve seat, spring and tray (3) Foreign substances, erosion and crack inside the feed water tube, heater tube and equalizing tube	1. Operation items and cautions (1) See the description of condenser and condenser shell. (2) When entering the deaerator, use the clean working uniform and footwear and take care not to allow foreign substances to drop inside the tube. Take only the minimum required tools with you, and take care not to allow them to drop inside the tube or leave them behind when you get out. (3) Since the reservoir bottom is curved, take care not to slip. 2. Cleaning and adjustment (1) Take the utmost care when assembling the air tight portions of the installed parts. (2) Use only the carefully treated internal installation bolts. (3) When the parts are covered with lustrous black film without deposits and adhered substances, wash them in water or wipe them with cloth, taking care not to damage the film.	1. Operation items and cautions (1) For the safety valve of the deaerator, see the description of Boiler Part, 2 (1) d. Safety Valve. (2) Conduct chemical analysis of deposits and adhered substances as required, and provide feed water treatment. (3) Record the observation and inspection results. (4) Record the positions and dimensions of corrosion, erosion and crack if any, and compare them with the previous records to have information on the progress of such defects; this will provide guiding information for the next inspection. (5) Adjust the set load on the injection valve spring, depending on the inspection results, and replace the worn parts with one ones (at intervals of 4 to 6 years). (6) Measure the wall thickness of the eroded parts. (7) Use a grinding to remove small erosions from the deaerator chamber shell inner surfaces. The parts with serious erosions, however, must be provided with build-up welding, and must be equipped with a protective cover. (8) Check for oxygen shortage.

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
		(4) Tube plate and tube expansions if provided with bent condenser	(4) Use the wire brush to remove deposits and adhered substances from the reservoir inner surface, tray heater tube outer surface, baffle plate or diaphragm; then wash them in water. Deformed trays must be repaired or replaced with new ones. (5) The cooling tube inner surface of the heater tube and bent condenser must be cleaned with the nylon brush as required. (6) Use the scraper and wire brush to finish the joint surfaces, bolts and nuts. (7) Use a soft copper wire to remove foreign substances clogged in the nozzle hole of the feed water distribution and injection valve. (8) After cleaning inside, keep the manhole closed except when it must be opened. (9) Replace the gaskets with new ones. (10) Make sure that there is no foreign substance or other thing left behind.	

(7) Auxiliary pump

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
a. Condensate pump	1. Inspect the condensate pump every two to four years.	1. During disassembling (1) Damage by foreign substances and seizure (2) Clearance of each part (3) Corrosion and erosion (4) Defects of shaft, bearing and journal (5) Defects of gland 2. After cleaning and adjustment (1) Crack, wear, erosion and damage of the impeller, guide vane and casing (2) Measure the shaft curvature and runout. (3) Looseness of fitparts such as impeller and sleeve (4) Bearing contact wear (5) Measure the levelness of the sole plate 3. During and after assembling (1) Measure the main shaft movement. (2) Inside the casing (3) Tightness of the casing, gasket and bolt (4) Bearing fit conditions (5) Tightness of the shaft seal part (6) Measure the centering. (7) Conduct test operation (after assembling).	1. Disassembling (1) Disconnect the coupling from the drive unit, and remove the drive unit. (2) Discharge drain from the casing, oil and coolant from the bearing box. (3) Remove the shaft seal part and stuffing box; then disassemble the main shaft and casing, and check each part. (4) Put on tally marks whenever required. 2. Cleaning and adjustment (1) Clean inside the impeller, guide vane and casing with emery cloth and rags. (2) Finish the journal, gland and thrust collar with oil stone. (3) Wash the bearing in proper solvent and clean it with compressed air. If contact is satisfactory, use a scraper to remove only the foreign substances included in the white metal surface. Damages must be provided with minimum repair. Wash the cutless bearing in water. 3. Assembly and recovery (1) Measure the clearance of each part. (2) Take care of the flanges and other connections at vacuum parts. (3) When placing the gland packing in position, confirm the spacer position. (4) Conduct the test to pass water through the seal water parts. (5) Replace the packings with new ones. (6) Make sure that there is no foreign substance or other thing left behind inside	1. Operation items and cautions (1) Remove the coupling bolt from the vertical pump; measure the clearance at this time. (2) According to the result of disassembling and inspecting the cutless bearing, determine the time for replacement. 2. Secular deterioration and reference cases (1) Check the lever for corrosion. (2) Carefully finish the attached piping. (3) Determine the time of disassembling according to water quality.

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
b. Circulating water pump	1. Inspect the circulating water pump every two to four years.	1. During disassembling (1) Deposits and adhered substances on the inner and outer surfaces of casing and suction tube (2) Damage due to foreign substances and seizure (3) Clearance of each part (4) Corrosion and erosion (5) Defects of shaft, bearing and journal (6) Gland damage (7) Wear of the cathodic protection electrode and corrosion preventive zinc plate (8) Corrosion of suction tube and protective tube (9) Defects of back wash valve and water chamber connection valve (10) Differential settlement of the circulating water pipe 2. After cleaning and adjustment (1) Crack, corrosion, erosion and wear of the impeller, shaft, sleeve, casing and wear ring (2) Looseness of the wear ring, sleeve and impeller fit parts (3) Shaft curvature (4) Connection pin inside vertical pump fixing sleeve 3. During and after assembling (1) Measure the main shaft movement and thrust position. (2) Inside the casing (3) Tightness of the casing, gasket and bolt (4) Bearing fit conditions (5) Tightness of the shaft seal part (6) Joint installation and gear coupling lubrication (7) Measure the centering. (8) Conduct test operation (after assembling).	1. Disassembling (1) Disconnect the coupling from the drive unit. (2) Discharge drain from the casing, oil and coolant from the bearing box. (3) Remove the shaft seal part and stuffing box; then disassemble the main shaft and casing, and check each part. (4) Put on tally marks whenever required. 2. Adjustment and cleaning (1) Clean the impeller with emery cloth and rags. (2) Remove the deposits and adhered substances from the casing inner and outer sides using the scraper or wire brush. (3) Finish the journal, gland and thrust collar with oil stone. (4) Wash the bearing in proper solvent and clean it with compressed air. If contact is satisfactory, use a scraper to remove only the foreign substances included in the white metal surface. Damages must be provided with minimum repair. 3. Assembly and recovery (1) Apply contamination preventive coating to the inner and outer sides if required. (2) Replace the cathodic protection electrode and corrosion preventive zinc plate if required. (3) Measure the clearance of the wear ring. (4) When placing the gland packing in position, confirm the spacer position. (5) Conduct the test to pass water through the seal water parts. (6) Replace the packings with new ones. (7) Make sure that there is no foreign substance or other thing left behind inside	1. Operation items and cautions (1) To determine the time for disassembly and inspection, it is recommended to record the secular changes in pump cut-off pressure. (2) For the vertical pump, measure the clearance when the coupling bolt is removed. (3) According to the result of disassembling the curless bearing, determine the time for replacement. (4) Apply contamination preventive coating if required. (5) For cautions in working with the circulating water pipe, see the description in Work procedure for (5) a. Condenser and condenser shell.

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
c. General pump (a) Vertical	1. Inspect the general pump every two to four years.	1. During disassembling (1) Measure the centering. (2) Tightness of the bolt and bushing (3) Inspect the shaft seal part. a.) Leakage b) Cooling (4) Inspect the bearings. a) Contamination of lubricating oil b) Leakage from bearing box (5) Inspect the casing. a) Leakage from casing fit surfaces (6) Measure the shaft movement. (7) Measure the sole plate levelness. 2. After cleaning and adjustment (1) Inspect the main shaft. a) Erosion, wear and crack of the impeller b) Contact damage and wear and crack on the wear ring and bushing c) Measure the main shaft runout. d) Measure the clearance of the wear ring and bushing. (2) Inspect the joint part. a) Wear of the shaft sleeve (collar) b) Packing damage (3) Inspect the shaft seal part. a) Bearing wear and damage b) Measure the clearance of bearings (4) Inspect the casing. a) Blow hole, erosion and crack b) Casing fit surfaces and bolts (5) Inspect the coupling. a) Wear and damage of the bolt and bushing b) Measure the fit part with the bearing. 3. During and after assembling (1) Measure the main shaft movement. (2) Inside the casing (3) Tightness of the casing, gasket and bolt (4) Bearing fit conditions (5) Setting and tightness of the shaft seal part (6) Measure the centering. (7) Conduct test operation (after assembling).	1. Disassembling (1) Disconnect the coupling from the drive unit, and remove the drive unit. (2) Discharge drain from the casing, oil and coolant from the bearing box. (3) Remove the shaft seal part and stuffing box; then disassemble the main shaft and casing, and check each part. (4) Put on tally marks whenever required. 2. Cleaning and adjustment (1) Clean the impeller with emery cloth, rags and compressed air. (2) Use the scraper and wire brush to remove deposits and adhered substances from inside the casing. (3) Finish the shaft seal part and journal with oil stone. (4) Wash the bearing with detergent and clean it with compressed air. 3. Assembly and recovery (1) Carefully check all parts and make sure that foreign substances and others such as tools and rags are not left behind. (2) Measure the clearance of the wear ring and sleeve, and correct them to have specified dimensions; then mount them in position. (3) Incorporate them into the main shaft and mount the bearing in position. Perform hand turning, and make sure that there is no contact inside. (4) Replace packings and gaskets with new ones. Use carefully treated bolts.	1. Operation items and cautions (1) It is recommended to conduct liquid penetrating test when inspecting the impeller. (2) It is recommended to correct the main shaft runout to be 10/100 mm or less. (3) It is recommended to replace the ball bearing on a periodic basis even if it is not defective. (4) Measure the clearances and keep the record to provide reference information for recovery, reassembly and disassembly.

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
(b) Horizontal type	1. Inspect the horizontal pump every two to four years.	1. During disassembling (1) Measure the centering. (2) Inspect the shaft coupling. a) Gear coupling (a) Noise and leakage (grease or gear oil) (b) Tightness of the bolt and packing b) Flange coupling (a) Tightness of the bolt and bushing (3) Inspect the shaft seal part. a) Leakage b) Cooling (4) Inspect the bearings. a) Contamination of lubricating oil b) Leakage from bearing box (5) Inspect the casing. a) Leakage from casing fit surfaces (6) Measure the shaft movement. 2. After cleaning and adjustment (1) Check the main shaft. a) Erosion, wear and crack of the impeller b) Contact damage and wear and crack on the wear ring and bushing c) Weld zones and set screws d) Measure the clearance of the wear ring and bushing. e) Measure the main shaft runout. (2) Inspect the joint part. a) Wear of the shaft sleeve (collar) b) Gland packing damage c) Mechanical seal contact, scratch and damage d) Contact of the O-rig with mechanical seal, and damages (3) Inspect the shaft seal part. a) Ball bearing wear damage and oil ring deformation b) Sleeve bearing wear, damage, wear and contact c) Thrust bearing wear, damage and crack, and pivot pad contact d) Measure the clearance of each part of the bearing.	1. Disassembly (1) Disconnect the coupling from the drive unit. (2) Discharge drain from the casing, oil and coolant from the bearing box. (3) Remove the shaft seal part and stuffing box; then disassemble the main shaft and casing, and check each part. (4) Put on tally marks whenever required. 2. Cleaning and adjustment (1) Clean the impeller with emery cloth, rags and compressed air. (2) Use the scraper and wire brush to remove deposits and adhered substances from inside the casing. (3) Finish the shaft seal part and journal with oil stone. (4) Finish the mechanical seal by lapping (or replace it with new one). (5) Wash the bearing coupling and gear with detergent and clean it with compressed air. (6) Measure the sleeve bearing with a micrometer or lead line 3. Assembly and recovery (1) Carefully check all parts and make sure that foreign substances and others such as tools and rags are not left behind. (2) Mount the bearing on the main shaft, and measure the clearance with the wear ring at the center, right and left ends, using a dial indicator or thickness gauge. (3) For the main shaft, measure all shaft movements, and set it at an approximately central position. (4) Measure the clearance of the wear ring and sleeve, and correct them to have specified dimensions; then mount them in position. (5) Incorporate the main shaft and mount the bearing in position. Perform hand turning, and make sure that there is no contact occurring inside. (6) Replace packings and gaskets with new ones. Use carefully treated bolts. (7) Tighten the casing fit surface to ensure that torque will be applied uniformly toward the outside from the central portion. (8) The center ring must be installed so that alignment will be ensured when the pump is normally operating, there is no contact inside.	1. Operation items and cautions (1) It is recommended to conduct liquid penetrating test when inspecting the impeller. (2) It is recommended to correct the main shaft runout to be 5/100 mm or less (at the center). (3) It is recommended to replace the ball bearing on a periodic basis even if it is not defective. (4) Measure the clearances and keep the record to provide reference information for subsequent disassembly. (5) Use a grinder to smoothen small blow holes and cracks. (6) Fitting with shaft (target values, units in mm) a) The coupling must be shrink-fit to the range from 1/100 to 3/100. For correction, the inner diameter side must be provided with hard chromium plating. b) The sleeve and bushing must be fitted to the range from 3/100 to 5/100. (7) Mark the casing bolts with chalk to ensure that they will not be tightened. (8) Determine the centering tolerance by studying the operating conditions. [Target value] within ± 5/100 mm in circumferential direction within ± 3/100 mm in facial direction (9) Measure the center ring and inspect the bearing once in one to two years

Equipment name	Extent of disassembly	Inspection item	Work procedure	Remarks
		(4) Inspect the casing. a) Blow hole, erosion and crack b) Casing fit surfaces and bolts (5) Inspect the coupling a) Wear and crack of gear coupling and tooth surface b) Gear coupling and O-ring deterioration and bolt damage c) Deterioration of grease and gear oil d) Wear and damage of flange coupling, bushing and bolt e) Measure the fitting between coupling and shaft 3. During and after assembling (1) Measure the main shaft movement and thrust position. (2) Inside the casing (3) Tightness of the casing, gasket and bolt (4) Bearing fit conditions (5) Setting and tightness of the shaft seal part (6) Joint installation and gear coupling lubrication (7) Measure the centering. (8) Conduct test operation (after assembling).		

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