THE NATIONAL BOARD
OF BOILER AND PRESSURE VESSEL INSPECTORS

FACSIMILE TRANSMISSION

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Message:

The attached 7 pages are from the 2001 edition of the National Board Inspection Code (NBIC) covering the basics of boiler inspection. Please understand there are many different types and sizes of boilers, so this has to be generic to allow for that.

Good luck.

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RB-3100 INSPECTION OF BOILERS

RB-3110 GENERAL CONDITIONS

a. Boilers are designed for a variety of service conditions. The temperature and pressure at which they operate should be considered in establishing inspection criteria. This part is provided for guidance of a general nature. There may be occasions where more detailed procedures will be required.

b. The condition of the complete installation, including maintenance and operation, can often be used by the Inspector as a guide in forming an opinion of the care given to the boiler.

c. Usually the conditions to be observed by the Inspector are common to both power and heating boilers, however, where appropriate, the differences are noted.

RB-3120 PRE-INSPECTION ACTIVITIES

a. A review of the known history of the boiler should be performed. This should include a review of information, such as:

1. Operating conditions
2. Date of last inspection
3. Current jurisdictional inspection certificate
4. ASME Code Symbol Stamping or mark of code of construction
5. National Board and/or jurisdiction registration number

b. The following parts should be removed as required to permit the inspection:

1. Manhole and handhole plates
2. Washout plugs
3. Inspection plugs in water column connectors
4. Grates of internally fired boilers
5. Insulation and brickwork, as appropriate
6. Pressure gage should be removed for testing, unless there is other information to assess its accuracy.

c. The boiler shall be cooled and thoroughly cleaned.

RB-3130 ASSESSMENT OF INSTALLATION, CAUSES OF DETERIORATION, TYPES OF DEFECTS

RB-3131 ASSESSMENT OF INSTALLATION

The external inspection of a boiler is made to determine if it is in a condition to operate safely. Upon entering the boiler area, the general cleanliness and accessibility of the boiler and its auxiliary apparatus should be noted. The boiler fittings, valves and piping should be checked for compliance with ASME Code or other standards or equivalent requirements.

RB-3132 CAUSES OF DETERIORATION

Deterioration of boilers may be caused by improper or inadequate water treatment, excessive fluctuations in pressure or temperature, or improper or lack of maintenance.

RB-3133 TYPES OF DEFECTS

Defects may include bulged or blistered plates, cracks or other defects in welds or heat-affected zones, pinhole leaks, improper or inadequate safety devices, wasted or eroded material.

RB-3140 EVIDENCE OF LEAKAGE

a. It is not normally necessary to remove insulating material, masonry, or fixed parts of a boiler for inspection unless defects or deterioration are suspected or are commonly found in the particular type of boiler being inspected. Where there is evidence of leakage showing on the covering, the Inspector should have the covering removed in order that a thorough inspection of the area may be made. Such inspection may require removal of insulating material, masonry, or fixed parts of the boiler.

b. For additional information regarding a leak in a boiler or the extent of a possible defect, a pressure test may be necessary.

1. To determine tightness, the test pressure need be no greater than the maximum allowable working pressure stamped on the pressure retaining item.

2. During a pressure test, where the test
A02 pressure will exceed 90% of the set pressure of a pressure relief device, the device shall be removed whenever possible. If not possible, a test gag may be used following the valve manufacturer's instructions and recommendations. Extreme caution should be employed to ensure only enough force is applied to contain pressure. Excessive mechanical force applied to the test gag may result in damage to the seat and/or spindle and may interfere with the proper operation of the valve. The test gag shall be removed following the test.

3. The temperature of the water used to apply a pressure test should not be less than 70°F (21°C), and the maximum temperature during inspection should not exceed 120°F (49°C).

4. Hold-time for the pressure test shall be 10 minutes prior to the examination by the Inspector.

5. Hold-time for the examination by the Inspector shall be the time necessary for the Inspector to conduct the inspections.

6. When the introduction of water for a hydrostatic test will cause damage to a boiler or boiler component, other testing media or vacuum testing may be used provided the precautionary requirements of the applicable section of the original code of construction or other standards are followed. In such cases, there shall be agreement as to the testing procedure between the owner and the Inspector.

RB-3150 INSPECTION OF PIPING, PARTS AND APPURTENANCES

RB-3151 PIPING

Piping should be inspected in accordance with RB-3400.

RB-3152 WATERSIDE DEPOSITS

a. All accessible surfaces of the exposed metal on the waterside of the boiler should be inspected for deposits caused by water treatment, scale, oil, or other substances. Oil or scale in the tubes of watertube boilers or on plates over the fire of any boiler is particularly detrimental since this can cause an insulating effect resulting in overheating, weakening and possible metal failure by bulging or rupture.

b. Any excessive scale or other deposits should be removed by chemical or mechanical means.

RB-3153 STAYS

a. All stays, whether diagonal or through, should be examined to determine whether or not they are in even tension. The stayed plates should be examined to determine whether cracks exist where they are punched or drilled for the stays or staybolts. Stays or staybolts which are not in tension or adjustment should be repaired. Broken stays shall be replaced.

b. The Inspector should test firebox staybolts by tapping one end of each bolt with a hammer and, where practicable, a hammer or other heavy tool should be held on the opposite end to make the test more effective. An unbroken bolt should give a ringing sound while a broken bolt will give a hollow sound. Staybolts with telltale holes should be examined for evidence of leakage which will indicate a broken or cracked bolt. Broken staybolts shall be replaced.

RB-3154 FLANGED AND OTHER CONNECTIONS

a. The manhole and reinforcing plates, as well as nozzles or other connections flanged or bolted to the boiler should be examined for evidence of defects both internally and externally. Whenever possible, observation should be made from the inside of the boiler as to whether connections are properly made to the boiler.

b. All openings leading to external attachments, such as water column connections, low water fuel cutoff devices, openings in dry pipes, and openings to safety valves, should be examined to ensure they are free from obstruction.

RB-3155 BULGES AND BLISTERS

a. A bulge may be caused by overheating of the entire thickness of the metal, thereby lowering the strength of the metal which is then deformed by the pressure in the boiler. Bulges may also be caused by creep or temperature gradients.

b. A blister may be caused by a defect in the metal such as a lamination where the side exposed to the fire overheats but the inner side retains its strength due to the cooling effect of the boiler water.

RB-3156 OVERHEATING

a. Overheating is one of the most serious causes of boiler deterioration. Deformation and possible rupture of pressure parts such as tubes may result. Tubes may become damaged by poor circulation, steam binding, or deposition of scale.

b. Particular attention should be given to the plate or tube surfaces exposed to the fire. It should be observed whether any part of the boiler has become deformed due to bulging or blistering. If a bulge or blister is large enough to weaken the plate or tube, or when evidence of leakage is noted coming from those defects, proper repairs must be made. The blistered area should be removed, the remaining thickness determined and repairs made as required. A bulge on a water tube should always be repaired. A bulge on a plate, if not extensive, may be driven back into place, otherwise the affected areas should be repaired with a flush patch.

RB-3157 CRACKS

a. Cracks may result from flaws existing in material. The design and operating conditions may also cause cracking. Cracking can be caused by fatigue of the metal due to continual flexing and may be accelerated by corrosion. Fire cracks are caused by the thermal differential when the cooling effect of the water is not adequate to transfer the heat from the metal surfaces exposed to the fire. Some

cracks result from a combination of all these causes mentioned.

b. Cracks noted in shell plates should be repaired.

1. Fire cracks that run from the edge of the plate into the rivet holes of girth seams, and

2. Thermal fatigue cracks determined by engineering evaluation to be self arresting may be left in place.

c. Areas where cracks are most likely to appear should be examined. This includes the ligaments between the tube holes in watertube boiler drums, between the tube holes on the tube sheet of firetube boilers, from and between rivet holes, at any flange where there may be repeated flexing of the plate during operation and around welded pipe and tube connections.

d. Lap joint boilers are subject to cracking where the plates lap in the longitudinal seam. If there is any evidence of leakage or other distress at this point, the Inspector should thoroughly examine the area and, if necessary, have the plate notched or slotted in order to determine whether cracks exist in the seam. Repairs of lap joint cracks on longitudinal seams are prohibited.

e. Where cracks are suspected, it may be necessary to subject the boiler to nondestructive examination to determine their location.

RB-3158 CORROSION

a. Corrosion causes deterioration of the metal surfaces. It can affect large areas or it can be localized in the form of pitting. Isolated, shallow pitting is not considered serious if not active.

b. The most common causes of corrosion in boilers are the presence of free oxygen and dissolved salts in the feedwater. Where active corrosion is found, the Inspector should advise the owner or user to obtain competent advice regarding proper feedwater treatment.

c. For the purpose of estimating the effect of severe corrosion over large areas on the safe working pressure, the thickness of the remaining sound metal should be determined by ultrasonic examination or by drilling.

d. Grooving is a form of metal deterioration caused by localized corrosion and may be accelerated by stress concentration. This is especially significant adjacent to riveted joints.

e. All flanged surfaces should be inspected, particularly the flanges of unstayed heads. Grooving in the knuckles of such heads is common since there is slight movement in heads of this design which causes a stress concentration.

f. Some types of boilers have ogee or reversed-flanged construction which is prone to grooving and may not be readily accessible for examination. The Inspector should insert a mirror through an inspection opening to examine as much area as possible. Other means of examination such as the ultrasonic method may be employed.

g. Grooving is usually progressive and when it is detected, its effect should be carefully evaluated and corrective action taken.

h. The fireside surfaces of tubes in horizontal firetube boilers usually deteriorate more rapidly at the ends nearest the fire. The Inspector should examine the tube ends to determine if there has been serious reduction in thickness. The tube surfaces in some vertical tube boilers are

more susceptible to deterioration at the upper ends when exposed to the heat of combustion. These tube ends should be closely examined to determine if there has been a serious reduction in thickness. The upper tube sheet in a vertical "dry top" boiler should be inspected for evidence of overheating.

i. Pitting and corrosion on the waterside surfaces of the tubes should be examined. In vertical firetube boilers excessive corrosion and pitting is often noted at and above the water level. Excessive scale on waterside surfaces should be removed before the boiler is placed back in service.

j. The surfaces of tubes should be carefully examined to detect corrosion, erosion, bulges, cracks, or evidence of defective welds. Tubes may become thinned by high velocity impingement of fuel and ash particles or by the improper installation or use of soot blowers. A leak from a tube frequently causes serious corrosion or erosion on adjacent tubes.

k. In restricted fireside spaces, such as where short tubes or nipples are used to join drums or headers, there is a tendency for fuel and ash to lodge at junction points. Such deposits are likely to cause corrosion if moisture is present and the area should be thoroughly cleaned and examined.

RB-3159 MISCELLANEOUS

a. The piping to the water column should be carefully inspected to ensure that water cannot accumulate in the steam connection. The position of the water column should be checked to determine that the column is placed in accordance with ASME Code or other standard or equivalent requirements.

b. The gas side baffling should be inspected. The absence of the proper baffling or defective baffling can cause high temperatures and overheat portions of the boiler. The location and condition of combustion arches should be checked for evidence of flame impingement which could result in overheating.

c. Any localization of heat caused by improper or defective installation or improper operation of firing equipment should be corrected before the boiler is returned to service.

d. The supports and settings should be carefully examined, especially at points where the boiler structure comes near the setting walls or floor, to ensure that deposits of ash or soot will not bind the boiler and produce excessive strains on the structure due to the restriction of movement of the parts under operating conditions.

e. When tubes have been rerolled or replaced, they should be inspected for proper workmanship. Where tubes are readily accessible, they may have been over rolled. Conversely, when it is difficult to reach the tube ends they may have been under rolled.

RB-3160 GAGES, SAFETY DEVICES AND CONTROLS

RB-3161 GAGES

a. Ensure that the water level indicated is correct by having the gage tested as follows:

1. Close the lower gage glass valve, then open the drain cock and blow the glass clear.

2. Close the drain cock and open the lower gage glass valve. Water should return to the gage glass immediately.

3. Close the upper gage glass valve, then open the drain cock and allow the water to flow until it runs clean.

4. Close the drain cock and open the upper gage glass valve. Water should return to the gage glass immediately.

b. If the water return is sluggish, the operation should be repeated. A sluggish response could indicate an obstruction in the pipe connections to the boiler. Any leakage at these fittings should be promptly corrected to avoid damage to the fittings or a false waterline indication.

c. Each hot water boiler should be fitted with a temperature gage at or near the boiler outlet that will at all times indicate the water temperature.

d. Where required, all the pressure gages shall be removed, tested and their readings compared to the readings of a standard test gage or a dead weight tester.

e. The location of a steam pressure gage should be noted to determine whether it is exposed to high temperature from an external source or to internal heat due to lack of protection by a proper siphon or trap. The Inspector should check that provisions are made for blowing out the pipe leading to the steam gage.

f. The pressure indicated on the pressure gage should be compared with other gages on the same system or with a standard test gage, if necessary. The Inspector should observe the reading during tests; for example, the reduction in pressure when testing the low water fuel cutoff control or safety valve on steam boilers. Defective gages should be promptly replaced.

RB-3162 SAFETY DEVICES

See Section RB-3500 for the inspection of safety devices (pressure relief valves) used to prevent the overpressure of boilers.

RB-3163 CONTROLS

a. Verify operation of low water protection devices by observing the blowdown of these controls or the actual lowering of boiler water level under carefully controlled conditions with the burner operating. These tests should shut off the heat source to the boiler. The return to normal condition such as the restart of the burner, the silencing of an alarm or stopping of a feed pump, should be noted. A sluggish response could indicate an obstruction in the connections to the boiler.

b. The operation of a submerged low water fuel cutoff control mounted directly in a steam boiler shell should be tested by lowering the boiler water level carefully. This should be done only after being assured that the water level gage is indicating correctly.

c. On a high-temperature water boiler it is often not possible to test the control by cutoff indication, but where the control is of the float type externally mounted, the float chamber should be drained to check for the possible accumulation of sediment.

d. In the event that controls are inoperative or the correct water level is not indicated, the boiler should be taken out of service until the unsafe condition has been corrected.

e. All automatic low water fuel cutoff and water feeding devices should be examined by the Inspector to ensure that they are properly installed. The Inspector should have the float chamber types of control devices disassembled and the float linkage and connections examined for wear. The float chamber should be examined to ensure that it is free of sludge or other accumulation. Any necessary

corrective action should be taken before the device is placed back into service. The Inspector should check that the operating instructions for the devices are readily available.

f. Check that the following controls are provided:

1. Each automatically fired steam boiler is protected from over pressure by not less than two pressure operated controls, one of which may be an operating control.

2. Each automatically fired hot water boiler is protected from over-temperature by not less than two temperature operated controls, one of which may be an operating control.

3. Each hot water boiler is fitted with a thermometer that will at all times indicate the water temperature at or near the boiler outlet.

RB-3170 RECORDS REVIEW

a. A review of the boiler log, records of maintenance and feedwater treatment should be made by the Inspector to ensure that regular and adequate tests have been made on the boiler and controls.

b. The owner or user should be consulted regarding repairs or alterations, if any, which have been made since the last inspection. Such repairs or alterations should be reviewed for compliance with the applicable requirements.

RB-3180 CONCLUSIONS

a. During all tests the actual operating and maintenance practices should be noted by the Inspector and a determination made as to their acceptability.

b. Any defects or deficiencies in the condition, operating and maintenance practices of the boiler and auxiliary equipment should be discussed with the owner or user at this time and recommendations made for correction.