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HISTORICAL STEAM BOILER INSPECTION

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Purpose

To ensure uniform application of the inspection requirements for steam traction boilers by TSSA Inspection staff in accordance with the Boilers and Pressure Vessels Regulation and Operating Engineers Regulation.

Scope

This procedure covers the initial and periodic (in-service) inspection of Historical Steam Boilers; defined as a boiler of welded or riveted construction, forming part of a locomotive, traction engine, calliope, or other steam plant.

Responsibility and Authority

The owner is responsible for all preparation of the boiler prior to inspection and providing any necessary assistance to the TSSA Inspector during the inspection.

The TSSA Inspector is responsible for scheduling the inspection and safely performing the inspections described in this document when assigned by the Regional Supervisor.

The BPV Administrative Assistant is responsible for distribution of written reports to Head Office data entry staff.

Resources

Technical Standards and Safety Act, Boilers and Pressure Vessels Regulation and Operating Engineers Regulation

CSA B51-Current Edition: Boilers, Pressure Vessels and Piping Code ASME Boiler and Pressure Vessel Code: Section I, 1971 Edition *(riveted construction)*

ASME Boiler and Pressure Vessel Code: Section I, current Edition (welded construction)

NBIC - National Board Inspection Code, Part 2

TSSA Electronic Database

TSSA Health and Safety Procedures

Instructions

Prerequisites by the Owner

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Boiler Identification

The Owner/User is responsible to maintain boiler identification for the life the of the boiler.

Boiler identification shall consist of the following:

- Manufacturer Name
- CRN
- Serial Number
- MAWP (e.g. 100 PSI)
- Heating Surface and/or Minimum Design Steaming Capacity (MDSC)
- Year Built
- OIN, if available
- National Board Number, if available

The location of the stamping shall be as per ASME Section I, Para. PG-111. Where the stamping becomes illegible and must be remarked, the stamping shall be made with low stress stamps and remarking verified by a TSSA Inspector. Alternatively, a nameplate identified as "Duplicate" and marked with the required information may be used and installed in a location acceptable to the TSSA Inspector.

Initial design registration by the Owner for CRN

For initial design registration of a *new or used riveted* steam traction boiler the following are required:

- i) A copy of the Manufacturer's Data Report (if available).
- ii) A drawing and calculations signed and stamped by a professional engineer licensed in Ontario based upon ASME Code Section I, 1971 Edition or for welded boilers the ASME Code Section I Edition in effect at the time of construction using stress values for materials from the original Code edition for calculation.
- iii) For used steam traction boilers, results of the NDE examination as described in this procedure.
- iv) A TSSA Inspector's completed "First Data Report" form.
- v) The above documentation shall be submitted to TSSA Engineering for registration.

Note: New welded boilers and boiler parts shall be built to the ASME Boiler and Pressure Vessel Code in effect on the date of issue of the purchase order.

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Steam Traction Plant Operating Engineers Registration by the Owner

- All steam traction plants above 5HP shall be registered as required by the Operating Engineers (OE) Regulation.
- The user of a steam traction plant shall display the OE certificate of registration in a visible inboard location.
- Where the Traction Plant is of a size which makes display of the OE Certificate of Registration impractical, the Traction Plant Operator shall always keep the certificate in their possession while the Traction Plant is in operation.

Steam Traction Boiler Operator Requirements

Steam Traction Operators shall hold a current OE Steam Traction Operator Certificate to operate the Steam Traction Boiler/Engine as required by the Operating Engineers Regulation

A Traction Plant log shall remain on board the steam traction plant or in possession of the operator, be maintained as follows and made available to the TSSA Inspector.

- Logbook to be bound and constructed so that pages are numbered and cannot be removed
- 2) Log to include an operating log with date and time of operation, actual hours the boiler was in operation (actual time spent on boiler operation by the operator), location of operation, and the name and certificate number of the operator
- 3) Log to include maintenance and repairs carried out, dates of fit out, lay up, waterside washout, insurance inspection (if insured), inspection by the designated administrative authority (if uninsured). Repairs must be carried out by an organization holding repair certification recognized by TSSA and inspected by a qualified inspector.
- 4) Only a certified traction operator may make entries in or sign the log book
- 5) All entries shall be in ink, corrections shall not be erased but single line crossed out, corrected, and initialled and dated by the certified steam traction operator
- 6) No person to deface, damage, destroy or without the permission of the user or owner remove the log from the plant or cause it to be unavailable for viewing upon request of an TSSA Inspector.
- 7) Log book to be maintained for a minimum of three (3) years after the last entry made, and shall be produced upon the request of an TSSA Inspector

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- 8) Where a boiler changes ownership, the log book shall be transferred to the new owner.
- 9) Where a boiler has been decommissioned, the owner shall notify TSSA using the applicable form.
- 10) Records of boiler feed water treatment performed must be maintained and detailed in the log book.

Owner Responsibilities for Inspection Preparation - Initial, Annual and Other

The owner shall prepare the boiler for inspection in the following manner:

- a) Remove all boiler lagging and insulation before NDE is performed. (as specified below)
- b) Remove covers on all inspection openings.
- c) Water wash all waterside areas, clean all mud and scale including around all inspection openings and provide boiler in a dry state for inspection.
- d) Remove ash and soot from tubes, firebox, ashpan and smoke box.
- e) Remove grates from firebox, as required by the TSSA Inspector.
- f) Remove arch bricks, as required by the TSSA Inspector.
- g) Remove built up grease and paint to the satisfaction of the TSSA Inspector.
- h) Ensure all staybolt telltale holes are clean and clear.
- Have necessary apparatus available for conducting hydrostatic test. (every two (2) years riveted boiler, every five (5) years welded boiler, or at the discretion of the TSSA Inspector)
- j) Make available, the Plant Registration and Steam Traction Operator Certificate, as applicable

Owner Responsibility for Nondestructive Examination (NDE) and Inspection of Riveted or Welded Boilers (as applicable)

NDE shall commence twenty (20) years from the initial date of service and may be extended to thirty (30) years if the hours of operation are 1000 hours or less, or at the discretion of the TSSA Inspector, and every ten (10) years thereafter, or more frequently at the discretion of the TSSA Inspector NDE shall be performed. The following non-destructive examinations, as a minimum, shall be performed and the results provided to the TSSA Inspector. All riveted boilers manufactured prior to 1971 shall have NDE performed every ten (10) years. The owner shall notify the TSSA Inspector of when the NDE is scheduled to be performed.

NDE Personnel Qualifications

a) Personnel performing the NDE examinations shall be qualified for the appropriate examination

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method as Level II or Level III Inspectors in accordance with the requirements of Canadian General Standards Board (CGSB). UT thickness measurements may be conducted by personnel who hold Level I ultrasonic qualification, or have received the equivalent theoretical training from a recognized organization acceptable to TSSA, e.g. NDE Institute of Canada. The owner/user is responsible for ensuring that all required NDE is performed by qualified personnel, for maintaining such records, and for presenting them to the TSSA Inspector for review.

For Riveted Boilers

- a) Ultrasonic thickness check of all pressure retaining boundaries to determine if the boiler is acceptable to continue operation at its current Maximum Allowable Working Pressure (MAWP). Initial thickness readings shall be taken on a maximum 4" grid (smaller grids are acceptable). If any one reading indicates thinning, then the area adjacent shall be mapped in detail to the TSSA Inspector's satisfaction.
- b) The external longitudinal seam riveted area (rivets and plate surface) of all riveted boilers shall be examined 100 per cent for cracks with liquid penetrant or magnetic particle examination. In addition, for all riveted boilers, 10 per cent of the longitudinal seam rivets are to be ultrasonically examined using the longitudinal wave mode, for shear failure of the rivets. Rivets to be examined shall be spaced evenly along the seam of alternating sides and if defects are found, the search area shall be expanded to establish all defective rivets. A UT probe fitted with "shoe" or adaptor made of suitable material such as plexiglass may be used between the rivet head and the ultrasonic transducer.
- c) All firebox and thermic siphon straight stay-bolts that cannot be visually examined and 10 per cent of all firebox rivets are to be ultrasonically examined using the longitudinal wave mode for shear failure. A UT probe fitted with a "shoe" or adaptor made of suitable material such as plexiglass may be used between the rivet head and the ultrasonic transducer.
- d) On the steam dome, the area around all rivets shall be given a complete liquid penetrant or magnetic particle examination to identify possible cracking of the rivets or base material. Further examination may be required at the TSSA Inspector's discretion.
- e) All accessible internal knuckle radius areas shall be examined for cracks using the liquid penetrant or magnetic particle method.
- f) Tubesheet tube ligament faces and all areas around the tubesheet stays shall be 100 per cent examined for cracks using the liquid penetrant or magnetic particle examination method.

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- g) NDE Acceptance Criteria: shall be in accordance with ASME Section I, 1971 Ed., for ultrasonic examinations and Section VIII, Div 1, 1971 Ed, for liquid penetrant and magnetic particle examinations.
- h) All records of tests, inspection certificates and other information are to be retained on file by the owner to demonstrate that all of these requirements have been met. Failure to do so may require the testing or examinations to be repeated.

For Welded Boilers

- a) Ultrasonic thickness check of all pressure retaining boundaries to determine if the boiler is acceptable to continue operation at its current Maximum Allowable Working Pressure (MAWP). Initial thickness readings shall be taken on a maximum 4" grid (smaller grids may be requested at the discretion of the TSSA Inspector). If any reading indicates thinning, then the area adjacent shall be mapped in detail to the TSSA Inspector's satisfaction to determine the lowest reading
- b) All longitudinal and circumferential butt-welded seams and the adjacent weld effected area of all welded boilers shall be examined with UT to verify remaining thickness. The thickness check shall be taken on a maximum 1" grid on both sides of the weld seam for the full length of the weld seam to determine if there is any reduction in thickness of the adjacent base material. If any reading indicates thinning of the nominal material thickness, then the area adjacent shall be mapped in detail to the TSSA Inspector's satisfaction to determine the lowest reading.
- c) Tubesheet tube ligament faces and all areas around the tubesheet stays shall be 100 per cent examined for cracks using the liquid penetrant or magnetic particle examination method.
- d) NDE Acceptance Criteria: Shall be in accordance with the ASME Section I, Code Edition used for the boilers construction or as agreed upon with the TSSA Inspector for ultrasonic examinations, liquid penetrant examinations, and magnetic particle examinations.
- e) All records of tests, examinations, inspection certificates, and other information are to be retained on file by the owner to demonstrate that all of these requirements have been met. Failure to do so may require the tests or examinations to be repeated.

Notes on stayed surfaces:

 Any reduction in original thickness noted during the NDE process shall be evaluated by the owner to determine the maximum allowable working pressure of the boiler based on the staybolt spacing and condition in

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accordance with the table in the National Board Inspection Code and make the results available to the TSSA Inspector for verification. Where there is a conflict between Owner and TSSA Inspector in establishing the MAWP, TSSA Engineering will be consulted to determine the MAWP of the boiler.

- 2) Any stayed surface 0.240 inches thickness or less found during the NDE process is NOT acceptable and shall be repaired to the original ASME Code required thickness before the boiler is put under pressure.
- 3) Any substantial grooving around staybolts where they meet a stayed surface, as determined by the TSSA Inspector, shall be repaired before the boiler is put under pressure.
- 4) Any thinning or necking of staybolts beyond that permitted by the table in the National Board Inspection Code shall be repaired before the boiler is put under pressure.

Notes on unstayed surfaces:

1) Any reduction in original thickness noted during the NDE process shall be evaluated by the owner to determine the maximum allowable working pressure of the boiler based on the boiler inside diameter and condition in accordance with the National Board Inspection Code or original Code of construction and make the results available to the TSSA Inspector for verification. Where there is a conflict between Owner and TSSA Inspector in establishing the MAWP, TSSA Engineering will be consulted to determine the MAWP of the boiler.

<u>Inspection by the TSSA Inspector</u> Notes for the TSSA Inspector

- The inspection shall verify that all non-destructive examination performed when required by this procedure and results are acceptable. The frequency and method of which is described under "Owner Responsibility" above.
- The boiler shall be inspected yearly. For riveted boilers this inspection shall
 include a hydrostatic test in alternate years, commencing with the original
 registration inspection, once every two years as a minimum. For welded
 boilers the hydrostatic test shall be at least once every five (5) years
 commencing with the original registration inspection.
- The TSSA Inspector shall review the owner/user(s) history of the operation and repair of the boiler as recorded in the Log book.
- The TSSA Inspector shall issue a directive, as appropriate, if repairs or alterations are required.

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- The M.A.W.P. for lap seam riveted boilers shall not exceed 100 psi.
- The TSSA Inspector is to verify that the owner/user is maintaining all records related to the boiler. These will assist the TSSA Inspector during the required periodic inspections.
- A Historical Steam Boiler falling within the scope of this procedure shall not be operated in the Province of Ontario unless it has a valid Certificate of Inspection issued by the Technical Standards and Safety Authority.

External Inspection (Annual unless indicated otherwise)

If desired, the TSSA Inspector may use a small ball peen hammer to "sound" rivets, bolted connections and stays, and mark any that are broken or suspect. The rivets should be checked by tapping the heads and listening for a clear 'ring'. If any rivets sound dull or do not ring, mark them as requiring further examination to verify continued use. Further examination may be carried out using an appropriate NDE method if necessary.

Examine all fittings and attachments including the following:

Safety Valves

- i) Shall be properly sealed and shall have the capacity to discharge all steam generated without
 - allowing the pressure to rise more than 6 per cent above the Maximum Allowable Working Pressure (MAWP), when the boiler is in a full firing condition.
- ii) Shall comply with the requirements of ASME Section I, Para. PG-70.
- iii) Shall be set at or below the MAWP and sealed.
- iv) Shall be serviced at the intervals in the CSA B51 Annex 'H" (a minimum of once
 - every five (5) years).
- v) Shall be ASME approved and be marked with the "V" or "VR" stamp.
- vi) Shall have a Canadian Registration Number (CRN) in accordance with CSA-B51.

Gauge Glass/Water Column

- i) Ensure they are fully operational i.e. free of deposit build-up and the shut off valves including
 - drain valve are free to operate.
- ii) Are fitted with an appropriate gauge glass guard to protect the operator as specified by the
 - Operating Engineers Regulation.

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- iii) On new boilers built after 2001, gauge glass shut off valves shall be fitted with stainless steel ball
 - checks as a component of the valve construction as specified by the Operating Engineers Regulation.
- iv) Verify the boiler connections are clear at valves and cross plugs.
- v) Establish the safe water operating level i.e. the bottom gauge glass connection shall be positioned as follows:

On horizontal fire tube boilers:

- with crown sheet 2" to 3" above crown sheet;
- without crown sheet 2" above highest tube.

On vertical boilers:

- dry top ¾ up from the bottom tube sheet;
- wet top 2" above the top tube sheet.

Operating Pressure Gauge

- i) The pressure gauge shall be positioned for clear visibility by the operator.
- ii) The gauge shall be mounted on a siphon or equivalent device with a shut off valve.
- iii) The gauge shall be calibrated every five (5) years or when suspect in error, against a dead weight tester or gauge of known accuracy with a test laboratory certificate or other means of verification.
- iv) The dial range of the gauge shall be adequate i.e. 1½ to 2 times MAWP.

Blow Down Valves

- Shall operate freely and at least one to be of the screw-down or slow opening type.
- ii) If fast acting, shall have provision for the valve handles to be secured to prevent accidental
 - opening and shall be the first valve nearest the boiler.
- iii) The bottom blow down piping shall have two (2) slow opening or one (1) quick-opening valve or cock at the boiler nozzle followed by a slow-opening valve.
- iv) Shall be dismantled and inspected at five (5) year intervals.

External Piping

i) Check for signs of corrosion or leakage.

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ii) Verify the proper material specification and grade are used (i.e. SA106 Gr.B)

- iii) Steam or water piping used from the boiler shell to the first valve shall have a minimum wall thickness of schedule 80 and of SA106 Gr.B material.
- iv) It is recommended that cross style fittings be used for cleaning and inspection purposes.
- v) Fitting ratings shall be a minimum of Class 300 for malleable iron fittings and Class 2000 for forged steel fittings.

Feed Water Piping

- i) Injector or feed pump outlet shall include a stop/check or a stop and check valve.
- ii) Feed stop and check valves to be dismantled and inspected as for blow off valves above.
- iii) Verify that two separate means of providing feedwater are fitted and operational.

Steam Piping

Main and auxiliary steam stop valves shall be dismantled and inspected as described for blow down valves above.

Boiler Supports and Support Brackets

Visually inspect for cracks, corrosion, erosion including axles and wheels. Other methods of inspection may be requested at the discretion of the TSSA Inspector.

Fusible Plug

- i) All solid fuel boilers shall have a fusible plug.
- ii) A fusible plug is optional only on oil or gas fired boilers equipped and operated with automatic
 - controls which shut off the fuel supply in the event of a low water condition.
- iii) Fusible plugs may be removed to visually examine the plug and the condition of the threads in the
 - crown sheet and fusible plug at the time of internal inspection, except where the plug is easily accessible for cleaning and inspection on the waterside to the satisfaction of the TSSA Inspector. The plugs shall be wire brushed or scraped to a bright surface of the fusible metal to remove all waterside and fireside deposits, prior to TSSA inspection. Fusible plugs shall not be repoured. Fusible plugs shall be replaced every five (5) years.
- iv) All fusible plugs for firetube boilers shall be constructed to meet with the ASME Code and be

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indicated as such by the ASME marking on the fusible plug.

- v) A fireside fusible plug shall protrude a minimum of 1-inch into the water.
- vi) Should the boiler be of a type requiring a waterside fusible plug, the waterside fusible plug shall not protrude into the fire area more than 1-inch.

Internal Inspection

- Inspect all accessible internal areas using mirror, flashlight, boroscope, or other inspection device paying particular attention to areas of corrosion and erosion, around water legs and the fire grate line.
- Internal inspection shall be carried out on the following as a minimum:

Fireside Inspection

- i) Inspect crown sheet, rear and front tube sheets, arch tubes and thermic siphons for signs of
- overheating, sagging, bagging, blisters, corrosion, erosion, cracking and general wastage.
 - ii) Inspect grate bars for operation and heat distortion. Check mounts for cracking and signs of excessive wear.
 - iii) Inspect tube ends for signs of leakage, overheating and proper installation.
 - iv) Inspect for cleanliness: soot or ash build-up.
 - v) Distortion of heat baffles/arch.
 - vi) Clear telltale holes of stay bolts.

Waterside Inspection (performed in alternating years when no hydrostatic test is performed)

- i) All internal surfaces must be dry prior to performing the inspection.
- ii) Inspect crown sheet and supporting stays or girders for scaling, corrosion, wastage or deposits,
 - sagging, distorting, and cracking.
- iii) Inspect stay bolts and through stays for wastage.
- iv) Inspect tubes, arch tubes and thermic siphons for scale build-up, corrosion, sagging or signs of overheating.
- v) Inspect water legs and mud-rings for corrosion, scale and deposit build-up and general wastage.
- vi) Inspect hand hole / manhole plates and seats for corrosion, pitting or wastage.

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- vii) Inspect threads on hand hole / manhole cover bolts for signs of wear, corrosion, wastage or cracking.
- viii)Inspect male and female threads on all washout plugs and openings.
- ix) Inspect longitudinal weld seam for corrosion and general wastage of weld and heat affected zone

Hydrostatic Test

- i) The required hydrostatic test (and N.D.E. if required) shall be performed before or after
 - completion of visual examination at the discretion of the TSSA Inspector.
- The TSSA Inspector shall witness a hydrostatic test making sure that the outside of the shell is dry prior to pressurizing the vessel.
- iii) It is recommended that the temperature of the test medium be a minimum of 70 degreesFahrenheit.
- iv) The test pressure shall be equal to a maximum of 1.1 times the MAWP as decided by the TSSA Inspector.
- v) The boiler shall be filled entirely with water. No air spaces are permitted.

Pressure Test Gauges

- i) At least one (1) gauge with evidence of calibration to national standards prior to use shall be utilised.
- ii) The pressure gauge(s) shall have a dial range of 1½ times the hydrostatic test pressure as a minimum and 4 times as a maximum.

Water Treatment

It is recommended that an acceptable water treatment program be used to minimize scale, control pH, minimize corrosion, pitting, reduce foaming or carry-over. Upon inspection of the boiler, the TSSA Inspector may request that an acceptable boiler feed water treatment program be implemented.

Note: Prior to completing the inspection, the TSSA Inspector shall confirm that the Certificate of Registration for the traction plant under the Operating Engineers Regulation is available in the owner's name. Where the Certificate of Registration is not available, the TSSA Inspector shall initiate an application for plant registration.

Reports

When the TSSA Inspector is satisfied that the boiler may be operated safely at the

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pressure indicated, the electronic database shall be updated, enter "Steam Traction" into the inventory "Remarks" field, and complete the following reports:

For the *Initial (First) Inspection* of the boiler

- The TSSA First Data Report
- The Steam Traction Boiler Checklist
- Legible photo of the Boiler Identification stamping
- The "Inspection Report" shall be completed by the TSSA Inspector and a copy of the Inspection Report distributed to the Owner/User.

For <u>Periodic (In-service) Inspection</u> of the boiler (inspections after the initial inspection)

- The Steam Traction Boiler Checklist
- The "Inspection Report" shall be completed by the TSSA Inspector and a copy of the Inspection Report distributed to the Owner/User.

The Steam Traction Boiler Checklist, TSSA First Data Report, and Inspection Report shall be submitted to the BPV Administrative Assistant at TSSA Head Office for processing.

Forms Applicable (See Table of Forms and Checklists)

- (8) TSSA Boiler or Pressure Vessel First Data Report
- (6) TSSA Inspection Report (Generated by TSSA Electronic System)
- (19)TSSA Steam Traction Boiler Checklist