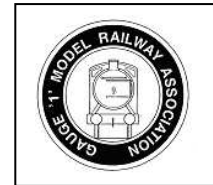


# THE GAUGE ONE MODEL RAILWAY ASSOCIATION

## PRESSURE VESSEL TEST PROCEDURE

Issue No. 3 — 5<sup>th</sup> July 2008



### INTRODUCTION

This document sets out the procedure to be adopted when pressure vessels (boilers and fuel tanks) used in Gauge One live steam locomotives are tested for safety. All locomotives operated at exhibitions and events organised or sponsored by the Gauge One Model Railway Association (or one of its local regional groups) must be tested to this procedure and a certificate of conformance issued.

Locomotives tested to earlier versions of this procedure continue to meet the Gauge One Model Railway Association's safety requirements. However, upon re-test all locomotives **MUST** be tested to this revised procedure and a new certificate issued.

### 1. DEFINITIONS

- 1.1 Throughout this document the word **SHALL** implies a **REQUIREMENT**. The words **SHOULD** and **CAN** indicate a **RECOMMENDATION**.
- 1.2 **Validity**. A certificate which covers the minimum standards laid down in this procedure, has not date expired and applies to pressure vessels which have not undergone alteration or repair without subsequent testing is a valid certificate.
- 1.3 Conversions used in this document are: 1 Bar = 14.7psi.
- 1.4 **Competent person**. For testing and evaluating pressure vessels for Gauge One models, is someone who has an appreciation of the design criteria, building and testing pressure vessels in this or larger gauges and has a working knowledge and understanding of one of the published books on boilers by K.N.Harris, M.Evans, 'LBSC' or A.Farmer.
- 1.5 **Pressure vessels**. Are any containers or vessels that can be subjected to a pressure above atmospheric pressure either by normal use or by accident.
- 1.6 **Low pressure boilers**. Are defined as having a working pressure of less than 2 bar (29.4 PSI). These are divided into two classifications:
  - 1.61 **Class LO**. Low pressure boilers whose outlet is always open i.e. there is no regulator or stop valve and the cylinders are of the conventional oscillating type where they are held against the port face by a spring. They may be fitted with a spring loaded reversing valve (such as was used by Bassett-Lowke or Mamod). They shall be fitted with a safety valve.
  - 1.62 **Class LS**. Low pressure boilers whose outlet can be closed by a regulator or stop valve or which feed directly to a piston or slide valve cylinder. They shall be fitted with a safety valve.
- 1.7 **High pressure boilers**. Are defined as having a working pressure greater than 2 bar. They shall be fitted with a safety valve and be made of copper and jointed with silver solder. Bushes to be made of gunmetal or bronze.
- 1.8 **Pressurized fuel tanks**. Are defined as any vessel designed to contain only butane liquid petroleum gas, where temperature cannot normally exceed 100 degrees Centigrade. They should preferably be constructed of copper and silver soldered. No soft solder to be used.
  - 1.8.1 Other pressurized fuel tanks, where the fuel (e.g. paraffin) remains liquid at atmospheric pressure should be referred to the Technical Secretary for certification.
- 1.9 **Copper pressure vessels**. Are defined as pressure vessels constructed entirely of copper (including flues in the case of boilers). The only exception is the use of phosphor bronze or monel metal for stays and phosphor bronze or gunmetal for bushes. Their construction should be silver soldered throughout but threaded stays fitted with bronze or brass nuts and sealed with soft solder are acceptable. The use of brazing is acceptable but alloys containing phosphorus, Sillbrallo, Phosphoralloy, Silphos are not acceptable inside coal fired boilers. TIG welding is not acceptable.
- 1.10 **Brass pressure vessels**. Are defined as any pressure vessels, which use brass anywhere in its structure apart from stay nuts.
- 1.11 **Steel pressure vessels**. Are defined as any pressure vessel having steel or stainless steel in any part of its structure. Pressure vessels which fall in this category are not acceptable for testing and certification by The Gauge One Model Railway Association.
- 1.12 All pressures quoted are gauge pressures. No absolute pressures are used.

## **2. TESTERS AND WITNESSES**

- 2.1 The Tester is the appointed person (who may be a member of one of the Association's Local Groups) and shall carry out the tests required for the issue and renewal of certificates for pressure vessels. The Tester shall be a member of The Gauge One Model Railway Association and shall be a Competent Person (as defined in para.1.4 above) who is neither the builder nor the owner. The witness should preferably not be the builder nor the owner of the pressure vessel.

## **3. INITIAL TEST - NEW PRESSURE VESSELS**

- 3.1 The pressure vessel shall be cleaned so that all joints are clearly visible, free from flux and other deposits.
- 3.2 All apertures shall be fitted with some means of sealing,
- 3.3 The use of soft solder to fix temporary blanking plates is not recommended since use of soft solder precludes later use of silver solder
- 3.4 New pressure vessels shall be tested and witnessed without cladding, lagging or any obstruction so that all parts of the structure can be observed during the test.

## **4. PREVIOUSLY UNCERTIFIED PRESSURE VESSELS - INITIAL CERTIFICATION TEST**

- 4.1 Where the pressure vessel is put forward for certification for the first time and is already lagged (e.g. in a new commercial model) there is not normally a requirement to remove the cladding and lagging providing the manufacturer issues a signed certificate indicating:
- All the materials used in construction including bushes and stays.
  - That it is silver soldered.
  - If and where any soft solder has been used,
  - The designed working pressure
  - The pressure it was tested to on completion.
- 4.2 Where the previous history is not known and there is no manufacturer's certificate then the Tester shall have the right to insist that the cladding and lagging shall be removed for the hydraulic test.

## **5. PRESSURE VESSELS WHICH HAVE PREVIOUSLY HELD CERTIFICATES**

- 5.1 If for any reason the expired certificate is not available or the pressure vessel has received structural repair or alteration it is not acceptable for re-test, therefore the procedure for testing an uncertified boiler shall be adopted. (paragraphs. 4.0 -4.2)
- 5.2 Providing that the old certificate is available for inspection and less than 8 years out of date then the following preparation may be used;
- 5.3 There is no requirement to remove the pressure vessel from the model or the lagging and cladding from the vessel.
- 5.4 Safety valves should be removed.
- 5.5 All other fittings should remain in place for the test. (except as in 5.6 (d))
- 5.6 In the case of boilers:
- (a) The smokebox door or front shall be opened to allow inspection of the whole of the boiler front plate.
  - (b) The burner, if fitted, shall be removed to allow inspection of the inside of the firebox.
  - (c) The ash pan and grate, if fitted, shall be removed unless the fire hole door is large enough to satisfy the Tester that a full inspection can be made with the aid of small mirrors.
  - (d) Model pressure gauges whose range is less than the test pressure should be removed to prevent damage.
- 5.7 Existing blower or blow down valves will serve to give a gradual release of pressure.

## **6. EQUIPMENT FOR TESTING**

- 6.1 Test Gauge. A reliable, large diameter pressure gauge (greater than 50mm diameter) with an identification mark shall be used.
- 6.2 The gauge range should be approximately 1.5 x the pressure of the test, (E.g. a 3" pressure gauge range 0-300 psi will be satisfactory for test pressures up to 200 psi,).
- 6.3 The test gauges shall be checked annually against a calibrated gauge for sticking movement and periodically calibrated against a master gauge held by the Technical Secretary of the Gauge One Model Railway Association or the master gauge used by a local Model Engineering Society.
- 6.4 Each test gauge shall have a record in which gauge identification, details and calibration results are entered.

- 6.5 Certificates issued by a recognised gauge testing authority are an acceptable alternative to keeping a logbook and must be retained.
- 6.6 Hand pumps fitted to the model will normally be sufficient to carry out the test
- 6.7 Stop valves. The fitting of a screw down stop valve between the pump and any non-return valve is recommended.

## 7. TEST PROCEDURE

- 7.1 Having prepared the vessel for test with the uppermost bush still open the vessel is filled with cold water. The pump shall be used for the final fill to purge the pipework and the vessel on test of any air bubbles.
- 7.2 The test should be carried out in a quiet environment in order that sounds can be detected from internal faults such as stays fracturing.
- 7.3 The pump is now used to slowly raise the pressure, stopping at several intermediate pressures for careful visual examination until the full test pressure is attained. Should any faults be detected they should be rectified before increasing the pressure.
- 7.4 When the full test pressure has been reached it shall be held whilst a full visual examination is made. The pressure is then released gently to zero. The cycle is then repeated until the full test pressure has been reached on three consecutive cycles, the final being held for at least 20 minutes for an INITIAL TEST and 5 minutes for a re-test whilst a further visual examination is made.

## 8. INTERPRETATION OF VISUAL OBSERVATIONS DURING HYDRAULIC TEST

- 8.1 Leaks. At test pressures slight leaks around stays, boiler flues and bushes as indicated by dampness or a slight dribble are unlikely to affect the strength of the vessel or in a boiler, its performance. No leaks are acceptable on a new vessel. Slight leaks may be acceptable at re-test at the discretion of the Tester. NB Leaks are not acceptable on any fuel tank.
- 8.2 Leaks of any type at seams between plates shall require great care to be exercised by the Tester, particularly in a boiler that has been previously certified. The area around the leak must be carefully cleaned so that any evidence of lack of penetration of the solder etc., deterioration or cracking of the joint, can be seen. Any signs of poor penetration or deterioration shall be reason for rejection. If there are no such signs and the leak is slight then a certificate can be issued but must have an entry bearing a description of the fault and its location added to be a guide when the next renewal test is carried out.
- 8.3 Distortion. On new vessels the copper will have been annealed during construction. It is not unusual to observe slight distortion during the first application of the test pressure. Anything but the slightest movement or distortion observed during renewal tests should be viewed with great suspicion and the vessel refused a certificate unless there is a satisfactory explanation. Any distortion observed must be noted on the test certificate and a particular point made of checking this feature at subsequent renewals.
- 8.4 Areas of particular note are front plates, throat plates, backhead, firebox sides (inner & outer), firebox tube plate and doorplate. All these are usually fairly flat and shall be adequately stayed to support them against pressure.
- 8.5 Cross tubes, water tubes and flues should be examined as far as possible to ensure that there is no collapse, deformation or corrosion that shall also be grounds for rejection. To enable this to be done boiler front tube plates should be clearly visible. A light in the firebox whilst viewing firetubes from the smokebox end is an effective way of detecting collapse of flues.
- 8.6 General Inspection. Joints should be carefully examined to ensure that the solder has flowed into the joint. It will be seen to have 'wetted' the surrounding metal. Joints which are made on dirty metal, where the temperature has been too low or not properly fluxed will have a dry appearance and the solder will tend to sit in globules on the surface. Such joints can trap flux blisters which are dissolved out during use, causing a leak. They also indicate areas where penetration may not be effective and a weak joint is present. If that possible weakness is on a seam between plates acceptance should be considered carefully. If the vessel is accepted then note of the observation should be made on the certificate.
- 8.7 The surface of the pressure vessel must be free from deep dents and severe scratches that significantly reduce the wall thickness and could become stress points.
- 8.8 Brass pressure vessels. At each test the Tester shall pay particular attention to an inspection for dezincification and age cracking. The possibility of rupture of antique brass boilers on test must be brought to the attention of the owner before the test is undertaken. Note, Antique brass boilers are outside the scope of the procedure and will not be certificated.

- 8.9 Brass fittings. At each hydraulic test all brass fittings shall have a visual examination. If necessary the fittings may be carefully removed and examined for evidence of corrosion and dezincification. Some discretion may be applied when carrying out this procedure.
- 8.10 Pressurized fuel tanks shall be subject to inspection for corrosion every four years and re-tested at the initial test pressure where, in the opinion of the tester, it is thought necessary. In any event a re-test every ten years is recommended.

## 9. MODEL PRESSURE GAUGE CALIBRATION.

- 9.1 If the pressure gauge range exceeds the initial test pressure, it can be left in place during the test and its calibration compared with the test gauge throughout its range. Any deviation should be recorded on the test certificate.
- 9.2 The position indicated on its dial when the test gauge shows maximum working pressure should be marked with a red line, where practicable.
- 9.3 If there is any evidence of the needle sticking anywhere in its range the cause shall be determined and rectified before putting into service.

## 10. STEAM TESTS

- 10.1 After the hydraulic test has verified that a boiler is structurally sound and the safety valve set hydraulically, the pressure gauge calibrated and all fittings in place, the boiler shall be steam tested. This test can be carried out with the cladding and lagging in place and the boiler mounted in the loco.
- 10.2 Steam shall be raised in the normal way observing that the safety valve releases at the maximum working pressure, making any fine adjustments as necessary.
- 10.3 Ensure that all burners are alight in alcohol fired locos. Coal fired locos should have their fire raked through to make sure that it is clear of ash and fresh coal added. With all outlet valves closed and no water being fed in, the blower shall be adjusted to give maximum steam generation. Gas burners shall be turned fully on to maximum heat generation.
- 10.4 Safety valve accumulation test. The pressure is observed using the calibrated model gauge. The safety valve shall release steam at sufficient rate to prevent the boiler pressure from rising more than ten percent above the maximum working pressure. If this pressure is exceeded the safety valve shall be deemed to have failed.

NB. It is considered good practice that every time steam is raised in a boiler that the safety valve is tested by lifting the spigot to allow steam to escape. This action prevents sticking of balls etc.

## 11. STANDARDS

- 11.1 Copper boilers. Hydraulic Certificates valid for 4 years, Steam Test valid for 2 years.
  - 11.1.1 Low pressure. Class LO. No hydraulic test is required. Safety valve should be tested to ensure release below 2 Bar.
  - 11.1.2 Low pressure. Class LS. New boilers initial test - 4 Bar. Renewal test - 3 Bar. Safety valve shall be tested to ensure release below 2 Bar
  - 11.1.3 High pressure boilers. New boilers Initial test - twice maximum working pressure. Renewal test - one and a half times maximum working pressure. Steam tests, safety valve setting and gauge calibration as defined in this procedure.
- 11.2 Brass boilers. Certificates valid for 1 year only. All hydraulic tests shall be at twice maximum working pressure.
- 11.3 Pressurized fuel tanks. All new published designs, and any other tank which is liable to reach 100 degrees Celsius in normal service shall be capable of an initial and any subsequent tests to 300psi and should be clearly labelled as being for use with Butane only.  
Other tanks subject to this procedure whose temperature is controlled by location (e.g. immersed in tender water tank), shall have a plate permanently fixed adjacent to the tank stating:  
**“For Butane only - the temperature of this tank must not exceed 60 degrees C”**.  
In this case, an initial and subsequent test pressure of 180psi is required. This plate will be made available to GIMRA members on request via local groups or directly from the Technical Secretary on receipt of a stamped addressed envelope. This plate may be attached by solder, rivets or epoxy resin
- 11.4 Gas tanks should be inspected every four years and re-tested at the discretion of the tester every 10 years. It is strongly recommended that tanks are retested on change of ownership.

**PROPANE OR PROPANE / BUTANE MIXES MUST NOT BE USED IN THESE TANKS.**

## **12. MARKING OF PRESSURE VESSELS**

- 12.1 Pressure vessels. All new vessels submitted for initial tests should have an identification code. This should be a serial number from a manufacturer or initials and personal mark of the builder and show working pressure.
- 12.2 Markings should be visible without having to remove the boiler or pressurized fuel tank from the locomotive.

## **13. CERTIFICATION**

- 13.1 Any pressure vessel having a test certificate validated by an insurance company should not be re-tested before the expiry of the certificate. Such certificates are acceptable.
- 13.2 Any boiler having a valid certificate issued by a model engineering society which is affiliated to the Northern Association of Model Engineers or The Southern Federation of Model Engineers is acceptable.
- 13.4 Certificates issued by the Gauge One Model Railway Association prior to 5<sup>th</sup> July 2008 will be accepted whilst they remain valid. All initial or renewal certificates issued on or after that date shall be to the requirements laid down in this document.
- 13.5 In order to comply with guide lines, testers should add "Under 2 Litres" in the remarks box.

## **14. INITIAL CERTIFICATES**

- 14.1 New, complete models. When all the tests have been carried out, the Tester and witness shall complete and sign a certificate.
- 14.2. New pressure vessel under construction. When the hydraulic test has been carried out the Tester and witness shall only complete the sections on hydraulic test and date the certificate accordingly.

## **15. RENEWAL CERTIFICATES**

- 15.1 Before a renewal test is carried out the Tester shall ascertain that the vessel has previously been covered by a valid test certificate. This may be an initial or renewal certificate or a certificate issued by any of the acceptable sources listed in clauses 13.1 and 13.2.
- 15.2 Identification markings. The identification mark of each pressure vessel shall be recorded in the section indicated.

## **16. NUMBERING OF TEST CERTIFICATES.**

The Tester shall number each certificate issued with his personal numbering system, including initials (eg CG for Chiltern Group) to indicate the local group area and record each certificate's date of issue, number and pertinent information in a record book.

## **17 DISPUTES AND CLARIFICATION**

- 17.1 If the Tester is uncertain about any aspect of the pressure vessel tests in respect of this procedure then he should decline to certify the pressure vessel and refer the owner for further tests by another Tester or the Technical Secretary of The Gauge One Model Railway Association.
- 17.2 Furthermore non-standard designs or alternative constructions outside the experience of the Tester should be referred to another Tester or the Technical Secretary of The Gauge One Model Railway Association.
- 17.3 If the owner does not accept the decision of the Tester, then the matter should be referred to another Tester or the Technical Secretary of The Gauge One Model Railway Association
- 17.4 The tester may decline models whose age and/or origin are unknown and the owner should be referred to the Technical Secretary of The Gauge One Model Railway Association.