

The Boiler Test Code 2018

VOLUME 2 - Boilers under 3 bar litres

Effective from 1st May 2018

Prepared by:

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Association of 16mm Narrow Gauge Modellers,
Gauge 1 Model Railway Association, Midland Federation of Model Engineers,
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1 Introduction

- 1.1 This Test Code has been prepared by:
- 10¼" Gauge Railway Society
 - 7¼" Gauge Society
 - Association of 16mm Narrow Gauge Modellers
 - Gauge 1 Model Railway Association
 - Midland Federation of Model Engineers
 - Model Power Boat Association
 - Northern Association of Model Engineers
 - Southern Federation of Model Engineering Societies
 - Walker Midgley Insurance Brokers
- 1.2 Small boilers are those with a pressure-volume product below 3.0 bar litres. Examination and test of this type of boiler is applicable if the boiler is fitted with, as a minimum requirement, a safety valve. The boiler may also be fitted with a water level gauge and a mechanical means of pumping water into the boiler whilst under working pressure. If no means of supplying water to the boiler whilst working is present, the fuel supply shall be so arranged that it is used up before the water is exhausted.
- 1.3 The Health and Safety Executive considers it good practice for persons using pressure equipment to provide the same level of health and safety protection as they would if they were duty holders under the Pressure Systems Safety Regulations 2000 (PSSR). To aid this process, this Code has therefore been prepared using the principles of the PSSR. Where applicable this Code complies with PSSR 2000.
- 1.4 It is considered that the procedures in this document represent good practice for model engineering applications.
- 1.5 This document shall be considered as the Written Scheme of Examination as described in the PSSR, when used in conjunction with the test certificate associated with an individual boiler.

- 1.6 When operating boilers where the Health and Safety at Work etc. Act 1974 applies, compliance with the requirements of PSSR shall be necessary. The PSSR require that this code is used in conjunction with the applicable Written Scheme of Examination certificate. Steam locomotives, including model steam engines, are classed as installed systems for the purposes of the Regulations.
- 1.7 Individuals or organisations seeking insurance need to check that the requirements herein are acceptable to their insurer.
- 1.8 The provisions of this Test Code shall come into effect on 1st May 2018 and shall not be retrospective.

2 Purpose

- 2.1 The purpose of this code is to cover the testing and documentation of the boiler and any non-isolatable fittings. Such fittings are pressure relief/safety valves and any outlet valve such as the regulator/steam blower valve. Any other fittings which cannot be isolated in service must be included in the test.
- 2.2 That boilers are constructed to a high standard, and any repairs or modifications are similarly to a high standard of safety.
- 2.3 That the standard of safety is maintained throughout the life of the equipment.
- 2.4 Following this code will enable the owner/user of a pressure system to fulfil duties and responsibilities that may be placed upon them by the requirements of the Pressure Systems Safety Regulations 2000 are satisfied (where applicable).
- 2.5 Flash steam boilers, drum boilers and coil boilers may not be tested under this code

3 Definitions

- 3.1 'Shall' is mandatory, 'should' is advisory.
- 3.2 Boiler: Any pressure vessel used for the generation of steam.
- 3.3 Fittings: Devices attached to the boiler to allow operation thereof. Including such items as safety valves, water gauges, pressure gauges, regulators, stop valves, feed valves, check valves, blow-down valves, superheaters, etc.

- 3.4 Mountings/bushes: Locations where fittings are attached to the boiler. Also, relates to the locations for fixing the boiler to a frame or support, or for attaching other items to the boiler.
- 3.5 Working Pressure (P_w): The maximum pressure at which, under normal circumstances, the boiler is to be operated and to which the boiler is certificated.
- 3.6 Limit (Safe Operating) Pressure (P_L): This is the maximum allowable pressure for the system in which a relief mechanism is fitted. For steam pressure systems this is the Working Pressure (P_w) plus 10%. The value is used for testing the correct operation of the relief mechanism only.
- 3.7 Validity: a certificate which covers the minimum standards laid down in this procedure, has not date expired and applies to boilers which have not undergone alteration or repair without subsequent testing is a valid certificate.
- 3.8 Conversions used in this document are: 1 bar = 14.5 psi.
- 3.9 Member: a person who is a member of the one of the groups listed in 1.2, either directly or through one of their affiliated societies.
- 3.10 Association(s): means one or more of the groups listed in 1.2 above.
- 3.11 Competent Person: for the purposes of this code, a Member of and appointed by the management committee of the club, society or Association under whose name the boiler is examined and/or tested after such persons have satisfied that committee that they have the appropriate level of experience and/or qualifications.
- 3.12 Witness: a person who observes the examination and test of a completed boiler and signs the certificate in such capacity. The witness shall be a Member and, at the Inspector's discretion, may be the owner/user of the boiler.
- 3.13 Inspector: either a Member and a Competent Person who is neither the builder nor the owner/user, or a similar officer appointed by another society or association that is recognised by the Associations, or a commercial organisation appointed by the Associations that can offer facilities for testing per this code.
- 3.14 For the purposes of this code, low pressure boilers are defined as having a Working Pressure of less than 2 bar (29.0 psi). These are divided into two classifications:

- 3.14.1 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.
- 3.14.2 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.
- 3.15 For the purposes of this code, high pressure boilers are defined as having a Working Pressure greater than 2 bar. They shall be fitted with a safety valve and jointed with silver solder. Bushes to be made of gunmetal or bronze.
- 3.16 Copper boilers are defined as boilers constructed mainly of copper (including flues). Phosphor bronze or monel metal may be used 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, though this may prevent any further silver soldering being performed effectively. The use of brazing is acceptable but alloys containing phosphorus, e.g. Sillbralloy, Phosphoralloy, Silphos, are not acceptable for coal fired boilers.
- 3.17 Brass boilers are defined as any boilers that use brass anywhere in their structure apart from stay nuts.
- 3.18 Steel boilers are defined as any boiler having steel or stainless steel in any part of its structure. Boilers which fall in this category are not acceptable for testing and certification under this code. Owners/users of such boilers are recommended to seek guidance from a model engineering society.
- 3.19 All pressures quoted are gauge pressures. No absolute pressures are used. All uses of "psi" mean gauge pressure.
- 3.20 Commercially Built means a boiler or model placed on the market for sale.
- 3.21 Owner/User: As defined in the Pressure Systems Safety Regulations 2000 Regulation 2. Steam locomotives, including model steam engines, are classed as installed systems for the purposes of the Regulations.

4 Role of Inspectors

- 4.1 Inspectors undertake their duties on a voluntary non-commercial basis and all examinations and tests are carried out entirely at the discretion of the Inspector. Inspectors are not under any obligation to test every boiler presented for certification and they will only test and certify boilers that they feel competent to test based on their own experience.
- 4.2 In addition to clause 4.1, an Inspector may, if not satisfied that a boiler and/or its associated equipment and fittings are fit for service, refuse to undertake an examination and test, and/or refuse to issue a certificate after examination and test.
- 4.3 If an Inspector refuses a test or certificate (other than when a postponement of the test has been made to effect an adjustment which it is anticipated will subsequently provide a satisfactory test), a record of the refusal shall be made, giving details of the boiler, the boiler owner/user, the reason for the refusal and the date thereof at the request of the owner/user.
- 4.4 The decisions taken by boiler Inspectors shall be taken as final (see section 19).
- 4.5 An Inspector shall not inspect their own work, unless that work has already been tested and passed by another Inspector.

5 Examination of new boilers

- 5.1 An Inspector shall be required to examine a boiler to satisfy himself that the requirements of clauses 5.4 and 5.5 are fulfilled, particularly where a boiler is already constructed and presented for examination. All prospective constructors should discuss such possible requirements with the Inspector before commencing construction.
- 5.2 The initial examination and test shall be carried out without any cladding present on the boiler. Boilers shall also be presented in such a way as to provide full access and visibility of all boiler surfaces.
- 5.3 As much of the boiler as possible (internally and externally) shall be examined to determine the general condition of the boiler.

- 5.4 The Inspector shall satisfy himself that: -
- a. The materials used are of the adequate thickness and the correct specification.
 - b. Where appropriate, material certificates are provided.
 - c. The boiler is constructed in accordance with the design drawings.
 - d. Joining procedures have been satisfactorily undertaken and that the joints are sound. Attention should be paid to the penetration of silver solder.
- 5.5 The Inspector shall satisfy himself that the boiler, fittings and mountings are in suitable condition to allow the subsequent hydraulic tests to be safely undertaken.
- 5.6 The boiler shall then be subject to a hydraulic test as described in Section 10 below. The test pressure shall be twice the Working Pressure ($2xP_w$). The system shall then be tested with non-isolatable fittings in place at one and one-half times Working Pressure.
- 5.7 The boiler shall be indelibly marked with a unique identification number in a suitable place so located as to be readily visible where practicable when the boiler is installed. The form and position of the marking shall not damage or compromise the structure of the boiler.

6 Initial test - new boilers

This section applies to 'home built' boilers. It does not apply to Commercially Built boilers which have been either manufacturer fitted to a complete model, or have been installed in a home built model, and were issued at manufacture with certificate of conformance with sound engineering practice (SEP) as outlined in the Pressure Equipment (Safety) Regulations, unless that boiler has received structural repair or alteration.

- 6.1 The boiler shall be clean so that all joints are clearly visible, free from flux and other deposits.
- 6.2 All apertures except those used during the test shall be fitted with some means of sealing,
- 6.3 The use of soft solder to fix temporary blanking plates is not recommended since use of soft solder precludes later use of silver solder

- 6.4 New boilers shall be tested without cladding, lagging or any obstruction so that all parts of the structure can be observed during the test.
- 6.5 The boiler shall be subjected to an initial hydraulic shell pressure test of twice Working Pressure ($2xP_w$) and the certificate is valid for the life of the boiler. The test procedure is as described in section 10 of this code.
- 6.6 A repeat hydraulic test shall be conducted after the working components have been attached to the boiler shell to prove the structural integrity of the boiler fittings and their attachment to the boiler. This includes the pressure gauge where feasible. The applied pressure shall be one and a half times Working Pressure ($1.5xP_w$). The test procedure is as described in section 10 of this code.
- 6.7 Boilers constructed with screwed hollow stays, such as those used in Aster boilers must be tested to twice Working Pressure ($2xP_w$) with all fittings in place (pressure gauges and safety valves excepted).
 - 6.7.1 Safety valves shall be set to operate at or below the Working Pressure
 - 6.7.2 The Working Pressure shall be marked on the pressure gauge.
 - 6.7.3 It is recommended that the range of the gauge should be at least 50% beyond Working Pressure and preferably twice the Working Pressure ($2xP_w$).

Most model steam boiler pressure gauges are calibrated in bar or lb/in² (psi). Other units occasionally encountered are the MegaPascal (MPa) or the Kilogram Force/Cm². 1bar = 0.1MPa or 1.0197 Kgf/cm².

7 Previously uncertified boilers - initial certification test

7.1 Where the boiler is put forward for certification for the first time and is already lagged (e.g. in a new Commercially Built models) there is no requirement to remove any cladding and lagging or remove the boiler from the model providing the manufacturer issues a certificate indicating:

- a. All the materials used in construction including bushes and stays
- b. That it is silver soldered
- c. If and where any soft solder has been used
- d. The designed Working Pressure
- e. The pressure it was tested to on completion

OR the manufacturer issues a certificate of conformance with sound engineering practice (SEP) as outlined in the Pressure Equipment (Safety) Regulations 2016.

7.2 Where the previous history is not known and there is no manufacturers certificate then the Inspector shall have the right to insist that the cladding and lagging shall be removed and/or that the boiler be otherwise fully exposed for the hydraulic test.

7.3 The boiler will be subjected to an initial hydraulic shell pressure test of twice Working Pressure ($2xP_w$) and is valid for the life of the boiler.

8 Lost or missing certificates

8.1 If the certificate is lost, and if the current certificate issuer cannot be traced and duplicate certificates issued, or the boiler has received structural repair or alteration, the procedure for testing a previously uncertified boiler shall be adopted.

9 Equipment for testing

- 9.1 Test Gauge: a test gauge which has, within the previous two years, been checked and calibrated to within $\pm 2\%$ either against a currently validated dead weight test apparatus or against other traceable equipment. The test gauge may also be calibrated by a commercial test facility that shall provide a calibration test certificate. The calibration record shall be available for examination. Any errors identified on the calibration record shall be taken in to account when subsequently using the gauge for test or calibration purposes. The test gauge shall be checked at every use for sticking movement and correct zero indication.
- 9.2 The gauge range should be approximately 1.5 x the pressure of the test, (e.g. a range 0-300 psi will be satisfactory for test pressures up to 200 psi).
- 9.3 Each test gauge shall have a record in which gauge identification, details and calibration results are entered.
- 9.4 Certificates issued by a recognised gauge testing authority are an acceptable alternative to keeping a logbook and must be retained.
- 9.5 Stop valves: the fitting of a screw down stop valve between the pump and any non-return valve is recommended to reduce the effect of leakage back through the test pump.

10 Test procedure

- 10.1 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.
- 10.2 The test should be carried out in a quiet environment in order that sounds can be detected from internal faults such as stays fracturing.
- 10.3 The pump is now used slowly to raise the pressure, stopping at several intermediate pressures for careful visual examination until the full test pressure is attained. Any faults detected should be rectified before increasing the pressure.
- 10.4 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.

11 Interpretation of observations during hydraulic test

- 11.1 No leaks are permissible on a new boiler.
- 11.2 Distortion. On new boiler, 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 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. It is good practice for the Inspector to raise and release pressure in increasing steps (thus work hardening the copper) until the maximum pressure is attained.
- 11.3 Areas of note are front plates, throat plates, backhead, firebox sides (inner & outer), firebox tube plate and doorplate. All these are usually flat and shall be adequately stayed to support them against pressure.
- 11.4 Cross tubes, water tubes and flues should be examined as far as possible to verify 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 where possible. A light in the firebox whilst viewing firetubes from the smokebox end is an effective way of detecting collapse of flues.
- 11.5 General Inspection. Joints should be carefully examined to verify that the solder has flowed into the joint. It should 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 complete 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.
- 11.6 The boiler must be free from deep dents and severe scratches that significantly reduce the wall thickness and could become stress points.

- 11.7 Brass Boilers. At each test, the Inspector shall look carefully for dezincification and age cracking. The possibility of rupture of brass boilers on test must be brought to the attention of the owner/user before the test is undertaken. Also, refer to Section 14.2 regarding brass boilers.

12 Model pressure gauge calibration

- 12.1 If the pressure gauge range exceeds the initial test pressure ($2xP_w$), 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.

The position indicated on its dial where the test gauge shows maximum Working Pressure should be indelibly marked with a red line, where practicable (a red mark on the bezel of the gauge is acceptable provided the bezel is immovable).

- 12.2 If there is any evidence of the needle sticking anywhere in its range the cause shall be determined and rectified before putting into service.

13 Safety checks and steam tests

- 13.1 After completion of hydraulic testing the following steps will be performed:

- 13.1.1 The inspection should commence with a thorough visual inspection whilst cold. All brass fittings shall have a visual examination. If the Inspector deems necessary, the fittings may be removed by the owner/user and examined for evidence of corrosion and dezincification.

- 13.1.2 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 model.

- 13.1.3 Steam shall be raised in the normal way observing that the safety valve releases at or below the maximum Working Pressure, making any fine adjustments as necessary.

13.1.4 Verify that all burners are alight in alcohol fired locos. Coal fired models 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 adjusted to achieve maximum heat generation.

13.1.5 Safety valve accumulation test. The pressure is observed using the marked pressure gauge fitted. The safety valve shall release steam at sufficient rate to prevent the boiler pressure from exceeding the Limit (Safe Operating) Pressure. If this pressure is exceeded the safety valve shall be deemed to have failed.

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

Correct operation of the following items shall be verified:

- a. Boiler water feeding arrangements (hand pump, injectors, mechanical pump, etc.)
- b. The correct operation of the pressure gauge shall be verified
- c. The water gauge(s) shall be blown down - if a valve has been fitted for this purpose, and the water levels shall be seen to recover without delay

13.1.6 The boiler shall then be steamed at maximum firing rate using the blower if fitted to achieve maximum steam generation. The test shall be continued for sufficient time as to confirm that stable conditions have been attained. The operation of the safety valves shall be observed to verify that they operate at no more than the Working Pressure of the boiler and that the pressure does not exceed the Limit (Safe Operating) Pressure during safety valve operation.

13.2 Subsequent annual safety and steam tests performed by the owner/user, witnessed and recorded.

13.2.1 The safety inspection of a boiler should be performed at intervals no greater than 14 months, or when the boiler is next steamed if greater than that time interval since previous steaming.

13.2.2 Steps 13.1.1 through 13.1.6 should all be performed and the outcome documented on the record of Annual Inspection and Steam Test, with the following variation to step 13.1.5 b:

- 13.2.2.1 When the safety valve releases, if the pressure gauge indicates the planned Working Pressure then there shall be no requirement to test the gauge against a gauge of known accuracy.
- 13.2.2.2 When the safety valve releases, if the pressure gauge does not indicate the planned Working Pressure then the gauge should be tested for accuracy against a gauge of known accuracy, or the gauge replaced with one which has been so tested.

14 Testing standards by boiler type

- 14.1 Copper boilers: the initial hydraulic pressure tests (6.5 and 6.6 above) are not repeated unless the boiler has been subjected to a structural modification or repair that may affect the integrity of the pressure system.
 - 14.1.1 Low pressure, Class LO: no hydraulic test is required; safety valve shall be tested to verify release at or below the Working Pressure. If the boiler does not have a pressure gauge then the safety valve should be tested off the boiler using a pressure gauge.
 - 14.1.2 Low pressure, Class LS: new boilers initial test - twice Working Pressure ($2xP_W$); safety valve shall be tested to verify release at or below Working Pressure.
 - 14.1.3 High pressure boilers: new boilers initial test - twice Working Pressure ($2xP_W$); safety inspections, steam tests, safety valve setting and gauge calibration as defined in this test code.
- 14.2 Brass boilers: The Initial Hydraulic test certificate is valid for life, unless the boiler has been subjected to a structural modification or repair which may affect its integrity. The initial hydraulic test shall be at twice Working Pressure ($2xP_W$). All subsequent hydraulic tests are valid for 3 years only. These shall be at one and a half times Working Pressure unless the boiler has been subjected to a structural modification or repair which may affect its integrity, in which case the test shall be at twice Working Pressure ($2xP_W$).

15 Marking of boilers

- 15.1 All boilers submitted for initial test shall have an indelible identification code. This may be a serial number from a manufacturer or initials and personal mark of the builder and show Working Pressure.

15.2 Markings should where practicable be visible without having to remove the boiler from the model.

16 Certificates

16.1 Certificates issued by a member of the one of the groups listed in 1.2, either directly or through one of their affiliated societies prior to the implementation of this code will be considered valid whilst they remain in date.

16.2 Certificates issued by a commercial builder are acceptable.

16.3 The certificate used as part of this code shall be common across and available from the Associations.

16.4 The certificates shall include the following information:

- a. The name of the Club/Society and Organisation issuing the certificate
- b. The name of the Owner/User
- c. The location where the test was carried out
- d. Identification of the system that the certificate relates to, e.g. boiler number
- e. Maker, if known
- f. Type of boiler
- g. Boiler volume in litres
- h. Material(s) used in construction
- i. Date of construction, if known
- j. Date of examination and hydraulic test, if applicable
- k. Date of examination and steam test, if applicable
- l. Result of the examination
- m. Expiry date of the certificate
- n. Working Pressure of the boiler
- o. Test pressure applied
- p. Parts not examined
- q. Any repairs needed and timescale for completion
- r. Confirmation of safety valve(s) operation
- s. Date of the report
- t. Name and signature of Inspector (and Witness where involved)

- 16.5 The completed certificate will be given to the owner/user of the boiler for safekeeping – if the Ownership changes, the certificate should pass to the new owner/user.

17 Initial certificates

- 17.1 New boilers not fitted to a model: when the hydraulic test has been carried out the Inspector and Witness shall complete the appropriate sections on hydraulic test and date the certificate accordingly.
- 17.2 New, completed models: when all the tests have been carried out, the Inspector and Witness shall complete the certificate.

18 Numbering of certificates

- 18.1 The relevant association will issue a personal identification code to each Inspector, or will issue Inspectors with pre-numbered certificates.
- 18.2 Inspectors shall number each certificate issued with their personal numbering system as assigned by the relevant association and record each certificate's date of issue, number and pertinent information in a record book.

19 Disputes and clarification

- 19.1 If the Inspector is uncertain about any aspect of the boiler tests in respect of this procedure, then he should decline to certify the boiler and refer the owner/user for further tests by another Inspector or the technical representative of the relevant association.
- 19.2 Non-standard designs or alternative constructions outside the experience of the Inspector should be referred to another Inspector or the technical representative of the relevant association.
- 19.3 If the owner/user does not accept the decision of the Inspector, then the matter should be referred to another Inspector or the Technical representative of the relevant association.
- 19.4 The Inspector may refuse to test boilers whose age and/or origin are unknown and the owner/user should be referred to the Technical representative of the relevant association.

Appendix A: References

The following documentation has been taken in to account when producing this Boiler Test Code:

- a. Pressure Equipment (Safety) Regulations 2016. No 1105
- b. The Pressure Systems Safety Regulations 2000. SI 2000 No 128
- c. Pressure Systems Safety Regulations 2000. Approved Code of Practice L122 (PSSR2000)

Further information can be obtained from the technical representatives of the clubs and societies listed in 1.1.

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