State of Washington
Department of Labor & Industries
Boiler & Pressure Vessel Program
7273 Linderson Way S.W.
Tumwater, Washington 98501

Miniature Hobby Boiler Inspection and Certification Requirements

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Section I. Purpose:

This document has been developed to assist the designers, builders, and users of Miniature Hobby Boilers with the necessary requirements and procedures for certification of miniature hobby boilers within Washington State. Under this authority, the Boiler and Pressure Vessel Program has developed these requirements and procedures contained herein in order to uniformly inspect and certify Miniature Hobby Boilers for safe operation in public areas. Annual testing will be handled outside of this document.

Section II. Authority:

The laws of Washington State [RCW 70.79.070 (3)] dictate that it is the responsibility of the owner of a Miniature Hobby Boiler to have the boiler inspected and certified by the Department of Labor & Industries, Boiler and Pressure Vessel Program, to insure that the miniature hobby boiler can be operated safely in public places.

Section III. Document Revision Control:

If revisions are made to any section/sections of this document, the entire document will be revised. The current document date and revision level will be indicated on the Title Page and on the header of each page of this document. At the Chief Inspector's option, a new Edition can be issued, with the revision level reset to zero.

Section IV. Boilers Defined:

1. Miniature Hobby Boiler defined:

   Miniature Hobby Boilers subject to certification are defined as those that fall within the following dimensions, limitations and criteria:

   A. A maximum of sixteen inches inside boiler shell diameter;

   B. A maximum of twenty square feet of total heating surface. See note #1.

   C. A maximum gross volume of five (5) cubic feet. See note #2.

   D. A maximum allowable working pressure for steel boilers of 150 PSIG

   Note #1: Total heating surface is the sum of the area of all the firebox surface areas and the flue heating surface area.

   Note #2: The total volume of the boiler outside envelope less the volume of the firebox.

2. Commercial Miniature hobby boiler defined:

   Commercial Miniature Hobby Boilers are defined as boilers meeting the requirements listed under Section III-1 (Miniature Hobby Boilers Defined), and obtained from a recognized manufacturer or business properly registered or licensed for sales in a state, or states of the United States of America. Such commercial boilers may be sold either as an individual miniature hobby boiler unit, or as a part of a finished product (i.e. locomotive, boat, tractor, etc.)

   Note: Commercially fabricated Miniature Hobby Boilers that have had any modifications or alterations made to the pressure envelope, subsequent to purchase, will be subjected to the requirements of miniature hobby boilers in Section III-1 above.

Section V. Abbreviations:

<	Less than
ASME	American Society of Mechanical Engineers
Certified Pressure	Maximum operating pressure safety valve setting (psig), at or below the MAWP.
MAS	Maximum Allowable Stress (PSI): The maximum stress allowed for design purposes in determining MAWP.
MAWP	Maximum Allowable Working Pressure (PSIG), resulting from the application of design criteria.
PSI	Pounds per Square Inch
PSIG	Pounds per Square Inch, Gauge.

Section VI. General Requirements:

1. The following general and technical requirements are applicable to all Miniature Hobby Boilers presented for certification to the state of Washington.

    a. All boilers shall be equipped with an ASME certified safety valve set at or below the calculated MAWP. Where size or other limitations make the installation of an ASME certified safety valve impossible or impractical, an acceptable non-ASME safety valve may be used with the approval of the inspector. The safety valve will be manufactured and tested to the satisfaction of the Inspector. Acceptable non-ASME safety valves will be tested in accordance with Section X(4).

    b. The certification test pressure for all hobby boilers shall be 2 times the MAWP calculated on Forms 1 and 2.

    c. At the discretion of the Inspector, with proper documentation, commercially fabricated Miniature Hobby Boilers may not be required to pass a certification hydrostatic test.

2. A copy of the applicable drawings and calculations for non-commercial boilers to be reviewed by the Inspector and returned to the applicant.

3. The boiler owner shall complete Form 1, lines 1-3 and Forms 2 & 3 completely. Ensure all documents are appropriately filled out and signed.

4. The boiler owner will make application to the Chief Boiler Inspector for a preliminary boiler inspection by telephoning the local Labor & Industries Office Boiler Inspector or by telephoning the Chief Boiler Inspector at 360-902-5270. The purpose of this preliminary inspection is to verify that the boiler is acceptable for certification, to verify the calculations for Maximum Allowable Working Pressure (MAWP) of the boiler, and to establish a date for the certification testing.

5. The Chief Boiler Inspector, upon receiving an Inspector approved Miniature Hobby Boiler Inspection Check List (Form 3), will issue a Washington State Special Number and a one year Certificate of Inspection.

6. Once the boiler has been certified, any change to the pressure envelope will require re-certification by the Inspector.

7. The fees and charges for inspection, testing and certification are as set forth in WAC-296-104-700.

Section VII. Materials:

1. The materials utilized in boiler fabrication shall be noted in the applicable sections of the Boiler Material Form (Form 2). When completed, the form shall be signed by the owner or fabricator thereby certifying that the noted materials used are as indicated.

2. Maximum allowable material stress will be indicated in the following table. This table lists materials and the stress that may be used in fabrication of boilers fabricated in accordance to the requirements set forth in this procedure. However, the boiler is not limited to these materials only.

3. Seamless and welded shells made from pipe for miniature boilers shall be not less than 3/16 in. (5.0 mm) in thickness. Shells or heads made from plate shall be not less than ¼ in. (6mm) in thickness. Heads used as tube-sheets, with tubes expanded, shall be at least 5/16 in. (8 mm) in thickness.

4. The maximum allowable stress (MAS) to be used for MAWP calculations shall be 0.75 times the maximum stress allowed, at 400 deg. F, by Section II Part D, ASME code for specific, known materials. All other shall be as prescribed in the table below.

Material	Form	Temperature	Stress Value
SA 53 gr. b ERW	Pipe	400 Deg. F.	12, 800
SA 53 gr. b Smls	Pipe	400 Deg. F.	15,000
SA 106 gr. b	Pipe	400 Deg. F.	15,000
SA 226	Pipe	400 Deg. F.	11,800
SA 192	Pipe	400 Deg. F.	11,800
SA 285 Gr. C	Plate	400 Deg. F.	13,800
SA 516 Gr. 70	Plate	400 Deg. F.	17,500
SA 36	Plate	400 Deg. F.	14,500
SA 36	Bar Stock	400 Deg. F.	13,300
SA 234	Fittings	400 Deg. F.	15,000
SA 105	Forgings	400 Deg. F.	17,500
Unidentified Steel	All	400 Deg. F.	10,300
Copper	All	See Footnote*	See Footnote*

* *These values to be determined by information available on a case by case basis.*

5. Where specific materials used in welding or brazing are not identified, the Inspector may require a test coupon be fabricated and tested to verify the material and weld strength.

Section VIII. Design Criteria:

1. The following equations, derived directly from ASME Boiler Code, Section I, shall be utilized in determining the MAWP for the boiler presented for certification. The MAWP shall be determined for all sections of the boiler, entered into the applicable areas of the Design Disclosure Form (Form 3), and certified by the person performing the calculations. In instances of complex, unusual, or marginal design, the Chief Boiler Inspector may require the MAWP of the boiler, or specific sections, be determined by a Registered Professional Engineer.

2. Upon completing the form, the minimum of all calculated MAWP's will be designated as the Boiler MAWP and utilized as the basis for establishing Certified Operating Pressure, but in no case shall they exceed 150 PSI for steel boilers and 100 PSI for copper boilers.

Formulas:

1. Boiler Shells.

   For Boiler Shells, Cylinders, and parts of Cylinders the following equation is limited to longitudinal sections.

$$P = \frac{2SEt}{D - 2Yt}$$

Where:

P	=	MAWP
S	=	MAS
D	=	Outside Diameter of Cylinder in inches
E	=	1.00 for Seamless pipe (ASME certified material)
		0.90 for welded seam (ASME certified material)
		0.60 for other welded seams
Y	=	0.40 for conditions less than 900 degrees F
t	=	Cylinder wall thickness

2. Dished Heads, not fully Hemispherical

This dished heads design equation is applicable in instances where the head is a section of a sphere, dished outward from the pressure envelope, however, not a full hemisphere. Where the head is dished inward to the pressure envelope, use 60% of the MAWP determined in the equation below.

$$P = \frac{0.96St}{L}$$

Where:

P	=	MAWP
S	=	MAS
L	=	Radius of the sphere in inches
t	=	Thickness of the sphere in inches

3. Full Hemispherical Heads

This dished heads design equation is applicable in instances where section of a sphere, dished outward from the pressure envelope, is a fully hemispherical.

$$P = \frac{1.65t}{L}$$

Where:

P	=	MAWP
S	=	MAS
L	=	Radius of the sphere in inches
t	=	Thickness of the sphere in inches

4. Flat Heads

The flat head equation is applicable to circular, flat heads utilized at the end of, or internal to, a cylinder.

$$P = \frac{St^2}{Cd^2}$$

Where:

P	=	MAWP
S	=	MAS
d	=	Inside diameter of the cylinder in inches
C	=	A Constant 0.20 for heads at the end of the cylinder 0.10 for internal heads
t	=	Thickness of the head in inches

5. Flat Stayed Surfaces

This formula is used for determining the number of stay bolts required for a flat surface.

$$P = \frac{SCt^2}{A}$$

Where:

P	=	MAWP
S	=	MAS
C	=	A Constant: 2.10
A	=	Area of the plate in inches For symmetrical stays, A= (pitch) ² For unsymmetrical stays, A= ab, where a & b are the pitches at right angles about a stay. For stayed tube sheets, A is determined by equation 8, page 11 below.
t	=	Thickness of the head in inches

6. Stays

$$P = \frac{Sa}{A}$$

Where:

P = MAWP

S = MAS

A = Area of the plate in inches
For symmetrical stays, A= (pitch) ²
For unsymmetrical stays, A= ab, where a & b are the pitches at right angles about a stay.
For stayed tube sheets, A is determined by equation 8, page 11 below.

a = Cross sectional area of the stays in inches.
For threaded stays, use the cross sectional area at the thread root.

7. Tubes

$$P = S\left[\frac{2t - 0.01D - 2e}{D - \left(t - 0.005D - e\right)}\right]$$

Where:

P = MAWP

S = MAS

D = Outside diameter of tubing in inches

t = Thickness of the tubing wall in inches

e = A Constant:
For welded tube ends, e= 0.0
(Note: For other end conditions, refer to ASME Power Boiler Section I, part PG-27)

8. The tube sheet area

   This equation is applicable to determining the area of the tube sheets to be supported by stays. Any unsupported areas of the tube sheet, or a row of tubes, and the boiler shell which is greater than two (2) inches in width must be supported by stays. This unsupported area's maximum is assigned by variable "H" (See note under "H" below) and is measured from tube or row of tubes to the boiler shell at its maximum distance.

$$A = \frac{4(H-2)^2}{3n} \quad \sqrt{\frac{2R}{(H-2)} - 0.608}$$

Where:

A	=	Area of the tube sheet supported by stays in inches squared
H	=	The unsupported area's maximum width in inches Note: For more information on the calculations of this area or determining "H", refer to ASME Boiler code Section 1, PFT 23.
R	=	Radius of the boiler shell
n	=	Number of evenly spaced stays to be used, normally one or two

Section IX. Fabrication and Welding/Brazing

Miniature boilers may be constructed by fusion welding or brazing, Postweld heat treatment, radiography of the welded joints, and nondestructive examinations are not required, but may be required by the Inspector.

All welding/brazing must be performed to a welding/brazing procedure which includes joint design, filler metal, position and technique. Quality workmanship must be accomplished for all welds to assure satisfactory penetration and fusion into base metal.

Section X. Appurtenances

Every miniature boiler exceeding 12 in. (300 mm) internal diameter of having more than 10 ft^2 (0.9 m^2) of heating surface shall be fitted with not less than three brass washout plugs of adequate size, which shall be screwed into openings in the shell near the bottom. Boilers not exceeding12 in. (300 mm) internal diameter and having less than 10 ft^2 (0.9 m^2) of heating

surface need have not more than two openings of adequate size for cleanouts, one of which may be used for the attachment of the blowoff valve; these openings shall be opposite to each other where possible. All threaded openings in the boiler shall be provided with a welded reinforcement, if necessary, to give four full threads therein.

Each miniature boiler shall be equipped with a blowoff valve or cock.

Every miniature boiler shall be provided with at least one feed pump or other feeding device, except where it is connected to a water main carrying sufficient pressure to feed the boiler or where it is operated with no extraction of steam (such as in a closed system). In the latter case, in lieu of a feeding device, a suitable connection or opening shall be provided to fill the boiler when cold. Feedwater openings or connections to miniature boilers shall be of adequate size and made of brass or copper pipe.

The feed pipe shall be provided with a check valve and a stop valve of a size not less than that of the pipe. The feedwater may be delivered through the blowoff opening if desired.

Each miniature boiler for operation with a definite water level shall be equipped with a water gage glass for determining the water level. The lowest permissible water level of vertical boilers shall be at a point one-third of the height of the shell above the bottom head or tubesheet. Where the boilers is equipped with an internal furnace, the lowest permissible water level shall be not less than one-third of the length of the tubes above the top of the furnace tubesheet. In the case of small boilers operated in a closed system where there is insufficient space for the usual water gage glass, water level indicators of the glass bull's-eye type may be used.

Miniature boilers shall have the lowest visible part of the water gage located at least 1/2 in. (13 mm) above the lowest permissible water level.

All valves, pipe fittings, and appliances connected to a miniature boiler shall be able to withstand the maximum designed pressure and temperature of the miniature boiler.
All miniature boilers operated with gas, electricity, oil, or mechanical firing shall be provided with an automatic low-water fuel cutoff, except electric boilers of the electrode type or those with a constant attendant who has no other duties while the boiler is in operation.

Section XI. Certification and Testing Procedures:

The following is a listing of materials and equipment to be provided by the applicant for boiler certification.

1. Certification documentation.

    a. Forms 1, 2, & 3 of this document filled in and signed as appropriate.

    b. A copy of the applicable drawings and calculations for non-commercial boilers to be reviewed by the Inspector and returned to the applicant.

2. Test equipment and conditions.

    a. A Hydrostatic test pump capable of attaining the test pressure.

    b. A calibrated gauge with a maximum pressure reading of at least one and one half (1 1/2), but not more than four (4) times the test pressure to be applied.

    c. A source of tap water for pressure test purposes.

    d. A well lighted area to inspect the boiler and perform the pressure test.

    e. All fittings and appliances required to blank openings, attach pumps, gauges, valves, etc. in order to perform the appropriate testing.

3. Once the appropriate forms have been verified, the boiler, already in test configuration, will be pressurized with the hydrostatic test pump, slowly, to the pressure required for the test, and held for 10 minutes. The pressure will then be reduced to the operating pressure of the boiler and held while the inspection is performed.

4. Safety valves, not ASME certified, will be hydrostatically tested five times, sequentially, verifying the pressure relief within ± 10% of the settings while not exceeding the MAWP.

5. Upon completion of the hydrostatic pressure test, along with any other inspections the Inspector may require, the boiler will be reconfigured for operation, filled appropriately, fired and brought into operation. The pressure will be increased to demonstrate the proper operation of the boiler including the lifting of the safety valve's by steam pressure.

Section XII. Appendix I Special provisions for previously tested Hobby Boilers:

1. It has been determined that during previous certification hydrostatic testing of hobby boilers, a boiler may have been stressed in excess of that allowed in ASME certified boilers. In order to determine the stress levels attained during that testing, owners of previously tested boilers are requested to calculate the stress levels attained during testing utilizing the following equations and the Boiler Stress Disclosure, Form 4.

2. In the event that any of the resultant section stresses are in excess of two times the MAS as shown on the Materials List, Form 2, a copy of the Boiler Stress Disclosure Form 4 will be provided to the Inspector. This form will be forwarded to the Chief Boiler Inspector for review. The Chief Boiler Inspector will determine the safety of the boiler for continued operation.

Stress Equations:

These equations are for use, only, to determine the stresses attained in previously tested hobby boilers.

1. Boiler shells, cylinders, and parts of cylinders.

   When applied to parts of cylinders, this equation is limited to longitudinal sections.

$$S' = \frac{P'(D - 2Yt)}{2Et}$$

   Where:

P’	=	Maximum hydrostatic pressure
S’	=	Stress Value
D	=	Outside diameter of cylinder in inches
E	=	l.00 for seamless pipe (ASME certified material)
		0.90 for welded seam (ASME certified material)
		0.60 for other welded seams
Y	=	0.40 for conditions less than 900 Degrees F.
t	=	Cylinder wall thickness

2. Dished Heads:

   This equation is applicable in instance where the head is a section of a sphere, dished outward from the pressure envelope, however, not a full hemisphere. Where the head is dished inward to the pressure envelope, use 60% or the MAWP determined in the equation below.
   Where:

$$S' = \frac{P'L}{0.96t}$$

P’	=	Maximum Hydrostatic Pressure
S’	=	Stress
L	=	Radius of the sphere in inches
t	=	Thickness of the sphere in inches

3. Hemispherical Heads:

$$S' = \frac{P'L}{1.6t}$$

   Where:

P’	=	Maximum Hydrostatic Pressure
S’	=	Stress
L	=	Radius of the sphere in inches
t	=	Thickness of the sphere in inches

4. Flat Heads

   This equation is applicable to circular flat heads utilized at the end of, or internal to a cylinder.

$$S' = \frac{P' C d^2}{t^2}$$

   Where:

   P’ = Maximum Hydrostatic Pressure

   S’ = Stress

   D = Inside diameter of the cylinder in inches

   C = A constant:

   0.20 for heads at the end of the cylinder

   0.10 for internal heads

   t = Thickness of the head in inches

5. Flat Stayed Surfaces:

$$S' = \frac{P' A}{C t^2}$$

   Where:

   P’ = Maximum Hydrostatic Pressure

   S’ = Stress

   C = A constant: 2.10

   A = Area of plate in inches

   - For symmetric stays, A = (pitch)²
   - For unsymmetrical stays, A = ab, where a & b are the pitches at right angles about a stay
   - For stayed tube sheets, A is determined by Equation 8 in Section VII, page 11 above

   t = Thickness of the plate in inches

6. Stays:

$$S' = \frac{P' A}{a}$$

Where:

P’ = Maximum Hydrostatic Pressure

S’ = Stress

A = Area of plate in inches

- For symmetric stays, A = (pitch)²
- For unsymmetrical stays, A = ab, where a & b are the pitches at right angles about a stay
- For stays supporting areas of the tube sheet, A is determined by Equation 8 in Section VII, page 11 above.

a = Cross sectional area of stay in inches

- For threaded stays, use the cross sectional area at the thread root

7. Tubes:

$$S' = P'\left[\frac{D-\left(t-0.005D-e\right)}{2t-0.01D-2e}\right]$$

Where:

P’ = Maximum Hydrostatic Pressure

S’ = Stress

D = Outside diameter of tubing in inches

t = Thickness of tubing wall in inches

e = A constant:

- For welded tube ends, e = 0.0
- For other ends conditions, refer to ASME Boiler Code, Section I, Part PG 27

FORM 1 – INSPECTION CHECK LIST

Boiler owner to complete lines 1, 2, & 3 prior to inspection

1. Boiler owner I.D. number: _____

2. Owner name: _____

3. Owner address: _____ *(street)*

_____ *(city, state, zip)*

4. Phone number, email: _____

The following to be completed by the Inspector only

Washington State Special number assigned: _____

Verify Materials Form (Form #2): _____

Verify Design Disclosure Form (Form #3): _____

Verify boiler drawings: _____

Verify Welding/Brazing Procedure _____

Verify Welder/Brazing Qualification _____

Verify Fittings and Attachments _____

Enter Maximum Allowable Working Pressure (MAWP): _____

Enter Certificate (Safety Valve Setting) Pressure: _____

Hydrostatic Test Pressure (*): _____

Verify Satisfactory Pressure Test: _____

Verify Satisfactory Visual Inspection: _____

Verify Satisfactory Steam Gauge Operation: _____

Verify Satisfactory Safety Valve Operation: _____

* *Enter pressure corresponding to test requirements.*

Safety valves are: ☐ ASME ☐ NON-ASME

Witness Satisfactory Boiler Operation: _____

Certify Boiler (**): ☐ Yes ☐ No

Inspector: _____ Number: _____ Date: ____/____/____

** *Attach written reason for not accepting, including reference to requirements.*

FORM 2 – MATERIALS LIST

Section	Material	MAS (psi)
Boiler Shell:		
Flat Stayed Surfaces:		
a.		
b.		
Stays:		
a.		
b.		
Tubes:		
a.		
b.		
Tube Sheets:		
a.		
b.		
Heads:		
a.		
b.		
Other Sections:		
a.		
b.		
c.		

Weld/Brazing Material:

Area: _____ Filler: _____ Root: _____

Area: _____ Filler: _____ Root: _____

Area: _____ Filler: _____ Root: _____

Owner: _____ _____ Date: ____/____/____

FORM 3 – DESIGN DISCLOSURE FORM

Section		Material	Section MAWP (psig)
Boiler Shell:			
Flat Stayed Surfaces:			
	a.		
	b.		
Stays:			
	a.		
	b.		
Tubes:			
	a.		
	b.		
Tube Sheets:			
	a.		
	b.		
Heads:			
	a.		
	b.		
Other Sections:			
	a.		
	b.		
	c.		

Owner: _____ Date: ____/____/____

FORM 4 – BOILER STRESS DISCLOSURE

Section		Stress (S') (psi)	2X MAS
Boiler Shell:			
Flat Stayed Surfaces:			
	a.		
	b.		
Stays:			
	a.		
	b.		
Tubes:			
	a.		
	b.		
Tube Sheets:			
	a.		
	b.		
Heads:			
	a.		
	b.		
Other Sections:			
	a.		
	b.		
	c.		

Owner: _____ Date: ____/____