

BUYING A BOILER?

Mike Leahy

outlines recent legislation and describes the effect that it has on the sale of boilers and kits or completed models.

The model engineering fraternity, in the UK, having recently undertaken a lengthy dialogue with the Health and Safety Executive on the safety aspects of our modelling activities, which came to a favourable conclusion, now finds itself involved in additional bureaucracy, regarding pressure equipment. Legislation in the form of *The Pressure Equipment Regulations 1999* (PER), imposed by the European Community, and *The Pressure Systems Safety Regulations 2000* (PSSR), now governs the design, manufacture, sale, installation, examination, testing and maintenance of nearly all pressure equipment and assemblies. Encompassing equipment from one extreme to another - from the simple Mamod type boiler to those used in power stations - the various types of boilers constructed and used by the model engineer fall within aegis of these regulations, eg. those powering miniature locomotives, miniature traction engines, miniature road vehicles, miniature stationary engines and boats, etc.

With the increased sales of model kits incorporating a boiler and the tendency for the self-builder to purchase a completed boiler, there has arisen the need of some easily digestible information to help a prospective purchaser understand the requirements of the new regulations. Both articles of legislation are lengthy tomes (60 pages and 62 pages respectively) each written in its own flavour of legalese, and what follows is presented as an interpretation of how the author understands their relationship to our model engineering activities. Whilst every endeavour has been made to ensure this information is correct it shall not be taken as legal advice.

It should be noted that boilers used in road vehicle and boating applications may be subject to additional regulations which are outside the scope of this article. These guidelines are intended to be read from a purchaser's point of view and should not be used by a manufacturer for whom they are incomplete.

The Regulations

The Pressure Equipment Regulations 1999 (PER), a Statutory Instrument, resulting from a Directive of the European Community through the Department of Trade and Industry (DTI), govern the design, manufacture and placing on the market of pressure equipment or assemblies. There are exemptions, but for our purpose, excepting equipment operating at 0.5bar or less, they will apply to our types of boilers/assemblies. The enforcing agency will be the Health and Safety Executive (HSE) excepting in those instances of private use

when it will be the duty of the weights and measures authorities

The Pressure Systems Safety Regulations 2000 (PSSR), issued by the Health and Safety Commission (HSC), govern the design and construction of pressure systems that fall outside the scope of the PER. They also govern the subsequent installation, examination, testing, operation and maintenance of pressure systems. For steam vessels these regulations include all equipment operating at a pressure of 0bar (0psi) upwards. PSSR is very similar in scope to previous legislation, the old *Pressure Systems and Transportable Gas Containers Regulations 1989* (PSTGCR), now revoked, retaining the well established provisions of PSTGCR excepting that the transportable gas container regulations have been removed along with regulations that overlap or duplicate the provisions of PER. As we have worked within the framework of the old PSTGCR for many years, PSSR should pose very few difficulties, if any. Strictly speaking PSSR only applies to pressure systems used at work. However there may be some implications when using miniature locomotives, etc. where the public may be present - it would need a case at law to establish this fact - and so in order to demonstrate a commitment to safety it is prudent to follow the principles in PSSR

Transportable gas containers are covered by *The Carriage of Dangerous Goods (Classification, Packaging and Labelling) and Use of Transportable Pressure Receptacles Regulations 1996* (CDGCPL2) and *The Transportable Pressure Vessels Regulations 2001* (TPVR) and are outside the scope of this article.

The boiler testing requirements of the *Southern Federation of Model Engineering Societies* (SFed), *Northern Association of Model Engineering Societies* (NAMES), *7/4" Gauge Society* (7/4"G Soc), etc contain additional, long established criteria (mainly to meet the demands of their insurers) and these also have been taken into consideration when writing this article. Where included, these requirements are clearly indicated and while they may have no legal standing it would be folly to ignore them. Additionally there are constraints imposed on the size of boilers that may be examined/tested within these testing requirements. Therefore, anyone wishing to subsequently avail themselves of these facilities should take into consideration any limitations they impose, before commissioning a boiler.

Effects of PER

Whilst this article is aimed at those purchasing boilers from a commercial supplier it may be pertinent at this point to establish the effect of PER on the model engineer who constructs his own boiler.

PER is intended to eliminate technical barriers to trade within the European Community and to harmonise the different sets

of regulations that each of the member countries had previously in place. The regulations were intended only to apply to commercial transactions but because of the catch-all nature of this type of legislation we found our activities caught in its net. Little thought, if any, was given to the activities of the amateur boiler maker and for that matter the cottage industry that has grown up to supply the hobby, and whilst there are no problems for the model engineer making a boiler for his own use, there arose a difficulty should he wish to sell it as a part of a working model at a later date.

However, as a result of representations made from within the hobby, *The Pressure Equipment (Amendment) Regulations 2002* have recently been made that retains the *status quo* for the model engineer who wishes to build his own boiler. In essence, the amendment, enables any pressure equipment that has a history of usage otherwise than in the course of business since its manufacture but before being made available for sale for the first time to be excluded from the requirements of the 1999 Regulations.

Any new boiler (excepting those with an operating pressure of less than 0.5bar) placed on the market before use, falls within the remit of the PER. In theory this could affect a club member building a boiler for another club member for payment but under most circumstances where more experienced club members simply offer help this should not be a problem (although when in doubt about the possible application of the PER you should seek your own legal advice). Of course any boiler built outside the remit of PER legislation should comply with PSSR in matters relating to design and construction (it would also be prudent to consider the design and manufacturing criteria within the essential safety requirements of PER as they contain much useful information as to what is deemed to be good practice).

The commercial boilermakers/model suppliers are obviously the people who will bear the brunt of this legislation. Whilst for the smaller sizes of boiler it may mean them having to undertake nothing more than additional paperwork and having to establish the fact that his boiler designs and construction are safe, builders of medium size boilers will, additionally, have to institute methods of production control and for those building the larger sizes of boiler there will probably be considerable costs involved in engaging the services of a Notified Body. However, there will, no doubt, be a knock-on effect for their customers in that the burden of the additional paperwork, drawings, increased costs, etc will be passed on to the purchaser by way of higher prices.

An obvious advantage to the commercial boilermaker is that he will be able to sell his product anywhere within the European Community without having to make reference

to local regulations (although this has not been a problem in the past).

The application of PER fully came into force on the 30th May 2002. Prior to that date other provisions applied and any boiler built to those provisions must have been completed and placed on the market on or before the 29th May 2002. It is therefore essential that all receipts for boilers purchased before the cut-off date be retained and be made available to subsequent purchasers of a model *ad infinitum*. This will establish that the model/boiler was first placed on the market before the legislation came into force and thus enable it to be re-sold as a working model. Likewise it is important that the self-builder keeps a record of the construction and use of a particular boiler along with subsequent pressure test certificates, etc to establish a *bone fide* set of credentials, thus enabling it to be sold on and that these records are made available to any subsequent purchaser.

When talking of pressure equipment/assemblies it is essential to understand that an assembly constitutes the boiler and all the pressure parts from the feedwater inlet (including the inlet valve) to the first joint downstream of the steam outlet (including the outlet valve). This includes superheaters and inter-connecting tubing which may be at a risk of overheating and are not capable of isolation by interposing shut-off-valves. Additionally included are the associated safety accessories and tubing connected to the boiler involved in services such as draining, venting etc. Items such as cylinders, injectors, feedwater pumps etc. are therefore not part of an assembly. When purchasing a kit or completed model, the provision of items such as safety valves, water gauges and pressure gauges, etc. would be deemed necessary to comply with the regulations.

The regulations are concerned with the risks created by a release of stored energy through a system failure. Technically, they are based upon the indisputable premise that as the pressure of the system, the size of the system and the hazardous nature of the system contents increase, so does the danger therefrom. Requirements for design, materials, construction and conformity assessment therefore increase in severity as these factors increase.

Categories

Depending on their pressure and volume, steam boilers can be classified as follows:

1. **Less than 0.5bar operating pressure.** No limit to volume. Falls outside PER and is governed by PSSR.
2. **Boilers up to and including 2 litres volume.** No upper pressure limit. 'Sound Engineering Practice' under PER applies.
3. **Category I.** Boilers above 2 litres volume, up to and including 50 bar-litres, maximum pressure 32 bar.
4. **Category II.** Boilers above 50 bar-litres, up to and including 200 bar-litres, maximum pressure 32 bar.
5. **Category III.** Boilers above 200 bar-litres, up to and including 3000 bar-litres, maximum pressure 32 bar, maximum volume 1000 litres.

6. **Category IV.** Even bigger, unlikely that anyone will build a model that falls into this category – one hopes!

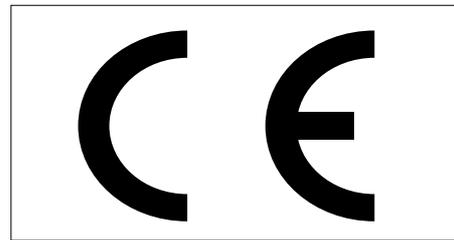
Outlined below is a general list of criteria applicable to the design, manufacture and placing on the market of all categories of boiler, derived from PER, PSSR and the boiler testing procedures of the various national organisations (eg. SFed/NAMES/7¼"G Soc). They will equally apply if purchasing a complete/part built model or kit, that incorporates a boiler.

Be safe in use.

Suitable for intended use. eg. Boilers for traction engines and portable engines are subjected to additional stresses, such as that imposed by the reciprocating motion and road shocks – due allowance must be made in the design for these additional stresses.

Comply with PER/PSSR. It shall be designed/manufactured in compliance with the relevant category of PER or PSSR.

Marking and labelling. Boilers to be marked accordingly, to comply with PER (or PSSR if below 0.5bar working pressure). The boiler should be marked in a visible, legible and indelible form with the identification of the manufacturer, its serial number, where required the CE mark and the Notified Body identification number (certain categories only). More than likely the above markings will be stamped on a dataplate firmly affixed to the boiler, preferably on the backhead where it can readily be seen.



The CE mark, which may not be less than 5mm in height.

Boilers which are manufactured under PER to 'Sound Engineering Practice' or those manufactured under PSSR must not carry the CE mark.

Additionally, other information should be supplied but, in cases where the equipment may be too small for it to be marked as above, this additional information may be supplied on a label attached to the equipment. For our purposes the information should include:

- name and address of manufacturer.
- year of manufacture.
- identification of equipment according to type and serial number.
- maximum allowable pressure (bar).
- volume of the equipment (litres). Volume is measured as the cold capacity of a boiler filled to the brim (such as for a hydrostatic test).
- minimum allowable pressure where it is other than atmospheric.
- the test pressure (in bars) and date.
- safety device set pressure (if a completed model).
- intended use.
- weight in kg.

Documentation. Additional paperwork also needs to be supplied:

- the appropriate pressure test and material certificates, and dependent on pressure and volume:
- a written declaration of conformity.

Many of the boilers we purchase eg. those for Gauge 0 and Gauge 1 locomotives and those used in model boats will be of less than 2 litres capacity and thus will not be stamped with the CE mark. They will have been built to comply with 'sound engineering practice' which though not formally requiring full adherence to the essential safety requirements will be designed and manufactured in such a way to ensure safe use. They will still need to be marked with a serial number and the identity of the manufacturer and be supplied with the relevant documentation.

Materials. Materials used in construction should be suitable for intended use. Boiler manufactures must obtain documentation from the material manufacturer showing that the material meets specification and, for equipment in Categories II, III and IV, must supply appropriate copies of the material certificates to the boiler user. Whilst not all categories of PER require certification of materials, it is a requirement of the SFed/NAMES/7¼"G Soc minimum boiler testing codes that, wherever steel is used in the manufacture, such documentation is necessary and that the barrel tube and plates be stamped with the correct numbers and the welding have been carried out by a suitably qualified welder.

Existing/published designs. Historic designs and methods of construction may continue to be used, provided the essential safety requirements are met. Unfortunately, the commercial boiler builder cannot claim 'grandfathers rights' for an old boiler design as he will still have to show that it was built to comply with the regulations. When working to an approved design, any deviation from the design should be duly documented along with supporting calculations.

New designs. If commissioning a new design technical documentation will have to be drawn up that will cover its design, manufacture and operation and will contain such things as:

- a general description of the pressure equipment.
- conceptual design and manufacturing drawings, with descriptions and explanations enabling the drawings to be understood.
- design calculations and their conclusions.
- jointing and non-destructive testing procedures.

Obviously any prospective purchaser will have to discuss these matters with the intended manufacturer, who will probably be the best person to carry out such work.

This is also an area that may have some implications for the model engineering press, as many of the series of articles describing a model include a design for a boiler. While historically such designs have proven to be safe and of adequate strength it may now be appropriate that the relevant calculations are made available to interested parties.

Test pressures. The initial test pressure should meet the SFed, NAMES, 7¼"G Soc or insurance company minimum boiler testing requirements.

Operating instructions. All boilers and assemblies must be accompanied by adequate instructions for use. Instructions for the user must contain all necessary safety information relating to:

- mounting, including different pieces of pressure equipment in any assembly.
- putting into service.
- use.
- maintenance including checks by the user.
- periodical examination.

Protective devices. Provision shall be made for the fitting of protective devices, eg. safety valve/s, water gauge, pressure gauge, etc. Provision should also be made for the fitting of a drain valve.

Inspection. In the larger boilers, provision should be made to enable internal inspection.

Kits For the purposes of this article, kits are defined as those supplied as a set of fully machined parts with a completely built boiler and able to be assembled with a minimum of equipment. Kits should be provided with such protective devices as may be necessary for preventing danger:

1. Be supplied with a water level indicator. (tri-cock water gauges should be fitted where practicable. This enables the water gauge to be isolated in the event of a gauge glass failure and also enables the gauge glass to be 'blown-down').
2. Be supplied with a safety valve(s) that will not allow the boiler to exceed 110% of working pressure no matter how hard it is worked.
3. Be supplied with a pressure gauge on which the working pressure of the model is clearly and indelibly indicated.
4. Have provision to be able to remove or shut-down the heat source in the event of an emergency (eg low water level, sticking safety valve, etc).
5. Provision should also be made for some sort of boiler drain valve.

Completed models. Completed models should be provided with such protective devices as may be necessary for preventing danger. The same devices as outlined in the Kit section above should be fitted and have been set and tested accordingly before delivery.

The accompanying tables show the different documentation one may expect to receive, according to category. Also include in each table is an outline of the requirements for design and manufacture to be undertaken by a commercial builder.

In summary

So, what should we expect to receive with the boiler when it is delivered? Basically nothing more than additional paperwork that shows that the boiler was manufactured to comply with PER or PSSR if below 0.5 bar. While it may seem as though one might expect to receive reams of paper, the relevant information will probably fit on one sheet of A4 paper.

Remember to keep all documentation in a safe place as it may be needed for inspection should there ever be a mishap with the boiler (highly unlikely!). It will definitely be needed, to be passed on, should you ever subsequently wish to sell the boiler/model; for without this documentation the model may not be sold as a working model.

As indicated earlier, the burden of these regulations will probably result in an increase in prices, but the figures of 30% or more which have been bandied about seem to be somewhat unrealistic. The majority of boilers manufactured by our boilermakers are of Category I or lower. There should be no additional costs for boilers up to 2 litres and little additional costs for boilers up to 50 bar-litres. If you have a design that is a borderline case then a judicious shifting backwards of the smokebox tubeplate or dropping the maximum allowable pressure by a few pounds or a combination of both may be sufficient to squeeze a boiler into a lower category. Bear in mind, however, that this will involve an alteration to design parameters requiring recalculation, new drawings, etc. Category II boilers and bigger will pose a problem, in that the costs involved in monitoring and engaging the services of a Notified Body will have to be met. No doubt the boilermakers will need to approach such organisations as a unified body with the hope of gaining some concession on fees. However, the fear is, these costs may be apportioned across the whole range of boilers thus placing a disproportionate burden on the purchasers of the smaller boilers.

Before closing it might be worth noting the effect that PER will have on the secondhand market. Any boiler, either as a stand alone unit or incorporated into a model, placed on the market prior to 30th May 2002 is exempt, provided evidence to support that fact is available (eg. a receipt). Any amateur built boiler placed on the market after that date will have to have a history of usage prior to it being placed on the market. All new commercially built boilers placed on the market after that date will have to have proof of compliance with PER, be stamped with the CE mark (excepting those of less than two litres capacity) and have the appropriate documentation. If these criteria can be met there should be no problems whatsoever, other than the need to ensure any paperwork is correct and accompanies the boiler during its lifetime. Therefore if buying a secondhand boiler or model incorporating a boiler, intending it to be used as a working model, then ensure that it comes with its credentials!

I would like to thank staff at both the Department of Trade and Industry and the Health and Safety Executive for their help in compiling this article.

(Mike Leahy represented the Southern Federation of Model Engineering Societies on the Miniature Railway Liaison Group, formed by the HSE to enable model engineers to participate in formulating health and safety guidance for their hobby. He was also party to representations made to the DTI on the Pressure Equipment Regulations.)

TABLE 1

LESS THAN 0.5BAR OPERATING PRESSURE. (No upper volume limit)

Below 0.5bar (approx 7.5psi) PER is not applicable. However, the boiler and any ancillary equipment (if supplied) must comply with the requirements of PSSR in matters relating to design and construction.

The pressure system or article shall be properly designed and properly constructed from suitable material so as to prevent danger. – PSSR Regulation 4.(2)

The pressure system shall be provided with such protective devices as may be necessary for preventing danger. – PSSR Regulation 4.(5)

What to expect:

Pressure Vessel only.

The boiler should be permanently marked to show the manufacturers identity and its serial number.

Documentation should include:

- the manufacturers name and address.
- the date of manufacture.
- the maximum allowable pressure (ie. 0.5bar).
- the minimum allowable pressure, if other than atmospheric. (A vessel of such a low operating pressure could be part of a condensing system and therefore subjected to vacuum).
- design temperature.
- valid pressure test certificate.
- operating instructions.
- the standard to which the vessel was built.
- steel boilers should have the appropriate material certificates, the barrel tube and plates be stamped with the correct numbers and the welding have been carried out by a suitably qualified welder (SFed/NAMES/7¼"G Soc requirement).

Additionally:

- provision should be made to allow the fitting of protective devices (eg a safety valve, a pressure gauge and, if a heated vessel, provision for fitting a device to assess water level).
- provision should be made to allow the boiler to be drained.

Kit.

In addition to the above, the fittings should be supplied and, if a heated vessel, a means of being able to remove or shut down the heat source in an emergency should also be provided.

Completed model.

In addition to the above, the fittings should be installed with the safety valve pressure set and tested. The boiler test certificate should be suitably amended to record this fact.

The manufacturer should be able to provide sufficient written information regarding design and construction as may reasonably, foreseeably be needed to enable the provision of the Regulations to be complied with. The manufacturer doesn't necessarily have to supply such information to the purchaser, but it must be retained for inspection should the need arise.

TABLE 2

**BOILERS UP TO AND INCLUDING 2 LITRES VOLUME.
(No upper pressure limit)**

Boilers in this category need to have been designed and manufactured in accordance with 'sound engineering practice' (SEP) in order to ensure safe use.

What to expect:

Pressure Vessel only.

The boiler should be marked to show the manufacturers identity and its serial number. CE marking shall **not** be affixed to SEP equipment.

Documentation should include:

- the manufacturers name and address.
- the date of manufacture.
- the maximum allowable pressure.
- the volume of the boiler.
- valid pressure test certificate.
- intended use.
- instructions for use.
- weight (empty).
- steel boilers shall have the appropriate material certificates, the barrel tube and plates be stamped with the correct numbers and the welding have been carried out by a suitably qualified welder (SFed/NAMES/7¼"G Soc requirement).

Additionally:

- provision should be made to allow the fitting of protective devices (eg a safety valve, a pressure gauge and, if a heated vessel, provision for fitting a device to assess water level).
- provision should be made to allow the boiler to be drained.

Kit.

In addition to the above, the fittings should be supplied and, if a heated vessel, a means of removing or shutting down the heat source in an emergency should also be provided.

Completed model.

In addition to the above, the fittings should be installed with the safety valve pressure set and tested. The boiler test certificate should be suitably amended to record this fact.

The manufacturer needs to be able to show the boiler has been designed and manufactured in accordance with 'sound engineering practice'. Copies of all drawings, calculations, etc relating to its design should be retained to enable subsequent inspection by the relevant authorities should the need arise. The manufacturer doesn't necessarily have to supply such information to the purchaser.

TABLE 3

**CATEGORY I
(Boilers above 2 litres volume, up to and including 50 bar-litres, maximum pressure 32 bar.)**

Boilers in this category need to have been designed and manufactured in accordance Module A of the Conformity Assessment Procedures. (Internal Production Control)

What to expect:

Pressure Vessel only.

The boiler should be marked to show the manufacturers identity, its serial number and the CE mark.

Documentation should include:

- the manufacturers name and address.
- the date of manufacture.
- the maximum allowable pressure.
- the volume of the boiler.
- valid pressure test certificate.
- intended use.
- instructions for use.
- weight (empty).
- a Declaration of Conformity, that the equipment satisfies the requirements of the Pressure Equipment Directive.
- boilers should have the appropriate material certificates.
- the barrel tube and plates of steel boilers shall be stamped with the correct numbers and the welding have been carried out by a suitably qualified welder (SFed/NAMES/7¼"G Soc requirement).

Additionally:

- provision should be made to allow the fitting of protective devices (eg a safety valve, a pressure gauge and, if a heated vessel, provision for fitting a device to assess water level).
- provision should be made to allow the boiler to be drained.

Kits and Completed models.

As Table 2.

The manufacturer will have drawn-up technical documentation for the equipment that includes manufacturing drawings, design calculations, examinations carried out, test reports etc. along with a Declaration of Conformity. The manufacturer must keep this documentation, for inspection by the relevant national authorities, for a period of ten years from the date of manufacture. A method of internal production control must be established that ensures the manufacturing process enables the manufactured pressure equipment to comply with the technical documentation and meet the requirements of the Directive. All the relevant Essential Safety Requirements must be met.

TABLE 4

**CATEGORY II & III
(Category II. Boilers above 50 bar-litres, up to and including 200 bar-litres, maximum pressure 32 bar)
(Category III. Boilers above 200 bar-litres, up to and including 3000 bar-litres, maximum pressure 32 bar, maximum volume 1000 litres)**

Boilers in these categories need to have been designed and manufactured in accordance with one or more of a number of conformity assessment modules, which increase in severity according to the increase of stored energy in the boiler. Design and manufacture will be monitored by a Notified Body.

What to expect:

Pressure Vessel only.

The boiler should be marked to show the manufacturers identity, its serial number, and the CE mark together with the identification number of the Notified Body involved at the production control stage.

Documentation and provisions:

As outlined for Category 1 (See Table 3) but

- all boilers should have the appropriate material certificates (eg. certificates of specific product control), prepared by the material manufacturer, affirming compliance with specification. Barrel tube and plates be stamped with the correct numbers, to relate materials to certificates.

Kits and Completed models.

As Table 2.

The manufacturer will have drawn-up technical documentation for the equipment that includes manufacturing drawings, design calculations, examinations carried out, test reports etc. along with a Declaration of Conformity. The manufacturer will work in conjunction with a Notified Body, whose job it is to monitor and verify that the pressure equipment has been manufactured according to the relevant assessment module. Typically the Notified Body will examine the technical documentation and quality control methods, conduct checks on samples, assess materials and check conformity to harmonised standards, approve procedures for joining and verify that personnel undertaking such joining are suitably qualified. All the relevant Essential Safety Requirements must be met. All documentation regarding design, manufacture, quality assessment, examinations and reports from the Notified Body and other similar records must be kept, for inspection by the relevant national authorities, for a period of ten years.

Table showing relevant PER category of some known miniature locomotives and traction engines.

Model	Gauge/Scale	Maximum Allowable Pressure	Boiler Capacity	Bar-litres	Category for PER
Tich	3½" gauge	80 psi (5.515 bar)	.895 pint (.508 litres)	N/A	SEP
Britannia	5" gauge	100 psi (6.895 bar)	12.5 pints (7.1 litres)	48.95	Category 1
Romulus	7¼" gauge	90 psi (6.201 bar)	30.1 pints (17.1 litres)	106.037	Category 2
McClaren T/E	6" scale	200 psi (13.79 bar)	225.4 pints (128.07 litres)	1766.085	Category 3
		1 bar = 14.5038 psi	1 litre = 1.760 pints	1 pint = 0.568 litres	10 psi = 0.689 bar