



**SPECIFICATION HSE SS 1000**

**WELDED PRESSURE DRUMS  
FROM 900 TO 1000 L CAPACITY  
MANUFACTURED FROM STAINLESS STEEL**

**Issue 2**

**September 1999**

## CONTENTS

		Page
Section 1	Scope .....	3
Section 2	Normative References .....	3
Section 3	Definitions .....	4
Section 4	Certificate of Compliance .....	5
Section 5	Material of Construction .....	5
Section 6	Drum Design .....	8
Section 7	Approval of Design and Construction .....	10
Section 8	Drum Manufacturing Process .....	11
Section 9	Inspection and Tests .....	12
Section 10	Information to be marked .....	19
Section 11	Position and size of marking .....	19
Appendix 1A	Specimen Design Certificate for Welded Steel Gas Drums .....	21
Appendix 1B	Specimen Certificate for Water Capacity, Weights and Material .....	22
Appendix 1C	Specimen Certificate for Mechanical Tests .....	23
Appendix 1D	Specimen Acceptance Certificate for Welded Steel Drums .....	24
Appendix II	Ultrasonic defect detection and thickness measurement .....	25
Appendix IIA	X-Ray Testing .....	27

## **1. SCOPE**

### **1.1. Permitted gases**

Permanent and liquefied gases for test-pressures up to 35 bar.

### **1.2. Filling pressure at 15°C (permanent gases)**

20 bar maximum.

### **1.3. Nominal water capacity**

900 litres to 1000 litres inclusive.

### **1.4. Material of construction**

One specified analysis of weldable stainless steel only.

### **1.5. Design Temperature**

The design temperature shall be -40°C to 50°C.

### **1.6. Drawing**

A fully dimensioned design drawing shall be produced.

## **2. NORMATIVE REFERENCES**

This Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EURONORM 120 -83 Sheet steel and strip for gas cylinders

EN 287-1 Approval testing of welder; Fusion welding; Part 1: Steels

EN 288-1 Specification and qualification of welding procedures for metallic materials; Part 1: General rules for fusion welding

EN 288-3 Specification and approval of welding procedures for metallic materials; Part 3: Welding procedure tests for the arc welding of steels

EN 962 Valve caps and guards

EN 10 002-1 Metallic materials; Tensile testing; Part 1: Method of testing (at ambient temperature)

EN 1089-1	Stamp marking of gas cylinders.
BS 341	Transportable gas container valves
BS 1319	Specification for medical gas cylinders, valves and yoke connections
EN 444	Non destructive testing.
EN 462	Image quality indicators (wire type)
EN 10045-1	Test method (V and U notches)
EN 10088	Stainless Steels
EN 970	Welding - Visual examination of fusion welded joints
BS 5355	Filling ratios and developed pressures for liquifiable and permanent gases.

### 3. DEFINITIONS

For the purpose of this standard, the following definitions apply:

#### 3.1. Yield Stress

See EN 10 002-1.

The term "yield stress" means either the 0.2% proof stress,  $R_{p\ 0.2}$ , or the 1.0% proof stress,  $R_{p1.0}$  shall be specified where there is no apparent definite value for  $R_{p\ 0.2}$ , as for example, is the case for austenitic steel.

NOTE: In the case of sheet-metal the axis of the tensile test-piece shall be at right angles to the direction of rolling. The permanent elongation at fracture ( $l = 5d$ ) shall be measured on a test-piece of circular cross-section in which the gauge length ( $l$ ) is equal to five times the diameter ( $d$ ) if test pieces of rectangular cross-section are used, the gauge length ( $l$ ) shall be calculated by the formula:

$$l = 5.65 \sqrt{S_0}$$

where  $S_0$  indicates the initial cross-sectional area of the test-piece.

#### 3.2. Batch

A batch shall consist of finished drums made consecutively during the same or consecutive days to the same design, size and material specifications and from the same material supplier on the same automatic welding machines and heat-treated under the same conditions of temperature and duration.

### **3.3. Filling Ratio**

The filling ratio is the mass of gas in kg which can be filled into 1 litre of drum water capacity.

### **3.4. Filling Ratio Reference Temperature**

The filling ratio reference temperature stated in BS 5355 at which the liquid density is to be evaluated for calculating the fill ratio.

### **3.5. Developed Pressure**

The developed pressure is the pressure achieved by the contents of a pressure drum filled according to BS 5355 when raised to the reference temperature for developed pressure.

### **3.6. Developed Pressure Reference Temperature**

The developed pressure reference temperature is the temperature at which the developed pressure is to be determined.

### **3.7. Settled Filling Pressure**

The settled filling pressure is the pressure (permanent gases) of the contents of the drum at 15°C.

## **4. CERTIFICATE OF COMPLIANCE**

The approved verification body shall certify that manufacture, inspection and testing of the drums was carried out in compliance with the requirements of this specification.

Note: A suitable form of certificates are shown in appendix I A, B, C and D.

## **5. MATERIALS OF CONSTRUCTION**

### **5.1. General**

5.1.1. The material used for drum manufacture shall be compatible with the intended gas service e.g. corrosive gases, embrittling gases. Reference - prEN ISO 11114-1. Transportable Gas Cylinders - Compatibility of Cylinders and Valve Materials with Gas Contents - Part 1. Metallic Materials.

5.1.2. All parts welded to the cylinder shall be made of compatible material with respect to the weldability.

5.1.3. The welding consumables shall be such that they are capable of giving consistent welds with minimum tensile strength at least equal to that specified for the parent material in the finished cylinder.

5.1.4.. The drum manufacturer shall obtain and provide certificates of the ladle analysis of the steel supplied for the construction of the pressure retaining parts of the drum.

5.1.5. The manufacturer shall be able to identify any drum with the cast of steel from which it is made.

## **5.2. Test requirements**

The material of the finished drums shall satisfy the requirements of clauses **8 and 9**.

**5.2.1.** In the event of failure to meet test requirements, retesting shall be carried out as follows:

**5.2.2.** If there is evidence of a fault in carrying out a test, or an error of measurement a further test shall be performed. If the result of this test is satisfactory, the first test shall be ignored.

**5.2.3.** If the test has been carried out in a satisfactory manner, the cause of test failure shall be identified.

In both cases the new batch shall be inspected and tested. All the relevant prototype or batch tests needed to prove the acceptability of the new batch shall be performed again. If one or more tests prove even partially unsatisfactory, all the cylinders of the batch shall be rejected.

## **5.4. Permissible steelmaking process.**

Electric and furnace or oxygen process with refinement of structure.

The steel shall be supplied in the solution annealed condition.

EN 10088 to apply. Steel grade 1.4541.

Steel analysis is given in table 1.

**Table 1: Steel chemical composition**

Element	% content by weight	
	minimum	maximum
Carbon		0,08
Silicon		1,00
Manganese		2,00
Phosphorus		0,045
Sulphur		0,015
Chromium	17,00	19,00
Nickel	9,00	12,00
Titanium	5 x C	0,70

Their permissible deviation on product analysis from specified range as per EN 10088-2 table 5.

Steel maker shall supply a certificate to EN 10204 stating:

- a. the steelmaking process;
- b. the ladle analysis;
- c. mechanical test results on heat treated samples.

These certificates shall be retained by the manufacturer of the drums.

### 5.5. Mechanical properties

The following shall be obtained:

tensile strength:	N/mm <sup>2</sup>	500 minimum - 750 maximum
yield strength:	N/mm <sup>2</sup>	240(1,0 % elongation) minimum
elongation on A <sub>s</sub> :		40 %
radius of bend test former:		4 x ta maximum (where ta = actual thickness)

## 5.6. Charpy-v notch impact values.

The impact test on V -notched test pieces shall be carried out as described in EN 10045-1

The minimum impact values on longitudinal test pieces apply to the average of 3 test pieces. One individual value may be lower than the specified value provided that it is not less than 70% of the value stated below:-

Longitudinal	90 J
Transverse	60 J

## 6. DRUM DESIGN

### 6.1. General requirements

#### 6.1.1. Drum

Permissible designs according to this specification are restricted to drum having concave to pressure dished ends, hot pressed-upper dished ends having an opening with block flange welded into the dished end, covered by a flange lid bolted to the block flange. Two triangular flanges being bolted to the flange lid to accept valves, each valve flange having dip tubes welded to the valve flange.

#### 6.1.2. Valve fittings

Valve fittings shall comply with the requirements of prEN 849, BS 341 : Part 1, BS1319 or other recognised standard as appropriate, in respect of quality and materials.

#### 6.1.3. Valve protection

Means for attaching valve protection shall be provided on all drums.

### 6.2. Nomenclature

$t$  = minimum cylinder wall thickness (mm) - to resist internal pressure and external forces due to normal handling, but excluding additional thickness for corrosion and other influences.

$t_e$  = is the minimum thickness of ends (mm) to resist internal pressure and external forces due to handling, but excluding any additional thickness for corrosion and other influences.

$D_o$  = external diameter of cylinder (mm)

$D_i$  = internal diameter of cylinder (mm)

$P_1$  = test pressure (bar)



- $P$  = pressure (bar) developed by gaseous contents at reference temperature (Design Pressure)
- $P_{\text{fill}}$  = settled filling pressure at 15°C (bar)
- $K$  = is the shape factor obtained according to the values  $h_e/D_o$  and  $t_e/D_o$ . See figure 1.
- $s$  = safety coefficient
- $V$  = welded joints efficiency
- $c$  = additional wall thickness equal to the tolerated minus deviation for the steel plates. (mm)
- $c_r$  = additional wall thickness for corrosion allowance (mm)
- $f$  = maximum permissible equivalent stress ( $\text{N/mm}^2$ ) at test pressure
- $Y$  = minimum specified yield stress ( $\text{N/mm}^2$ )
- $T$  = minimum specified tensile strength ( $\text{N/mm}^2$ )

### 6.3. Maximum developed service pressure (p)

The maximum developed pressure in service (p) shall:-

- a) Not exceed 65% of the test pressure  $P_1$  for permanent gases;
- b) Not exceed the test pressure  $P_1$  at the reference temperature and fill ratio listed in BS 5355 for liquefiable gases.

#### 6.3.1 Settled Filling Pressure and Fill Ratio

The settled filling pressure (permanent gases) and fill ratio (liquifiable gases) at 15°C shall comply with BS 5355 such that the developed pressure at the reference temperature shall not exceed the value  $P$ .

### 6.4. Test pressure ( $P_1$ )

The test pressure  $P_1$  shall be the design pressure  $P$ .

### 6.5. Mechanical properties for design

The mechanical properties of the drum used for design (and guaranteed by the manufacturer as minimum values) shall be:

$$\begin{aligned} Y &= 240 \text{ N/mm}^2 \\ T &= 500 \text{ N/mm}^2 \end{aligned} \quad \text{the corresponding ratio } Y/T \text{ is } 0,48$$

## 6.6. Design stress at test pressure

The design stress at test pressure shall be:  $f = 0,75 Y \times V$

*V for 100 % radiography = 0.95*

## 6.7. Thickness of cylindrical shell

Thickness  $t$  shall not be less than that from formula (1)

$$t = \frac{0.3P_1D_i}{7f-P_1} + c + c_r \quad \text{or} \quad t = \frac{0.3P_1D_o}{7f-0.4P_1} + c + c_r \quad (1)$$

except that the thickness of the cylindrical wall determined by equation (1) shall not be less than the value given by equation (2):

$$t = 2.48 \sqrt{\left(\frac{D_i}{T}\right)} \quad (2)$$

## 6.8. Thickness of dished ends.

### 6.8.1. Design on ends concave to pressure

When the material of the ends is the same as that used for the cylindrical part of the shell, the wall thickness of the domed ends shall be the greater of:-

- (i) the thickness of the cylinder wall; or
- (ii) the value calculated from the equation  $t_e = tK$

### 6.8.2. Limitation of shape

In a semi-ellipsoidal end the ratio  $h_o/D_o$  shall be not less than 0.192.

## 7. APPROVAL OF DESIGN AND CONSTRUCTION

Before manufacture commences, three copies of detailed design drawings, together with design calculations in accordance with section 6 of this specification, and a statement on the method of manufacture (see section 8), shall be submitted to the approved verification body for approval. Design drawings shall carry an unique identifying number.

No alteration shall be made to the design or method of manufacture after approval, unless such alteration has received prior agreement of the approved verification body.

## **8. DRUM MANUFACTURING PROCESS**

### **8.1. Welding procedures**

Each manufacturer, before proceeding with the production of a given design of drum, shall qualify the welding procedures and welders to EN 288 and EN 287. Records of such qualification shall be kept on file by the manufacturer.

- a) Procedure qualification tests shall be performed in such a manner that the welds shall be representative of those made in production.
- b) Welders shall have passed the qualification tests for the specific type of work and procedure concerned.
- c) Re-qualifying of the procedure, as well as the welder, shall be required if there is change in any of the essential variables as detailed in the Qualification Standard.

### **8.2. Welded joints**

**8.2.1** The welding of the longitudinal and circumferential seams including the boss-weld shall be by an automatic process.

**8.2.2** The longitudinal joint, of which there shall be no more than one, shall be butt-welded fittings

### **8.3. Non-pressure-containing attachments**

**8.3.1** Neckrings, footrings, handles, bosses, pads and rolling hoops not subject to pressure of the contents may be attached to the drum by welding, provided that such attachments are made of weldable and compatible steel.

**8.3.2** Each attachment shall be designed to permit inspection of the welds, which shall be clear of longitudinal and circumferential joints, and so designed as to avoid trapping water.

**8.3.3** A footing of adequate strength shall be fitted when applicable to the drum to provide stability, and welded so as to permit inspection of the bottom circumferential weld. The footing shall be suitably drained and the space enclosed by the footing suitably ventilated.

**8.3.4.** One rolling ring may be welded to each of the head and bottom shrouds. No rings shall be welded to any pressure bearing part of the drum.

### **8.4. Out-of-roundness**

The out-of-roundness of the cylindrical shell shall be limited so that the difference between the maximum and the minimum outside diameter in the same cross-section is not more than 1% of the mean of these diameters for two piece cylinders and 1.5% for three piece cylinders.

### **8.5. Straightness**

Unless otherwise shown on the drawing, the maximum deviation of the cylindrical part of the shell from a straight line shall not exceed 0.3% of the cylindrical length.

### **8.6. Verticality**

When the drum is standing on its base, the cylindrical shell and top valve openings shall be vertical to within 10mm per 1.0 metre length.

## **9. INSPECTION AND TESTS**

### **9.1. General**

The inspection and testing of the drums shall be carried out to the satisfaction of the approved verification body, who shall certify that the drums comply with the requirement of this specification.

The purchaser and the approved verification body shall have reasonable access to those parts of the works engaged on the order, for purposes of ensuring that the cylinders comply with the requirements of this specification.

Adequate notification of, and facilities for inspecting and testing shall be provided by the manufacturer to the approved verification body.

#### **9.1.1. Visual Inspection**

Before assembly, the pressure parts of the drum shall be visually examined, in accordance with EN 970, by the manufacturer for uniform quality and freedom from defects.

Before the drum is closed, the longitudinal welds shall be visually examined by the manufacturer, from both sides.

All welds shall have an even finish without concavity and shall merge into the parent metal without undercutting or abrupt irregularity.

The manufacturer shall ensure that the welds show continuous penetration of the weld seams and that they are free of defects.

#### **9.1.2. Non-destructive Testing**

All welding seams to be radiographed and ultrasonic tested:

##### **9.1.2.1. Radiographic techniques**

Radiographic examination shall be in accordance with EN 444

Radiographic sensitivity shall be determined in accordance with EN 462.

Defect assessment to AD-Merkblatt HP 5/3.

### **9.1.2.2. Ultrasonic Techniques**

To AD Merkblatt HP 5/3 and DIN 54125

Before carrying out ultrasonic examination of the welds, the adjacent parent metal shall be ultrasonically examined to establish the thickness of the material and to locate any flaws which may prevent effective examination of the weld.

Defect assessment in accordance with Appendix II.

### **9.2. Prototype tests**

In addition to acceptance tests specified in clauses 9.5 and 9.6, the prototype tests specified in 9.2. to 9.4. are required on all new drum designs except where there is written evidence of prototype testing having been previously carried out by an approved verification body. These tests are to be approved by the approved verification body.

A drum shall be considered a new design if:

- a. it is manufactured in a different factory;
- b. the shape of the dished end is different (a convex to pressure dished end is not recommended);
- c. an increase in hydraulic test pressure which does or does not require a change in wall thickness. (Where a drum is to be used as a lower pressure than that for which design approval has been given and prototype testing carried out successfully, it shall not be deemed a new design);
- d. the inner diameter has changed by more than 5%.
- e. if the charge pressure (permanent gases) or fill ratio (liquifiable gases) is increased, (with no increase in test pressure) resulting in an increase in the fatigue stress used for the assessment in section 9.4.2., only the assessment in 9.4.2. shall be repeated for the that design.

The drums used for tests shall be from the first production batch of the new design, and shall be certified by the manufacturer as being representative of the particular design and manufacturing process, including welding process and heat treatment (stress relieving or normalising). The prototype drum must not be painted but be in a virgin condition.

### **9.2.1. Hydraulic burst test**

One drum of each new design shall be subjected to a hydraulic burst test. The rate of pressurisation shall not exceed 5 bar/second. In the course of the test, the yield pressure, burst pressure, burst mode and volumetric expansion shall be recorded.

The burst test shall satisfy the following acceptance criteria:

The yield pressure shall be equal to or greater than  $4/3$  times the design test pressures.

The burst pressure shall be equal to or greater than 2.0 times the design test pressure.

The drum shall burst from a point within the side wall in longitudinal direction.

The appearance of the fracture (rupture line) must be even and not show a brittle fracture.

The drum shall remain in one piece after bursting.

## **9.3. Mechanical tests**

### **9.3.1 General**

The mechanical tests shall be carried out on the parent material and the welds.

Test specimens shall be cut from locations on the drum as indicated in figure 2.

A test section may be substituted for drum specified above. This test section will consist of one domed end welded to a cylindrical portion of a length not less than half the cylindrical section of a complete cylinder. All weld and production processes will be carried out in accordance with the standard production procedures. This will be verified by the approved verification body. The test specimens will be cut from the test section as indicated in figure 2.

The specimen for tests on the parent material shall be cut so that no part of the gauge length of the test specimen is within  $4t$  of the edge of the weld, where  $t$  is the minimum design thickness as specified on the drawing(s), see 1.6 (including any corrosion allowance).

The mechanical tests carried out on each drum shall be in accordance with 9.3.2 to 9.3.6

A test specimen of each type required under 9.3.2 and 9.3.3 shall be cut from the cylindrical shell and from one of the end pressings.

Test specimens of each type required under 9.3.4 to 9.3.6 shall be cut transversely across the longitudinal weld and alternately from the top and bottom circumferential welds on successive containers selected for test.

### **9.3.2 Tensile test on parent material**

The tensile test specimens T1 and T2 (see figure 2) shall be made from strips cut from a finished container with the axis of the strips, where possible, parallel to the axis of the container. Where necessary, test specimen T1 shall be cut transverse to the axis of the container as shown in figure 2. The form and dimensions shall be as specified in BS EN 10002. The face and back of the test specimen shall not be machined, but shall represent the surface of the container as manufactured.

The tolerance on form (i.e. the difference between maximum and minimum values of a given dimension in any one test specimen) for the machined surfaces of a test specimen shall be in accordance with the tolerance grade IT9 of BS 4500 : Part 1.

NOTE. The test specimens may be carefully straightened cold as necessary to place them in the testing machine

Tensile testing shall be carried out as specified in BS EN 10002. The limit of error of measurement shall be not more than +0.5% or 0.01 mm, whichever is the greater, as prescribed BS EN 10002 and shall be interpreted as applying to each individual measurement. If individual measurements of the thickness of a test specimen, the two faces of which are formed by the surfaces of the container wall, differ from one another, the minimum value shall be taken for calculation.

When the parallel length is in excess of the gauge length, a series of overlapping gauge lengths shall be marked, or alternatively gauge marks be applied every 5 mm, 10 mm or 20 mm along the parallel length so that the elongation on the prescribed gauge length can be determined by some suitable method of interpolation.

The tensile testing machine shall be maintained to grade 1.0 of BS 1610: Part 1. The results obtained from the tensile test shall meet the minimum requirements of paragraph 5.5.

### **9.3.3 Bend test on parent material.**

The width of the test specimens B1 and B2 (see figure 2) shall be not less than 25 mm or four times the minimum design thickness of the drum as shown in the drawing(s), see 1.6, (including any corrosion allowance), whichever is the greater. The face and back of the test specimen shall not be machined except that the edges may be rounded off. When bent at room temperature round a former, of diameter not greater than 'n' times the thickness of the specimen, until the gap between the ends is not greater than the diameter of the former, the specimen shall remain uncracked. Values of 'n' are given in table 1.

### **9.3.4 Tensile test on the welds**

The test specimens T3 and T4 (see figure 2) shall be cut transversely to the weld and shall be the full thickness of the material at the welded joint. The shape and dimension of the test specimen shall be as shown at figure 3.

In preparing the test specimens the face and back shall not be machined except to remove the backing strip or the tongue of a joggle joint. The face and back of the test piece shall each represent the surface of the parent material and the weld.

NOTE. The test specimens may be carefully straightened cold as necessary in order to place them in the testing machine.

The tensile strength shall be not less than that specified for the parent material and where there are different parent materials joined by the weld it shall be not less than that specified for the parent material with the lowest tensile strength.

Tensile testing shall be carried out as specified in BS 18. The tolerance on form and limits of error measurement shall be described in 9.3.2. The tensile testing machine shall be maintained to grade 1.0 of BS 1610 : Part 1.

### **9.3.5 Bend test across the welds.**

The width of the test specimen shall be 25 mm or four times the design thickness of the container, whichever is the greater. In preparing the test specimen the corners shall be rounded off and the backing strip or the tongue or a joggle joint and any weld reinforcement shall be machined off before testing.

Specimens B3 and B4 (see figure 2) shall be bent with the outer surface of the weld in tension, and specimens B5 and B6 (see figure 2) with the inner surface of the weld in tension.

When bent at room temperature round a former, of diameter not greater than  $n$  times the thickness of the specimen, until the gap between the ends is not greater than the diameter of the former, the specimen shall remain uncracked. Value of  $n$  is given in table 1. In a joggle joint welding configuration defects in the exposed end grain of the material shall not be sufficient reason for rejection, providing all other material tests are passed.

### **9.3.6 Nick- break tests on the welds**

Two nick-break test specimens shall be made, the specimens NB1 and NB2 (see figure 2) being similar to those required for a bend test, except that a slot is cut along the weld on each side at the centre line. The slot shall be of a form shown in figure 4. The specimen shall then be broken cold in the weld by pressure or blows applied to one of the slotted faces, and the pressure shall reveal a sound, homogenous weld with complete penetration, free from oxide, slag inclusions or excessive porosity.

## **9.4. Prototype Fatigue Tests**

### **9.4.1. Drum Test**

One drum shall be taken from the first batch or production run made to a new design, except where there is written evidence of prototype testing having been previously carried out by an approved verification body, and submitted to the pressure cycling tests. The drum shall be certified by the manufacturer to be representative of his design and manufacturing procedure.



The drum shall be considered to have passed the test if it satisfactory complete, without any sign of leakage, either;  
 12000 cycles over a range equivalent to 0.9 x test pressure; or  
 80000 cycles over a range equivalent to 0.6 x test pressure.

#### 9.4.2. Fracture Mechanics Assessment.

As an alternative to the prototype fatigue test, as specified in 9.4.1., a fracture mechanics assessment to PD 6493 may be made to illustrate that defect growth due to fatigue will not reduce the integrity of the drum. Once material properties have been found it should be demonstrated that the maximum allowable defect size will not grow to the Critical Crack Size in 100 000 cycles from atmospheric to the developed pressure at 35°C.

Calculated values for the range of hoop stresses to be considered shall use the equation:

$$t_{act} = \frac{P_{fat} D_i}{2f_f - P_{fat}}$$

Where:

$t_{act}$  = Drum actual thickness minus the corrosion allowance.

$P_{fat}$  = Pressure for fatigue assessment. This is the developed pressure at 35°C.

$f_f$  = Stress for fatigue assessment.

#### 9.5. Product sample test

Drums shall be subjected to initial inspection in accordance with the following specifications:  
 On an adequate sample of drums:

- (a) Testing of the material of construction in respect at least of yield stress, tensile strength, and permanent elongation at fracture;
- (b) Measurement of wall thickness at the thinnest point, and calculation of stress;
- (c) Checking the homogeneity of the material for each manufacturing batch, and inspection of the external and internal condition of the drum.

This category comprises mechanical tests for steel as well as for welded seam. The test pieces shall be welded in elongation of the longitudinal seam. There shall be one test-piece per heat treatment batch. The rules laid down in AD-Merkblatt (sheet) HP 5/2 to be adhered to.

For sampling purposes a batch is defined as a group of containers of the same design, manufactured from the same cast of steel, having undergone the same heat treatment. One batch consisting of not more than 50 drums.

## **9.6. Hydraulic proof test**

Every drum shall be subjected to a hydraulic test. The test pressure shall be determined by the requirements of Clause 4. No pressure greater than 65% of the test pressure shall have been applied to any cylinders before the test.

All rigid pipe work, flexible tubing valves, fittings and components shall be capable of withstanding a pressure twice the maximum test pressure of any cylinder to be tested.

Pressure gauges shall comply with the requirements of industrial class 1 of BS1780 : Part 2 or equivalent standards, they shall be tested at regular intervals, and in any case not less frequently than once a month.

The design and installation of the equipment and the cylinder connected to it shall be such as to avoid trapping air in the system.

The test pressure shall be established from the markings on the drum. When applied to the drum(s) it shall not exceed 3% or 10 bar, whichever is the lower.

On attaining the test pressure the drum(s) shall be isolated from the pump and the pressure held for a minimum period of 30 minutes, during which period the pressure as registered on the test gauge shall remain constant.

Under these conditions of test the drum(s) shall not show any sign of leakage, visible deformation or defect.

If there is a leakage in the pressure system it shall be corrected and the drum(s) retested.

The interior of each cylinder shall be thoroughly dried by a suitable method immediately after hydraulic testing. Drums shall not be heated above 80°C.

## **9.7. Water capacity check**

The water capacity of each drum shall be checked and recorded. This shall be done by weighing and by filling the drum with a calibrated column liquid, or by other means approved by the approved verification body, in order to ensure compliance with the required water capacity in the design drawing.

## **9.8. Visual inspection**

Each drum shall have a final visual examination of welded joints, carried out in accordance with EN 970.

If, in the judgement of the Approved Verification Body a drum fails to meet the standards required by the specification, it shall be rectified or rejected.

### **9.9. Record of tests**

A record shall be kept of all tests made at the drum manufacturers works

### **10. INFORMATION TO BE MARKED**

Each drum that complies with the requirements of this specification shall be permanently and legibly marked with the following information.

- a. The manufacturers mark and drum serial number.
- b. The test pressure (bar) and date of hydraulic test, indicated by the month and year and the identification mark of the person or company who conducted the test.
- c. The identification mark(s) of the approved verification body.
- d. The number of this specification, i.e. HSE SS 1000.
- e. The design water capacity of the drum as specified on the design drawing (1).
- f. The weight of the drum, including permanent fittings only (Kg).
- g. The settled filling pressure at 15°C (bar) for permanent gases.
- h. The fill ratio for liquifiable gases.
- i. Identification of the product carried in accordance with the Carriage of Dangerous Goods (Classification, Packaging and Labelling) and Use of Transportable Pressure Receptacles Regulations 1996.

With the exception of item (c), (h) & (i), all of the above markings shall be made by the drum manufacturer.

Where a range of gases are to be carried, the fill ratio for each gas will be marked. This can be on a separate plate to the other information.

### **11. POSITION AND SIZE OF MARKING**

The manufacturers mark shall be on the head of the drum. No permanent marking shall be made on the body of the drum.

The marked characters shall normally be at least 10 mm high.

Item (i) shall be marked as required by the The Carriage of Dangerous Goods (Classification, Packaging and Labelling) and Use of Transportable Pressure Receptacles Regulations 1996.

## APPENDIX 1A

### Specimen Design Certificate for Welded Steel Gas Pressure Drums

Certificate No: ..... Customer No: ..... Date: .....

Manufacturer ..... Specification .....

(Customer .....

Order No: (

(Manufacturer .....

Gas .....

(Customer ..... Quantity, ordered .....

Serial No(s): (

(Manufacturer .....

Minimum specified yield stress ..... Minimum specified tensile strength .....

Drawing	Test Pressure	Min Thickness		External Diameter	Nominal Length without cap or valve	Water Cap Nominal /Min*	Weight		
		Cyl,shell	Head				Min*	Max*	Nom*
		bar	mm	mm	mm	mm	L	Kg	Kg

\* Delete as appropriate

Identification marks stamped on the cylinder Name Plate

- a) manufacturer's marks
- b) the number of this Specification
- c) filling pressure at 15°C
- d) date of hydraulic test
- e) Approved verification Body's mark (s)
- f) test pressure
- g) customer's mark(s) (if any)
- h) drum serial number
- i) weight of cylinder without valve

## APPENDIX 1B

### Specimen Certificate for water capacity, weight and material

#### Water capacity and weight

Water capacity between ..... and ..... L

Weight between ..... and ..... Kg

#### Material

The drum in batch(es) ..... were manufactured from the following cast(s) of steel:

Steelmaker: .....

Cast	Steel	C	Si	Mn	P	S	Cr	Mo	Ni

## APPENDIX 1C

### Specimen Certificate for water capacity, weight and material

Bath No	Steel Code	Test piece dimensions	Upper yield stress or 0.2% proof stress	Tensile strength	Elongation
<b>Bend tests satisfactory at</b>					

For and on behalf of the manufacturer

.....

For and on behalf of the Approved  
verification Body

.....

## APPENDIX 1D

### Specimen Certificate for water capacity, weight and material

**Manufacturer** ..... **Date** .....

**Customer** ..... **Spec** .....

**Size** ..... **Approved Verification Body**

**Gas** ..... **Man Order No:** .....

(**Customer** .....

**Serial No(s)**

(**Manufacturer** .....

**Customer's Order No:** .....

**Batch No(s)** .....

We hereby certify that the drums produced to design certificate number .....  
comply with the following requirements.

#### **Minimum cylindrical shell thickness**

The wall thickness of all cylinders has been measured and found to be not less than ..... mm.  
Each drum has been X-Ray tested 100% of circumferential and longitudinal seams and found to be  
satisfactory.

#### **Hydraulic pressure tests**

Each cylinder has been proof tested to a pressure of ..... bar and found to be satisfactory.

Date of press tests: .....

#### **Ultrasonic tests**

Each drum has been ultrasonically examined on the parallel walls to a 5% standard and found to be  
satisfactory.

Drums meet requirements of ADR-RIV and IMDG-CODE.



## APPENDIX II

### Ultrasonic defect detection and thickness measurement

#### II.1 DEFECT

##### II.1.1 General

This method covers the pulse echo testing of welded steel drums.

##### II.1.2 Surface condition

Both the surface and the reflection surfaces of the drum shall be clean and free from any materials that will interfere with the test, eg loose scale.

##### II.1.3 Equipment

The test equipment shall be of the pulse type and shall be capable of detecting the calibration notches to the degree required in the calibration procedure specified in II.1.5.

##### II.1.4 Couplant

A coupling method that ensures adequate transmission of ultrasonic energy between the testing probe and the drum shall be used.

##### II.1.5 Calibration standards

II.1.5.1 A calibration standard of a convenient length shall be prepared from a drum of similar diameter and wall thickness, material surface finish and metallurgical condition to the cylinder to be inspected. The calibration standard shall be free from discontinuities which may interfere with the detection of the reference notches.

II.1.5.2 A longitudinal and transverse reference notch shall be introduced on the outer and inner surfaces of the calibration standard. The transverse and longitudinal notches may be positioned within 25 mm of each other but the pairs of notches on the inner and outer surfaces shall be separated by at least 50 mm along the axis of the standard.

The standard notches shall be  $25 \pm 0,25$  long and their width shall not be more than twice the nominal depth. The notch depth shall be 5% of the minimum wall thickness or 0,25 mm, whichever is the greater. The tolerance on depth shall be  $\pm 10\%$  of the nominal notch depth. The cross section of the notch

shall be nominally of rectangular section but if spark erosion methods are employed the bottom of the notch may be rounded.

#### **II.1.6 Calibration of equipment**

Using the calibration standard specified in II.1.5 the equipment shall be adjusted to produce clearly identifiable indications from inner and outer surface notches. The relative response from notches shall be as near equal as possible. The indication of smallest amplitude shall be used as the rejection level and for setting visual, electronic monitoring or recording devices.

The equipment shall be calibrated with the reference standard and/or probe moving in the same manner, in the same direction and at the same speed as will be during the inspection of the cylinder.

#### **II.1.7 Frequency**

The ultrasonic test frequency shall be between 2 MHz and 6 MHz.

#### **II.1.8 Assessment of results**

Any drum not showing a defect indication shall be considered to have passed this ultrasonic inspection.

*Note: A defect indication is one that is equal to or greater than the less indication of the reference notches.*

If surface defects are removed by grinding than after correction the drum shall be resubjected to ultrasonic defect detection and thickness measurement.

## APPENDIX IIA

Report No: .....

### Report on Radiographic Examination

Sheet ... out of ..... Sheets

Details on Object	Manufacturer:		Purchaser:	
	Object:		Construction Drawing:	
	Material:		Dimensions:	
	Welding Procedure:		Extent of Tests:	
Technical Test Data	Source of radiation: (e.g. g- or X-rays)		Manufacturer and Type of Film:	
	Image Quality Indicator:	Foils: v	h	Manufacturer and Type of Film: Distance from Source of Radiation- to Surface of Workplace:
	Tube Voltage:	kV	Activity	ps <sup>-1</sup>
	Tube Current:	mA		
	Time of Exposure:		Size of Focus/Source of Radiation  mm . mm	
	Requirements: AD-Merlblatt HP 5/3 and		.....	
	Tested after/before Heat Treatment:			
Place and Date of Tests:				

**Test Results**

Test Section	Name of Film	Arrangement of Exposures DIN 54111	BZ DIN 54 109	Finding <sup>1)</sup>	Valuation <sup>2)</sup>		Remarks
					Factory	TÜO	

<sup>1)</sup> Abbreviation according to DIN 8524

<sup>2)</sup> 1 = no defects, 2 = slight defects, 3 = defects which need not be repaired, 4 = defects where the weld needs repairing, 5 = defects requiring a new weld.

**For random sample test**  
cc. to AD-Merkblatt HP 5/3. Point 4.2

.....

**Date**                                      **Test Supervisor**                                      **The Inspecting Authority**

**Report No:** .....

**Sheet:** .....

**Radiographic Examination**

Test Section	Name of Film	Arrangement of Exposures DIN 54111	BZ DIN 54 109	Finding <sup>1)</sup>	Valuation <sup>2)</sup>		Remarks
					Factory	TÜO	

**TRANSPORTABLE PRESSURE RECEPTACLES****APPROVAL OF DESIGN SPECIFICATION**

Recognising the requirements of Schedule 8 of the Carriage of Dangerous Goods (Classification, Packaging and Labelling) and Use of Transportable Pressure Receptacles Regulations 1996 SI 2092

APPROVAL CERTIFICATE No: CDGCPL 2 /1997/3

The following design specification is approved for the purpose of the above regulation;

**SPECIFICATION HSE SS 1000****WELDED PRESSURE DRUMS FROM 900 TO 1000 L CAPACITY  
MANUFACTURED FROM STAINLESS STEEL.**

The current specification at the time of manufacture shall be used.

This certificate of approval may be revoked in writing at any time.

CERTIFIED AT BOOTLE on 1997

Signature

Head of Technology Division  
Directorate of Science and Technology  
a person authorised by the Health and Safety Executive  
to perform its function under Schedule 8 of the above  
regulation.

To: Mr M Fountain Head of Technology Division DST

Via: Mr K Wilson HoU DST E5

26/9/1997

From: H Bainbridge DST E5

**The Carriage of Dangerous Goods**  
**(Classification, Packaging and Labelling) and**  
**Use of Transportable Pressure Receptacles Regulations 1996 SI 2092**  
**Schedule 8 Approval**

**TITLE            SPECIFICATION HSE SS 1000**

**WELDED PRESSURE DRUMS FROM 900 TO 1000 L CAPACITY  
 MANUFACTURED FROM STAINLESS STEEL.**

Herewith is an approval certificate for your signature. For support information the following is given:

**1. Background.**

Franz Klaffs & Co have been supplying large transportable carbon steel gas containers to the UK since 1974.

This stainless steel specification is for a batch of drums for BOC.

There is no British Standard for a drum of this material and capacity.

**2. Specification**

This specification is a copy of the HSE Approved Specification FKCO 1120 (HSE), suitably modified for the change in material.

A fatigue assessment was carried out by TUV, and the burst tests were witnessed by Lloyds. The cylinder failed at a pressure in excess of twice the test pressure.

**3. List of Enclosures**

- 1) Certificate for Approval
- 2) Specification to be approved  
 SPECIFICATION HSE SS 1000  
 WELDED PRESSURE DRUMS FROM 900 TO 1000 L CAPACITY  
 MANUFACTURED FROM STAINLESS STEEL.
- 3) REPORT OF FATIGUE ASSESSMENT

- 4) BURST TEST CERTIFICATE.

