

NYCOMED AMERSHAM PLC

QUALITY AND SAFETY ASSURANCE

RAW MATERIALS REQUIREMENT (RMR)

Title: Titanium rod to IMI 130, of nominal diameter less than 10 mm

Prepared by: A W Pearson

Date: February 2001

Approved by:

SD Ant

Production

Date:

B Hendry

Design Authority

Date: 7/2/2001

M. Shepperson

QA Manager

Date: 22.2.01

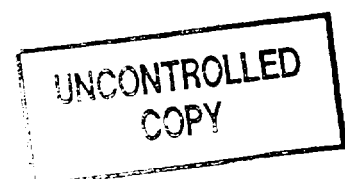
Scope

This RMR relates to material used for, or in connection with, the encapsulation of radioactive sources.

This RMR shall be applied to material purchased by Nycomed Amersham plc and to material purchased for the manufacture of machined components for supply to Nycomed Amersham plc.

Contents

1. Specification.
2. Sub-contractor purchase and receipt procedures.
3. Nycomed Amersham receipt procedures.



sh/msw/rmr disc 5

Q A AUTHENTICATED

1 Specification

Primary Specification: BS ISO 5832-2: 1999(E). Grade 2.
Additional Specification: IMI 130.

1.1 Approved suppliers

As listed in RS 164 QA Approved Suppliers List in compliance with QCP 048.

1.2 Condition

Material shall be supplied in the hot rolled, annealed and centreless ground condition.

1.3 Chemical Composition

The composition shall conform to the specification for Grade 2 in Table 1 of BS ISO 5832-2: 1999(E), as detailed below:-

Element	Min %	Max %
Nitrogen	-	0.03
Carbon	-	0.1
Hydrogen	-	0.0125
Iron	-	0.2
Oxygen	-	0.25
Total of all other impurities*	-	0.3
Titanium	Balance	

* 'other' impurities not specified in standard.

1.4 Physical properties

Property	Min	Max
0.2% Proof Stress (N/mm ²)	230	-
Tensile Strength (N/mm ²)	345	-
Elongation (%) on 50 mm	20	-
Reduction of Area (%)	30	-

1.5 Documentation

For the purposes of this RMR, a batch of metal shall be defined as a discrete cast or sub-division of a cast as identified by the producer. Every batch of metal supplied shall be traceable.

The supplier will submit Certificates of Chemical Analysis and Physical Properties and Certification of Conformance with this RMR.

2. Sub-contractor purchase and receipt procedures

The requirements of RMR 347 apply.

3. Nycomed Amersham receipt procedures

The requirements of QCP 100 apply.

AMERSHAM INTERNATIONAL PLC
INDUSTRIAL PRODUCTS DIVISION
RAW MATERIALS REQUIREMENT (RMR)

Title: Cork for Transport Containers

Prepared By:

Date: 11 May 1988

Approved by: Production

Date:

QA Manager

13/5/88

N/A
C. H. McCall

Scope

This document give details of the specification and approval procedure for cork used as part of transport containers used for the transportation of radioactive material. The cork in a number of shapes and sizes defined in Packaging Group (International Division) manuals.

(Note: previous issue was C)

Contents

1. Specification

Compressed cork manufactured with resin binder and medium sized cork granules. See attached.

2. Sample Procedure

One item per batch

3. Test Schedule

Check dimensions to drawing.
Check density - see 1.2 under specification
Check paperwork - see 1.11

(4) Approval Procedure

QCP 100
(All Cork used by IPD is approved by IPD-QA)

Q.C.
AUTHENTICATED

1. Specification

- 1.1 Resin type: Urea formaldehyde
- 1.2 Density: 270 kg/m^3 (17 lb/cu ft)
- 1.3 Tensile strength: 5.5 kg/cm^2 min (80 lb/in² min)
- 1.4 Compressibility: 7.0 kg/cm^2 (100 lb/in²) expressed in % 20-40.
- 1.5 Recovery: 80% min, dimensional change 1.5%.
- 1.6 Flexibility: No breakage
- 1.7 Fluid resistance: 3 hours in boiling water - no disintegration,
24 hours in test fuel at room temperature -
no disintegration
- 1.8 Bonding between segments: Urea formaldehyde resin. Clamp for six
hours or until fully set.
- 1.9 Example of material: Chingford 22
- 1.10 Identification: each item must be identified with a batch number,
eg month/year.
- 1.11 Documentation: Amersham order will include reference to this
specification and its issue number and the
appropriate drawing number and issue number.
Copies of these documents available on request.

Certificate of Conformity is required, cross
referencing at least the specification and the
order number, and batch number.
- 1.12 Each item within a batch must be identified with a batch number
to indicate the month and year of manufacture eg 0588.

Q.C.
AUTHENTICATED

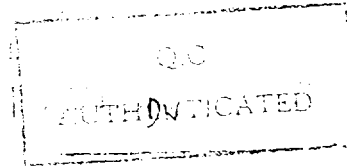
AMERSHAM INTERNATIONAL plc.

International Operations

Packaging Group

Packaging Material Specification

Uranium for Shielding



Prepared by: D.W. Ryers Date: 01/12/87

Authorised by: D Warden Date: 7th December 1987

1: Specification

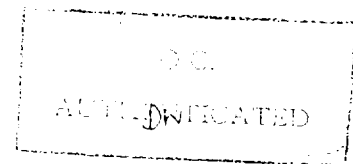
- a) Material : Uranium U235 content not greater than 0.7%
- b) Density : Not less than 18g/cc
- c) Purity : Alloying content not greater than 5%
- d) Porosity :
 - i) No single void to exceed 15% of item wall thickness in the general direction of radiation.
 - ii) No void with dimensions exceeding 10% of item wall thickness to be grouped closer than three diameters apart.
 - iii) No void with dimensions exceeding 10% of item wall thickness to be aligned along the general direction of radiation.

2. Inspection

- a) Density : Calculate by dividing measured weight by calculated volume.
- b) Porosity : Either by surveying shielding efficiency by radiography or by direct imaging of defects using ultrasound techniques.
- c) Inspection Frequency : 100% unless agreed otherwise in writing.
Note: This is most likely to be relaxed with the submission of well proven and documented production procedures.

3. Transport and Storage

- a) Cleanliness : Surfaces must be clean of swarf, dirt and all grease.
- b) Storage and Transport : Packaging must protect items from dirt and moisture and comply with all relevant transport regulations.



Amersham International plc

Packaging Design Group

Load test to destruction on 0666 handles

1. Introduction

Three sample 0666 drums were taken from a new supply and lids were fitted using standard Aeroquip clamp bands. These assemblies were supplied to AEA Technology lifting equipment group for load test.

2. Results

2.1 AEA Technology report

The report from AEA Technology takes the form of a memorandum from the Harwell Safety Officer Lifting Equipment (reference RLR\M02\94) to the Amersham International local QARS representative (copy attached at page 2).

2.2 Normal lifting

At normal lift loads with a safety factor of five (ie at a load of 135 kg per handle), no damage or deformation was identified for any assembly.

2.3 Overload testing

One sample was loaded to destruction. Some distortion was noted at 500kg, an initiation of failure at 700kg with a total failure at 1100kg. The mode of failure was normal for a close set group of spot welds in that the parent material of the drum body tore out before the welds parted.

3. Illustrations

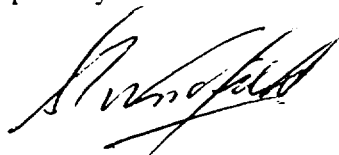
Copies of photographs taken at the time of test are included at pages 3 - 5.

Summary prepared by

Reviewed

Date

Date



15/7/96.

15/7/96



TCT 1811
page 2 of 5
pack44/tct1811.wpd

Memorandum

To D Fry
Amersham International
10.23

From R L Roberts
Safety Officer Lifting Equipment
B 33
Harwell

Extension 2114
Facsimile 2103

Date 26 January 1994

REPORT of LOAD TEST TO THREE TYPE 0666 DRUMS on 25 JANUARY 1994

Three of the above type drums from lot No ID LH0167 were load tested with 135kgs to each handle for a period of two minutes, the cans were identified as A, B and C. Each can had its lid and securing band fitted, can 'C' also had its cork insert in place.

Results of the 135kgs load test.

Can A No deformation or damage at the handle to can interface.
Can B No deformation or damage at the handle to can interface.
Can C No deformation or damage at the handle to can interface.

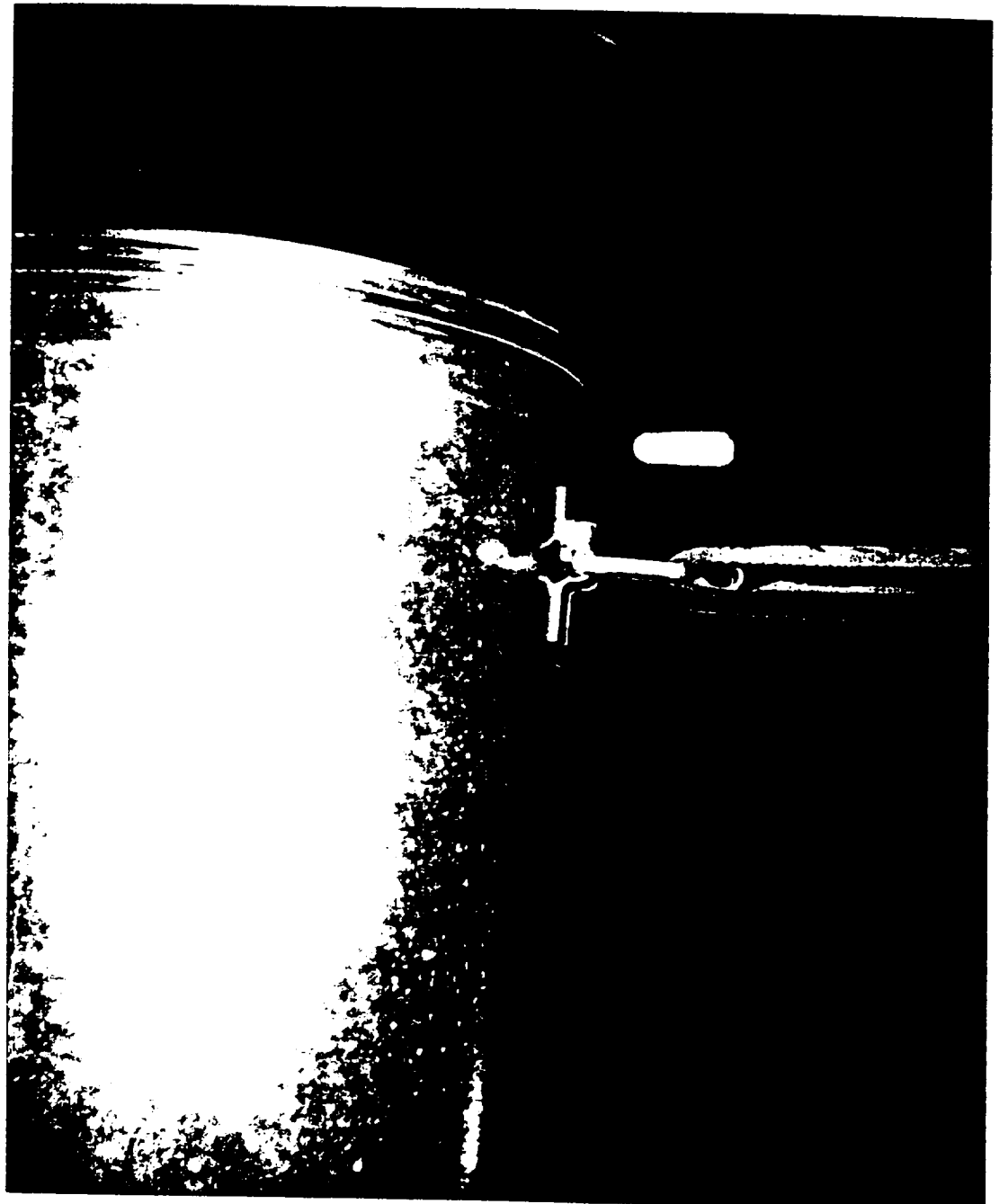
Drum 'C' was then tested to destruction.

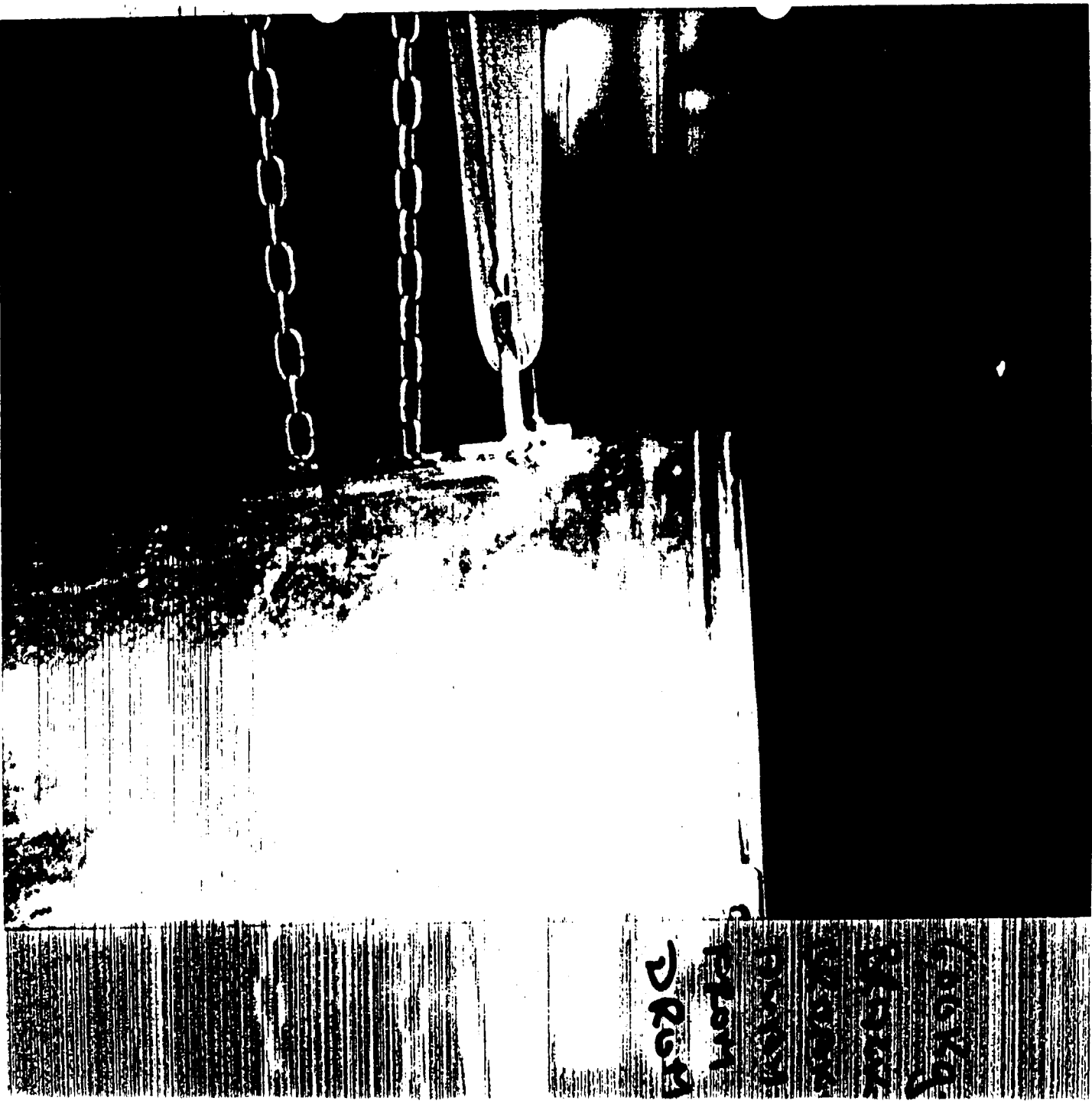
Both handles were showing signs of movement at 500kgs, at the handle to can interface.
At 700kgs the handle securing pad started to part from the can, and at 1100kgs one of the handle securing pads parted from the can, it actually broke away taking part of the can with it.
Both handles showed signs of distortion.
For this test large diameter segment pieces were fitted over the handles to protect the roundslings used, also with the use of roundslings the load was spread evenly along the whole width of the handle, thus giving a more representative result.

The load cell used for the measurement of the load is a calibrated unit.

A handwritten signature in black ink, appearing to be 'RLR', is written over the text of the memorandum.

600 Kg m
SLACKET
DRUM
INTERFAC
STARTS
TO
DISTORT
CLACKING
ON OUTER
FACE
DRUM
TO
SLACKET





1100 Kgm 12017





Memorandum

To D Fry
Amersham International
10.23

From R L Roberts
Safety Officer Lifting Equipment
B 33
Harwell

Extension 2114
Facsimile 2103

Date 26 January 1994

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Can A No deformation or damage at the handle to can interface.

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Can C No deformation or damage at the handle to can interface.

Drum 'C' was then tested to destruction.

Both handles were showing signs of movement at 500kgs, at the handle to can interface.

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The load cell used for the measurement of the load is a calibrated unit.

A handwritten signature in dark ink, appearing to be 'RLR', is written below the text.

AMERSHAM INTERNATIONAL plcPACKAGING DESIGN GROUPIAEA Type B package test sequenceContainer design number 3619CContents

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Introduction

In consultation with the Department of Transport engineer, two critical orientations were agreed. Having regard for potential damage to the pot seals and loss of the drum lid, one is inverted with the centre of gravity of the assembly above the clamp closure. Having regard for potential degradation of the thermal shield, another is near-flat on the base. As this latter orientation was agreed on the day of test, a third assembly, C, has been added to those described in the test quality plan, TCT1863 issue 1, draft 2. Other amendments to this earlier document are incorporated for clarity of description

Part A: Specification of test assemblies

A1 Design description: Container design number 3619C

A2 Design drawings: Assemblies A and C (dummy) To list DL24882 issue A
Assembly B(3619C) To list DL24614 issue C

A3 Quality Assurance:

<u>Item</u>	<u>Drawing</u>	<u>Batch / serial number</u>		
		Assembly A	Assembly B	Assembly C
3619 Drum assembly	A24229 issue B	3619/29	3619/28	3619/24
Cork liner	A24883 issue A	18451802	---	18451802
	A24620 issue B	---	18057701	---
Cork cover	A24693 issue B	18451801	18451801	18451801
Dummy inner pot	A24884 issue B	18057701	---	18057701
3668 inner pot	DL24614 issue C	---	3668/01	---
Clamp band closure torque		1.4 kgf.m (10 lbf.ft)		

Temperature sensitive strips were fitted to the under face of the steel cover plate on the lead dummy pot. These were protected from damage in the thermal test by smoke and resin fumes by an O ring clamped between the two.

A4 Variations from design specification:

The test units were confirmed by inspection to be to specification

A5 Serial numbers: Assembly A 3619/29
Assembly B 3619/28 / 3668/01
Assembly C 3619/24

A6 Package contents: The packages had no contents

A7 Package weight: 180 kg

Commercial - in - confidence

Test number 1863
page 3 of 43
Issue 2 - Report
Disc reference
pack44/tct1863.hpw

A8 GA dummy package design number 3619C (Assemblies A and C)

Item	Description	Drawing No.	Qty
1	ASSY DRUM DES NO. 3619: M/ST & ST/ST	A24299	1
2	LINER: CORK	A24883	1
3	COVER: CORK	A24883	1
4	DUMMY DESIGN NO. 3608: LEAD	A24884	1
5	O RING SIZE 1195-30	THIS	1

NOTES

1. CALCULATED WEIGHT 182 kg

TOLERANCES	MATERIAL	SIZE (TDS) LIST	GENERAL NOTES	SCALE	DATE	ISSUE	MOD No.	18.10.84	STV	APPROVED	QA APPROVED
UNLESS OTHERWISE STATED			THIRD ANGLE PROJECTION	1/2							
SURFACE FINISH			ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE STATED								
TEXTURE			DO NOT SCALE								
UNLESS OTHERWISE STATED			APPROVAL								
			THIS DRAWING IS NOT TO BE USED FOR ANY OTHER PURPOSE WITHOUT THE WRITTEN PERMISSION OF THE DESIGNER								

TITLE DUMMY GA
DESIGN NUMBER 3619C

USED ON -

SHT. SIZE A2

DRG NO. A24882

SHT. OF SHTS 1

SHTS 1

Amersham
The Health Sciences Group

[illegible]

Test number 1863
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pack44/tct1863.hpw

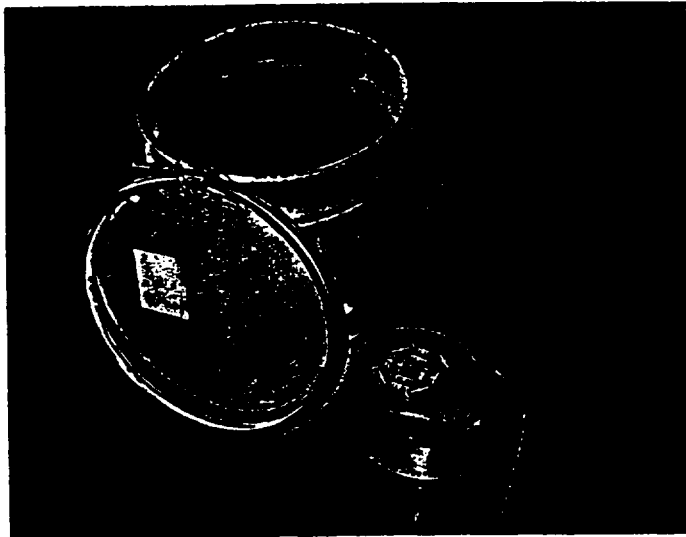


Figure 1
Assemblies A and C - components

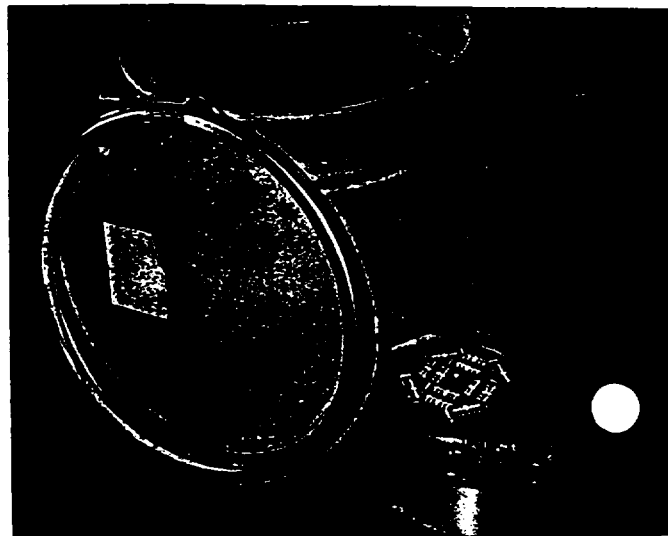


Figure 2
Assemblies A and C - components



Figure 3
Assembly B - components

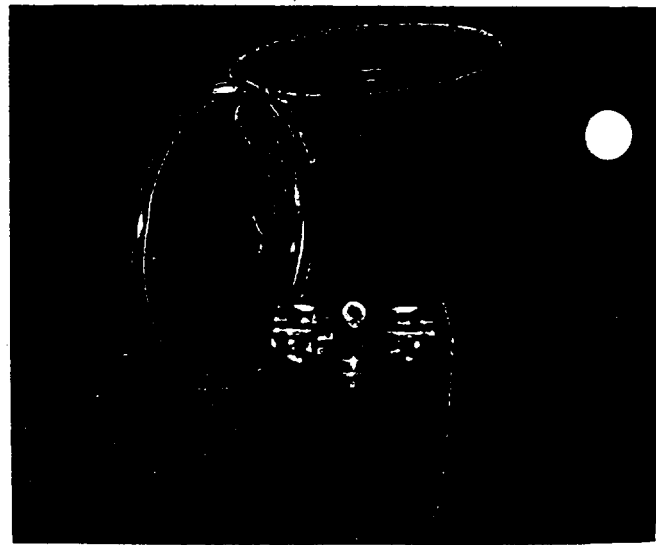


Figure 4
Assembly B - components

Part B: Tests and test procedures

B1 Regulatory description

- i) IAEA Safety Series 6 paragraph 624 - 1m penetration test
- ii) IAEA Safety Series 6 paragraph 622 - 1.2m free drop test
- iii) IAEA Safety Series 6 paragraph 627a - Drop I - 9m free drop
- iv) IAEA Safety Series 6 paragraph 627b - Drop II - 1m punch test
- v) IAEA Safety Series 6 paragraph 628 - Thermal test (Furnace)

B2 Standard procedures

- i) Packaging Group procedure PGP17 using the 6kg bar
- ii) Packaging Group Procedure PGP15 issue 4. A quick release shackle is used in place of the parachute release shown in PGP15. The operator stands on a strong platform to measure the 1.2m drop height and to release the package.
- iii) Packaging Group Procedure PGP15 issue 4, using the quick release shackle described above and confirming the 9m drop height by the installed swinging arm.
- iv) No standard procedure has been written for the Drop II (punch) test. The following procedure will be followed:

Safety As location of impact is as important as orientation in the punch test, it is not practical for the shackle release operator to evacuate the test compound. To ensure his safety and to provide a well controlled access to the release mechanism to ensure impact as planned, he should stand on a suitable strong platform (an 0924 drum is ideal).

Follow PGP15 (as B2(i)), excepting paragraphs 4.3 - 4.6

While ensuring that there is no chance of an unintentional release, hoist the package sufficiently to set punch and package in the intended location and orientation of impact.

Attach a piece of weighted string, 1m long, to the position on the package it is intended to impact the punch.

Hoist the package until the plumb bob weight hangs on the punch at the intended impact position. Do not remove the plumb line.

Ensuring the set alignment remains true by means of the plumb line, gently twist the release lever of the shackle.

- v) IPM108 issue 1

B3 Maintenance

No maintenance will be carried out on the packages between tests.

B4 Drop test facility

Drawing AIRC002 (Lloyds British - submitted to the Department of Transport as a separate document) shows the general layout of the Amersham Laboratory site drop test target. This comprises an 8 tonne cube of reinforced concrete with a steel face plate weighing about 500kg: the electric hoist is rated at 500kg. A 9m height indicator, operated from a personnel access platform, is incorporated in the superstructure. Figure 5 shows the general layout of the test site. The punch is a six inch diameter bar, fifteen inches high as described in IAEA SS6 paragraph 627(b), welded vertically on a base plate 445 x 445 x 12mm.

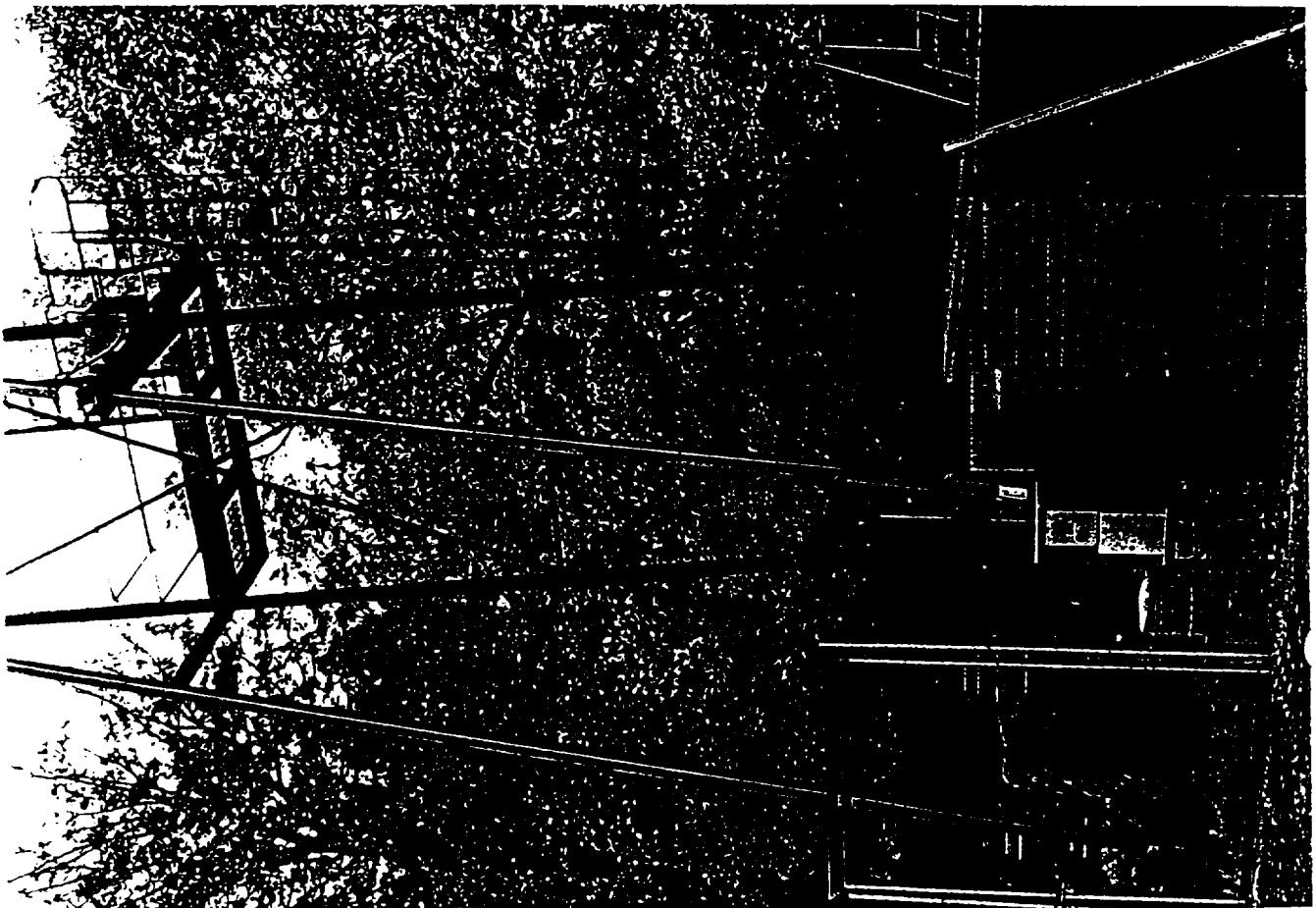


Figure 5
Amersham Laboratories drop test facility

B5 Recording and instrumentation

The tests will be recorded on video tape and by photography. The tape will be available for viewing and used for analysing the impact orientations if necessary. Only the photographs will be appended to this report. No mechanical instrumentation is to be installed.

B6 Impact attitudesAssembly A

- | | | |
|-----------------------------------|--------|---|
| i) <u>1m penetration test</u> | 1863/1 | Centre of drum lid |
| ii) <u>1.2m free drop test</u> | 1863/2 | Centre of gravity above the lid corner at the closure bolt |
| iii) <u>Drop I (9m free drop)</u> | 1863/3 | Centre of gravity above the lid corner at the closure bolt |
| iv) <u>Drop II (Punch test)</u> | 1863/4 | Inverted with impact by the edge of the punch onto the folded drum side |

Assembly B

- | | | |
|----------------------------------|--------|---|
| i) <u>1.2m free drop test</u> | 1863/5 | Centre of gravity above the lid corner at the closure bolt |
| ii) <u>Drop I (9m free drop)</u> | 1863/6 | Centre of gravity above the lid corner at the closure bolt |
| iii) <u>Drop II (Punch test)</u> | 1863/7 | Inverted with impact by the edge of the punch onto the folded drum side |

Assembly C

- | | | |
|----------------------------------|---------|---|
| i) <u>1.2m free drop test</u> | 1863/8 | Onto the drum base at about 5° from flat |
| ii) <u>Drop I (9m free drop)</u> | 1863/9 | Onto the drum base at about 5° from flat |
| iii) <u>Drop II (Punch test)</u> | 1863/10 | Onto the drum base to strike a base reinforcement bar just off centre |

B7 Damage assessment criteria

After each test the container will be examined to review the general level of mechanical damage, particular attention being given to continued security of the drum lid and closure clamp. No forceful attempt will be made to remove the lid between tests beyond that necessary to confirm the criteria below.

B8 Pass / fail criteria

Following the penetration test and the 1.2m free drop test:

The minimum source to surface distance, established by examination of surface distortion, shall be reduced by not more than 10%.

Following the 9m free drop test and the punch test:

The drum lid shall be retained on the drum body for at least one half of its circumference

The drum lid shall not be removable by manual force alone

The outer surface of the drum shall be intact to such an extent that the package components are securely retained in the design relationship

The damage to the 3619C and the dummy assemblies shall be compared to confirm that the dummy assemblies will represent the 3619C adequately when subjected to the thermal test

The inner pot in assembly B shall show a leaktightness of no greater than 1×10^{-5} mbar.l/s

Assemblies A and C shall be secure enough that they may be transported to the thermal test facility under routine conditions without subsequently failing the above criteria.

Following the thermal test:

The assembly shall be essentially intact with the lead pot located approximately central in the package

The inner pot shall be intact and have risen to a temperature of no greater than 200°C

Part C - Mechanical test schedule

Date: 2 November 1994

Condition of test equipment: Drop test rig, cameras - Good
Penetration rig - not usable

Ambient weather conditions: Fine, dry, calm

Persons present: A R Webster, Department of Transport
S T Winfield, Amersham International
A Lewis, Amersham International

Test reference 1863 / 1 (1m penetration test)

<u>Check</u>	<u>Operation</u>	<u>Video</u>	<u>Photo</u>
	Position the drum under the 6kg penetration bar in the guide tube to achieve impact close to the centre of the drum lid and away from the metal label		
	Measure 1m from the upper face of the connector to the lower face of the penetration bar. Photo record		
	Set the video running		
	Release test bar. Confirm impact position and review damage. Photo and video record		

Damage report

This test was not carried out due to unserviceability of the test rig

Test reference 1863 / 2 (1.2m free drop test, assembly A)

<u>Check</u>	<u>Operation</u>	<u>Notes</u>
✓	Stand package on the drop test target and hoist from a base flange lifting point to achieve a drop onto the clamp bolt	
✓	Attach slings to the quick release shackle and raise the package for photo record of orientation	①
✓	Evacuate the compound of all but the drop operator and secure the gate	
✓	Set the video running	from 1931
✓	Raise the package until the 1.2m drop height is confirmed	
✓	Very gently twist the release lever to release the package	
✓	Stop video record. Photo record position of the package as it came to rest	
✓	Set the package to a convenient viewing position and photo record damage	
✓	Figures 6 - 8 refer	

Damage report

The upper rim of the drum was distorted and the clamp closure twisted in such a way that the loops around the bolt were vulnerable to release by the edge of the punch in Drop II. In view of the fact that other work is in hand to protect this feature, it was agreed that the planned test sequence could continue. The lid was securely retained on the drum body.

Analysis of damage against criteria of B8

- ✓ Accept. Continue to next test as planned
- Accept. Continue to next test, revised
- Fail

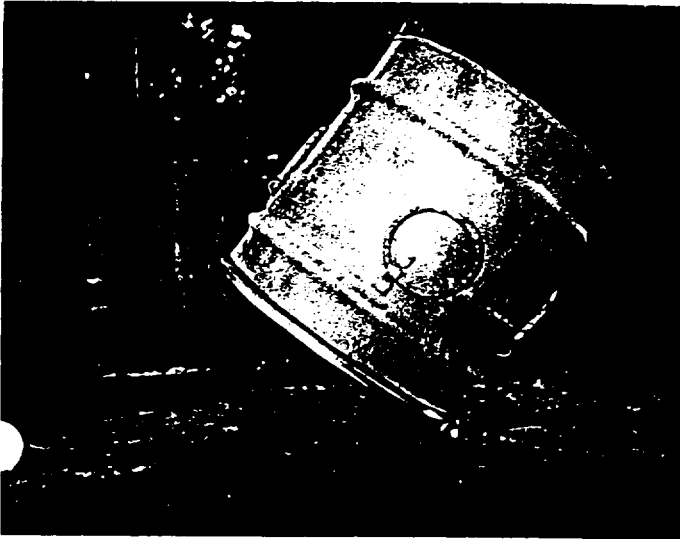


Figure 6
1863/2 - Drop test orientation

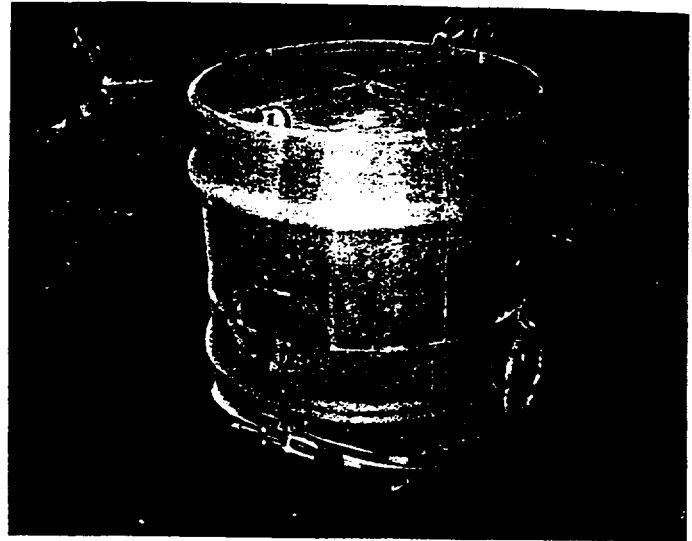


Figure 7
1863/2 - Immediately post test

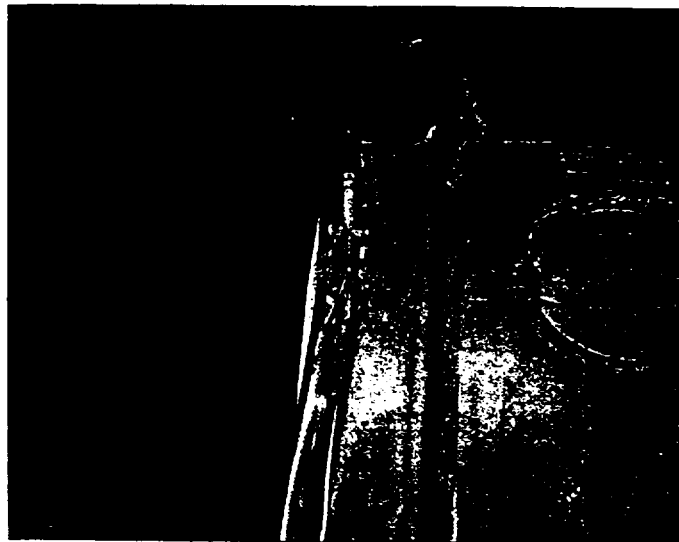


Figure 8
1863/2 - Damage

Test reference 1863 / 3 (9m free drop test, assembly A)

<u>Check</u>	<u>Operation</u>	<u>Notes</u>
✓	Stand package on the drop test target and hoist from a base flange lifting point to achieve a drop onto the clamp bolt	
✓	Attach slings to the quick release shackle and raise the package for photo record of orientation	④
✓	With the exception of the release operator on the personnel access platform, evacuate the compound and secure the gate	
✓	Raise the package until it is just clear of the 9m indicator when viewed from the personnel access platform. Withdraw the indicator and prepare for release. Set the video running	
✓	Gently rotate the release lever (using the release string if convenient), to release the package. Ensure that the package is stationary immediately prior to release	
✓	Stop video record. Photo record position of the package as it came to rest	⑤
✓	Set the package to a convenient viewing position and photo record damage	⑥

Figures 9 - 11 refer

Damage report

The upper face of the drum was flattened over about one third of its area. The closure was further twisted into the drum side, evidence of contact being clearly visible. The clamp and lid could not be removed by manual force. No cork was visible.

Analysis of damage against criteria of B8

Accept. Continue to next test as planned
 Accept. Continue to next test, revised
 Fail



Figure 9
1863/3 - Drop test orientation



Figure 10
1863/3 - Immediately post test

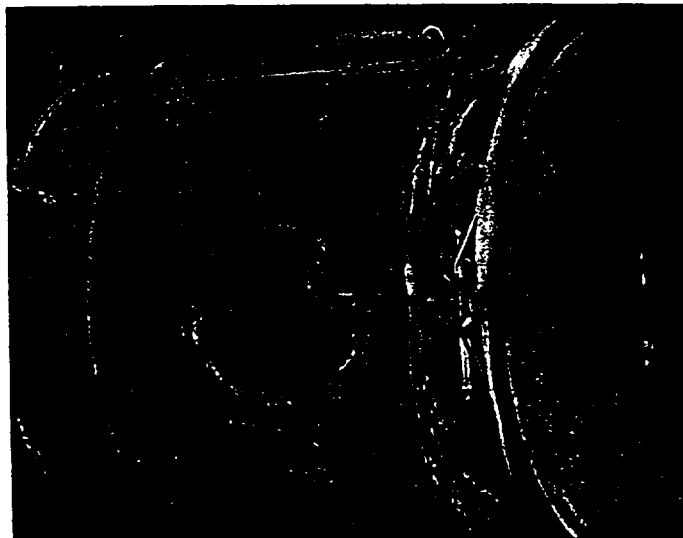


Figure 11
1863/3 - Damage

Test reference 1863 / 4 (1m free drop onto punch, assembly A)

<u>Check</u>	<u>Operation</u>	<u>Notes</u>
✓	Stand package on the drop test target and hoist from a base flange lifting point to achieve a drop into the crumpled side of the drum.	
✓	Attach a 1m plumb line to the required point of impact on the drum	
✓	Attach slings to the quick release shackle and raise the package for photo record of orientation	⑦
✓	Raise the package until the bob weight is just clear of the punch	
✓	While keeping the bob weight at the desired point of impact on the punch, very gently rotate the release lever to achieve release of the package	
✓	Set the package to a convenient viewing position and photo record damage	

Figures 12 - 13 refer

Damage report

The punch brushed the creases resulting from the Drop I, firm impact occurring on the handle strap. No significant additional damage was observed. Figure 12 shows the damaged area of the package at the conclusion of the mechanical testing. The assembly was satisfactory to continue to the thermal test as planned.

The photographic equipment (camera and/or film) failed during this test sequence. All subsequent records show only the cumulative damage of all mechanical tests on each assembly - see discussion at Part E below.

Analysis of damage against criteria of B8

Accept. Continue to next test as planned

Fail

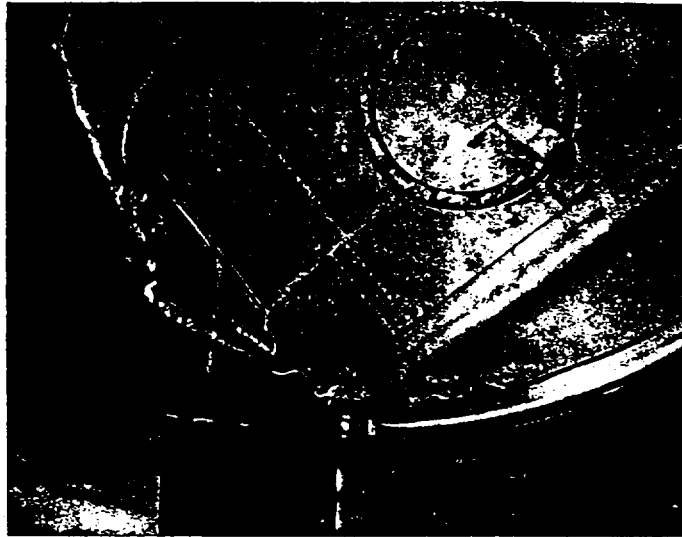


Figure 12
1863/4 - Drop test location and orientation



Figure 13
1863/4 - Damage to assembly A after all mechanical tests

Test reference 1863 / 5 (1.2m free drop test, assembly B)

<u>Check</u>	<u>Operation</u>	<u>Notes</u>
✓	Stand package on the drop test target and hoist from a base flange lifting point to achieve a drop onto the clamp bolt	
✓	Attach slings to the quick release shackle and raise the package for photo record of orientation	④
✓	Evacuate the compound of all but the drop operator and secure the gate	
✓	Set the video running	
✓	Raise the package until the 1.2m drop height is confirmed.	
✓	Very gently twist the release lever to release the package	
✓	Stop video record. Photo record position of the package as it came to rest	⑩
✓	Set the package to a convenient viewing position and photo record damage	⑪

Figures not available due to equipment failure

Damage report

The upper rim of the drum was distorted inwards and the clamp closure twisted. The lid was securely retained on the drum body. Visually, the damage was nearly identical to that observed on assembly A in test 1863/2.

Analysis of damage against criteria of B8

Accept. Continue to next test as planned
Accept. Continue to next test, revised
Fail

Test reference 1863 / 6 (9m free drop test, assembly B)

<u>Check</u>	<u>Operation</u>	<u>Notes</u>
✓	Stand package on the drop test target and hoist from a base flange lifting point to achieve a drop onto the clamp bolt	
✓	Attach slings to the quick release shackle and raise the package for photo record of orientation	
✓	With the exception of the release operator on the personnel access platform, evacuate the compound and secure the gate	
✓	Raise the package until it is just clear of the 9m indicator when viewed from the personnel access platform. Withdraw the indicator and prepare for release. Set the video running	
✓	Gently rotate the release lever (using the release string if convenient), to release the package. Ensure that the package is stationary immediately prior to release	
✓	Stop video record. Photo record position of the package as it came to rest	
✓	Set the package to a convenient viewing position and photo record damage	

Figures not available due to equipment failure

Damage report

The upper face of the drum was flattened over about one third of its area. The closure was further twisted into the drum side, evidence of contact being clearly visible. The clamp and lid could not be removed by manual force. No cork was visible. Damage was nearly identical to that observed on assembly A in test 1863/3.

Analysis of damage against criteria of B8

Accept. Continue to next test as planned
Accept. Continue to next test, revised
Fail

Test reference 1863 / 7 (1m free drop onto punch, assembly B)

<u>Check</u>	<u>Operation</u>	<u>Notes</u>
✓	Stand package on the drop test target and hoist from a base flange lifting point to achieve a drop into the crumpled side of the drum.	
✓	Attach a 1m plumb line to the required point of impact on the drum	
✓	Raise the package until the bob weight is just clear of the punch	
✓	While keeping the bob weight at the desired point of impact on the punch, very gently rotate the release lever to achieve release of the package	
✓	Set the package to a convenient viewing position and photo record damage	

Figures 14 - 17 refer

Damage report

The punch brushed the creases resulting from the Drop I, firm impact occurring on the handle strap. No significant additional damage was observed. The damage was nearly identical with that observed on assembly A in test 1863/4.

Analysis of damage against criteria of B8

Accept

Fail

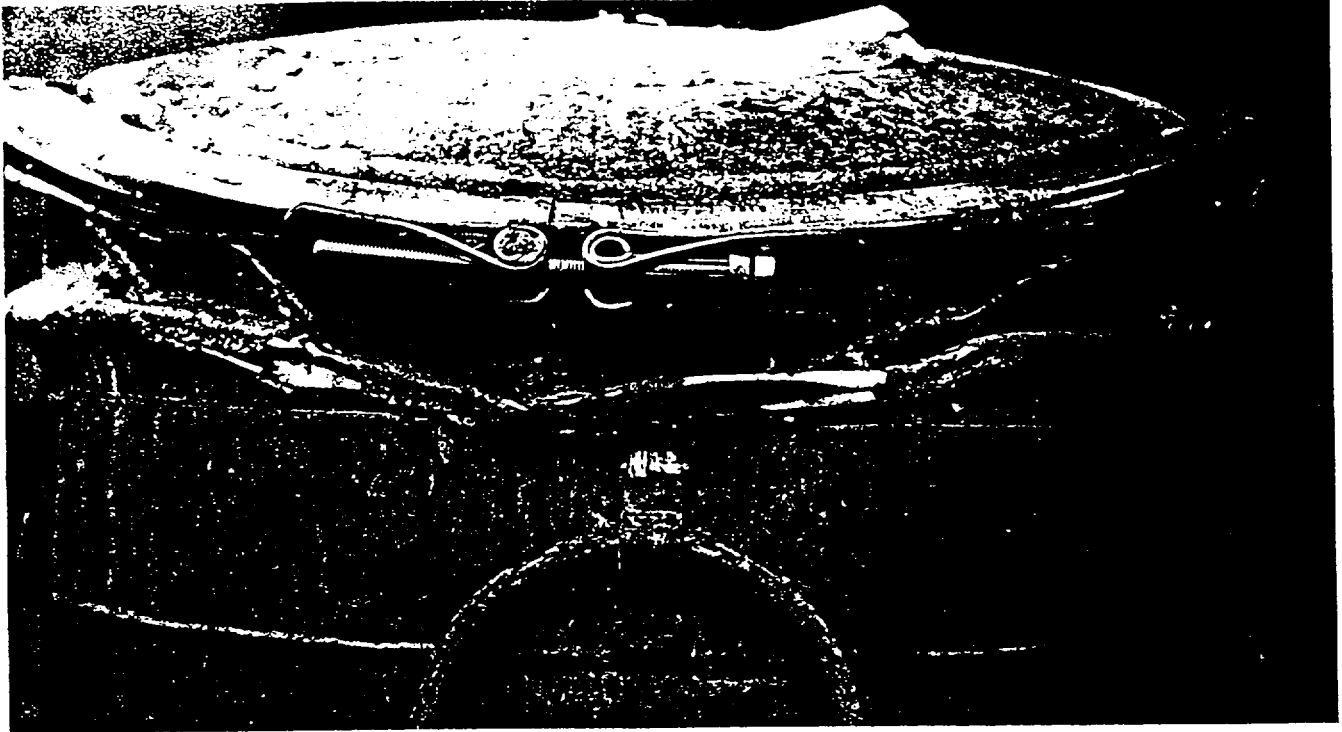


Figure 14
1863/7 - Damage to assembly B from all mechanical tests



Figure 15
1863/7 - Damage to assembly B compared with undamaged drum

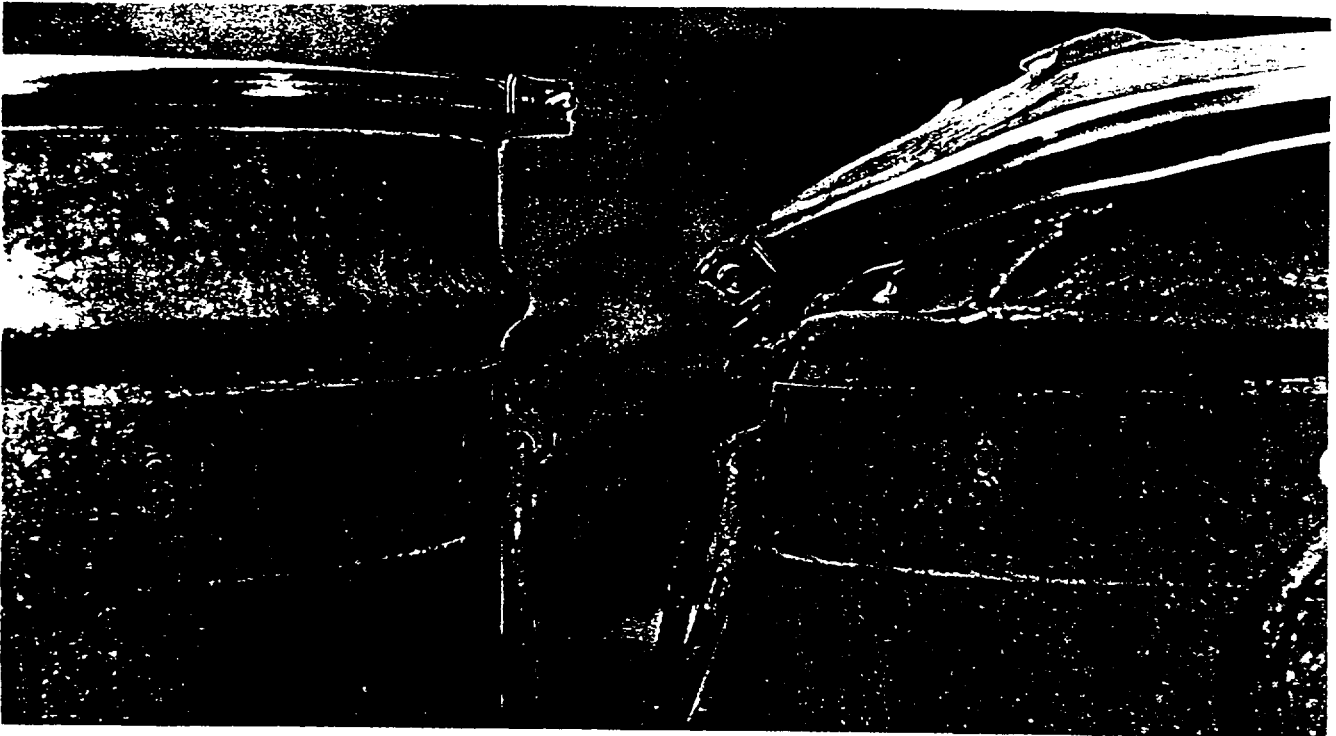


Figure 16
1863/7 - Damage to assembly B compared with undamaged drum

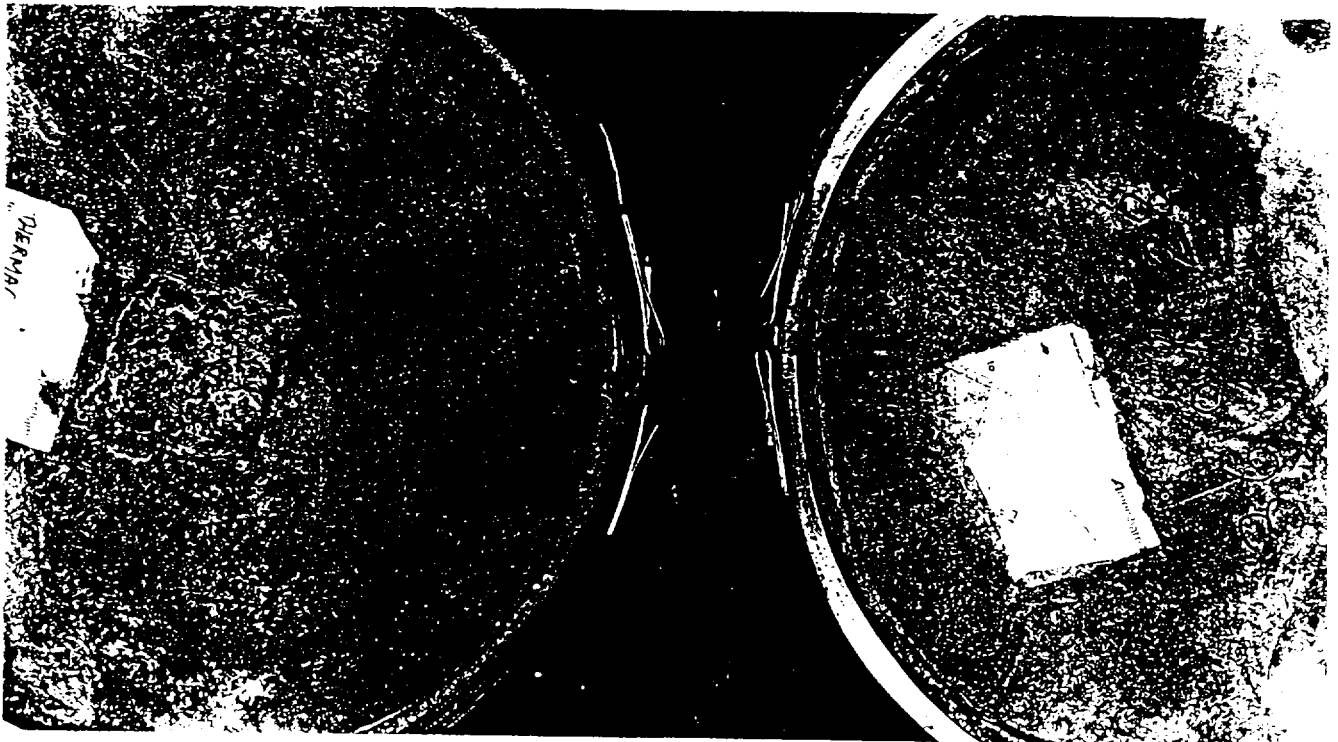


Figure 17
1863/7 - Damage to assembly B compared with undamaged drum

Test reference 1863 / 8 (1.2m free drop test, assembly C)

<u>Check</u>	<u>Operation</u>	<u>Notes</u>
✓	Stand package on the drop test target and hoist from two handles to achieve a near flat drop onto the drum base	
✓	Attach slings to the quick release shackle and raise the package for photo record of orientation	
✓	Evacuate the compound of all but the drop operator and secure the gate	
✓	Set the video running	
✓	Raise the package until the 1.2m drop height is confirmed	
✓	Very gently twist the release lever to release the package	
✓	Stop video record. Photo record position of the package as it came to rest	
✓	Set the package to a convenient viewing position and photo record damage	

Figures not available due to equipment failure

Damage report

The base of the drum showed minor distortion. Each of the quadrants between the base reinforcement showed bowing of about 3mm. The drum skin was unbroken.

Analysis of damage against criteria of B8

Accept. Continue to next test as planned
Accept. Continue to next test, revised
Fail

Test reference 1863 / 9 (9m free drop test, assembly C)

<u>Check</u>	<u>Operation</u>	<u>Notes</u>
✓	Stand package on the drop test target and hoist from two handles to achieve a near flat drop onto the drum base	
✓	Attach slings to the quick release shackle and raise the package for photo record of orientation	
✓	With the exception of the release operator on the personnel access platform, evacuate the compound and secure the gate	
✓	Raise the package until it is just clear of the 9m indicator when viewed from the personnel access platform. Withdraw the indicator and prepare for release. Set the video running	
✓	Gently rotate the release lever (using the release string if convenient), to release the package. Ensure that the package is stationary immediately prior to release	
✓	Stop video record. Photo record position of the package as it came to rest	
✓	Set the package to a convenient viewing position and photo record damage	

Figures not available due to equipment failure

Damage report

The overall drum height was reduced by 20 - 23mm all round. The drum base disc had distorted downwards to contact the target plate over a diameter of about 200mm. Significant tearing was in evidence around all four reinforcement ribs, although only a very small amount of cork was visible. The lower 'rolling ring' of the drum side had been reduced to nil. The lid disc had bowed up by about 4mm over a diameter of about 350mm. The lid itself was fully retained.

Analysis of damage against criteria of B8

Accept. Continue to next test as planned
Accept. Continue to next test, revised
Fail

Test reference 1863 / 10 (1m free drop onto punch, assembly C)

<u>Check</u>	<u>Operation</u>	<u>Notes</u>
✓	Stand package on the drop test target and hoist from two handles to achieve impact of the punch onto one or two reinforcement ribs with the edge of the punch close to the centre line of the drum.	
✓	Attach slings to the quick release shackle and raise the package for photo record of orientation	
✓	Raise the package until it is 1m above the punch	
✓	Very gently rotate the release lever to achieve release of the package	
✓	Set the package to a convenient viewing position and photo record damage	

Figures 18 - 21 refer

Damage report

The reinforcing ribs were forced up into the cork, showing a maximum of 15mm of cork at the centre of one segment - ie the upper edge of the rib had penetrated 35mm into the cork. The weld at the circumference of one rib was broken.

Analysis of damage against criteria of B8

Accept. Continue to next test as planned

Fail

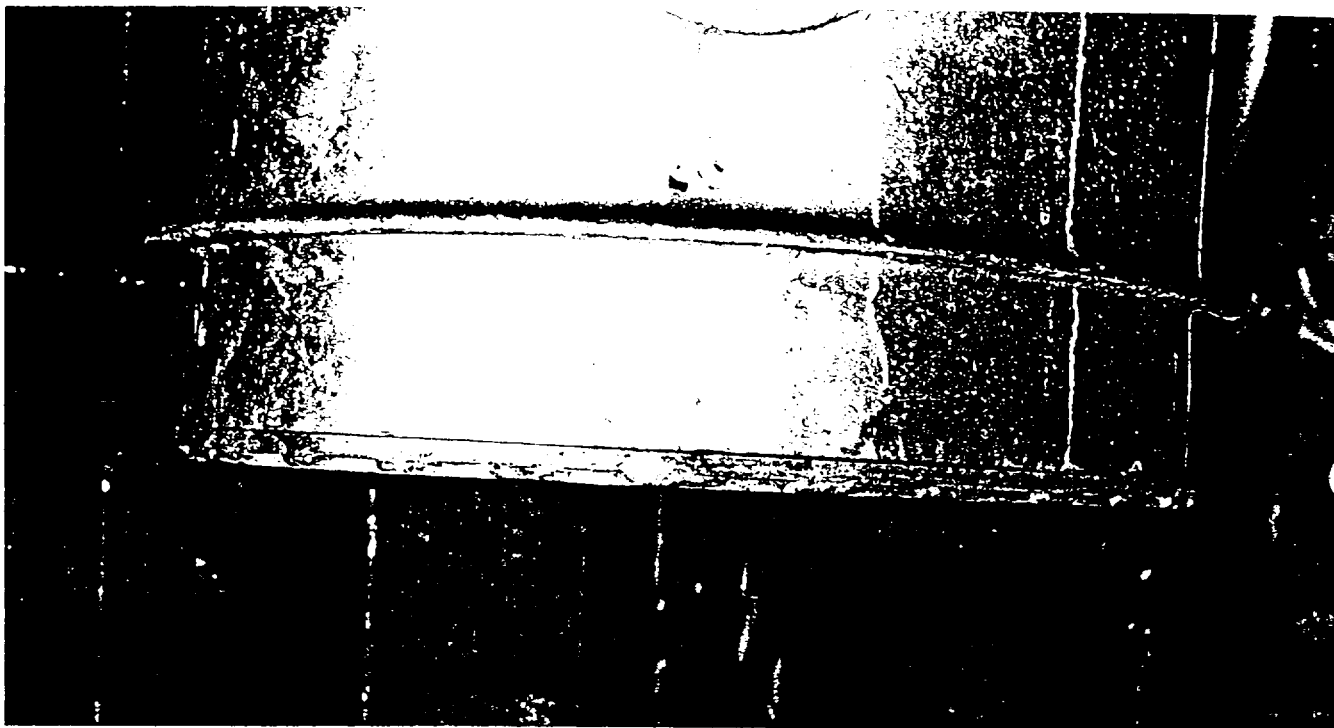


Figure 18
1863/10 - Damage to assembly C after all mechanical tests - side view



Figure 19
1863/10 - Damage to assembly C after all mechanical tests - base view

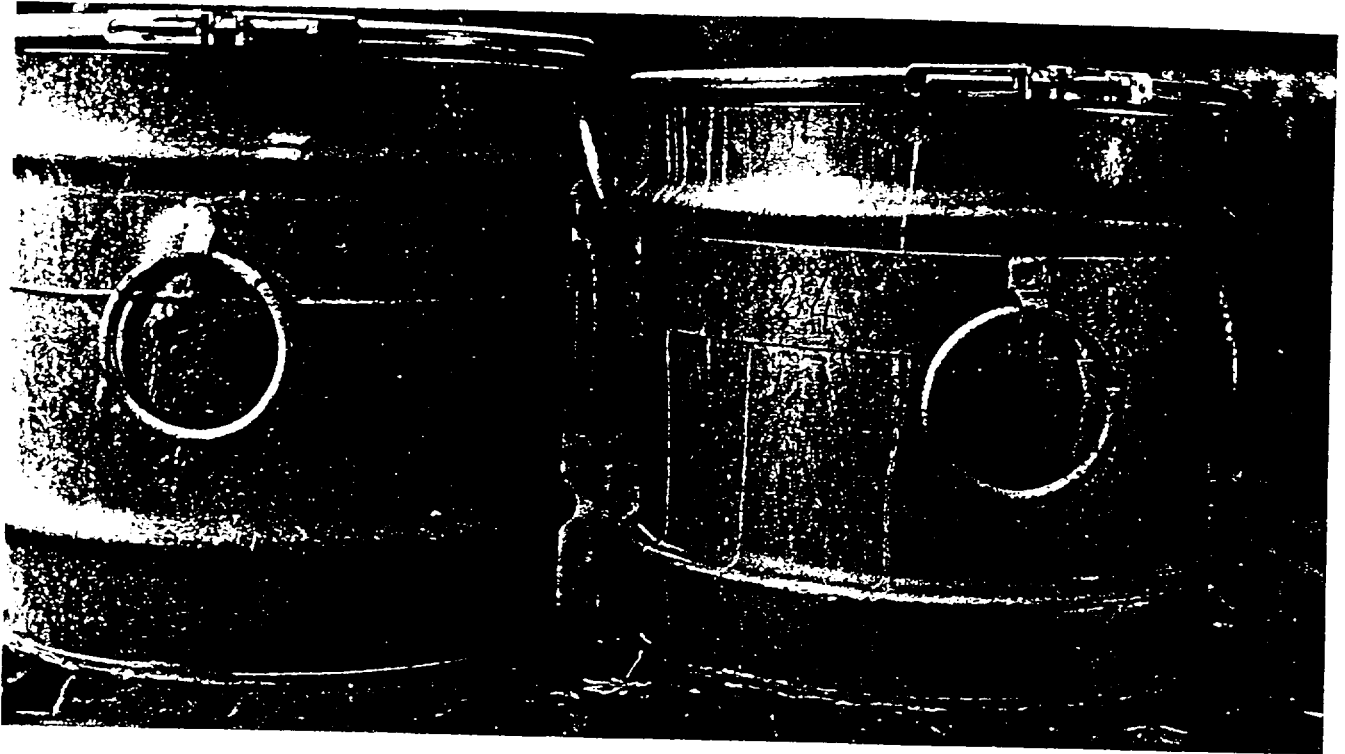


Figure 20
1863/10 - Damage to assembly C compared with undamaged drum

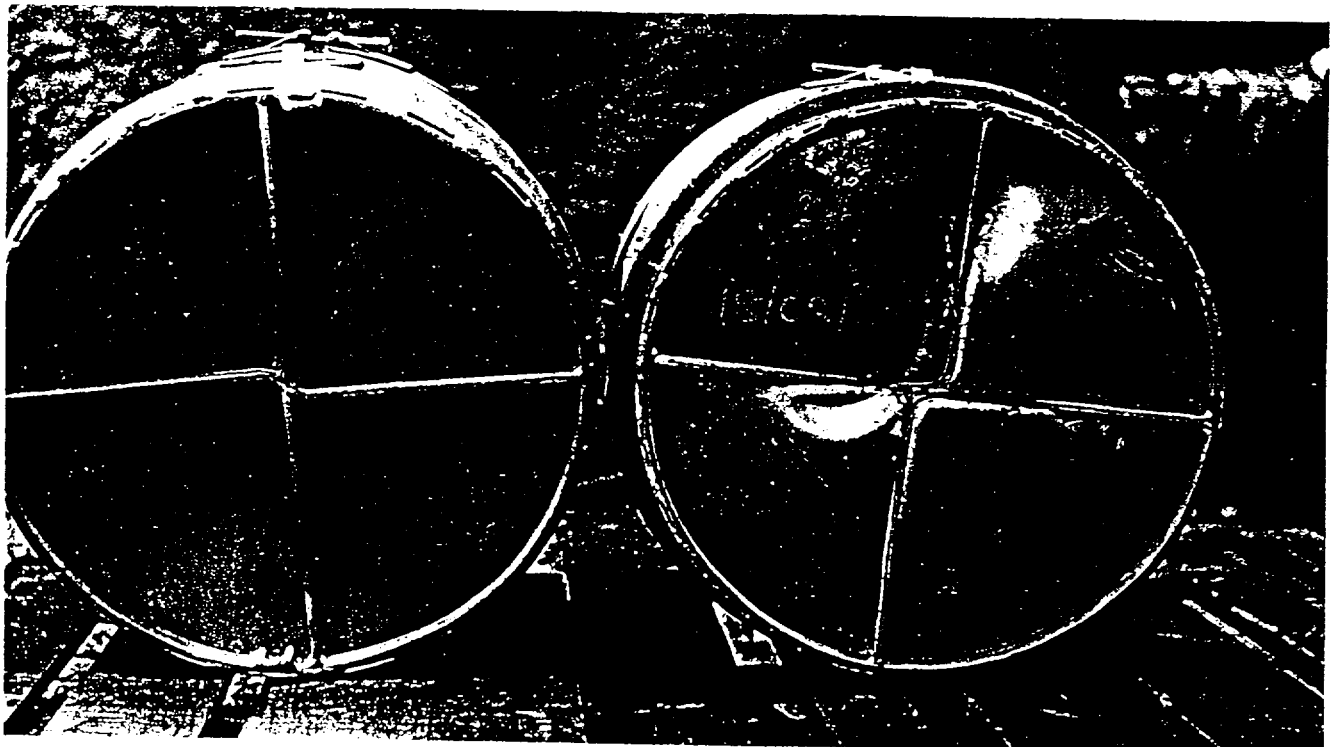


Figure 21
1863/10 - Damage to assembly C compared with undamaged drum

Part D - Thermal test schedule

Date: 17 November 1994

Test site: Warrington Fire Research Centre

Persons present: A R Webster, Department of Transport
S T Winfield, Amersham International
D Williams, WFRG

Test reference 1863 / 11 (Thermal test, assembly A)

<u>Check</u>	<u>Operation</u>	<u>Notes</u>
✓	Position support blocks and ambient thermocouples in the furnace. Ensure that there is a minimum of 150mm clearance underneath the drum at the start of the test	
✓	Organise lifting equipment to allow access for the package through the furnace roof	
✓	Light the furnace burners and allow the furnace to achieve a steady temperature of 820°C	
✓	Open the furnace roof and insert the package. Replace the roof section with the minimum of delay, and start the test timer when the ambient temperature shows a minimum of 800°C	
✓	Observe progress of the test with intermittent video records of the drum state and the ambient thermocouples output. Maintain an ambient of 800 - 820°C	
✓	After a test duration of 30 minutes, remove the package from the furnace and place on the laboratory floor to cool for not less than 18 hours	

Figures 22 - 23 refer

Test commentary

Package lowered into the furnace at 10.27h. The indicated furnace ambient temperature dropped back to about 750°C, recovering to about 860°C within a minute and stabilising between 800°C and 820°C within a further minute. There was copious flaming around the drum for the full 30 minutes. There was no noticeable yield in the handles nor deformation of the drum. Package removed at 10.59h.

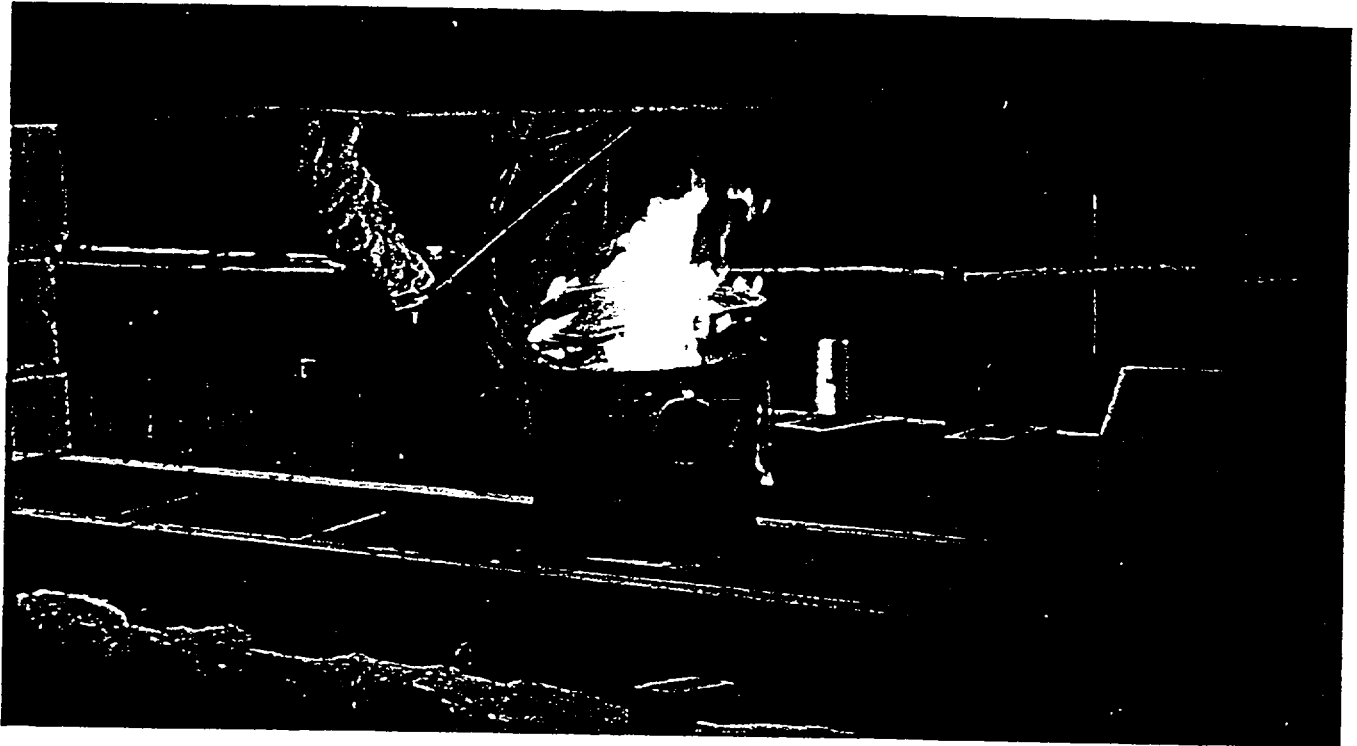


Figure 22
1863/11 - Assembly A - Removal from furnace

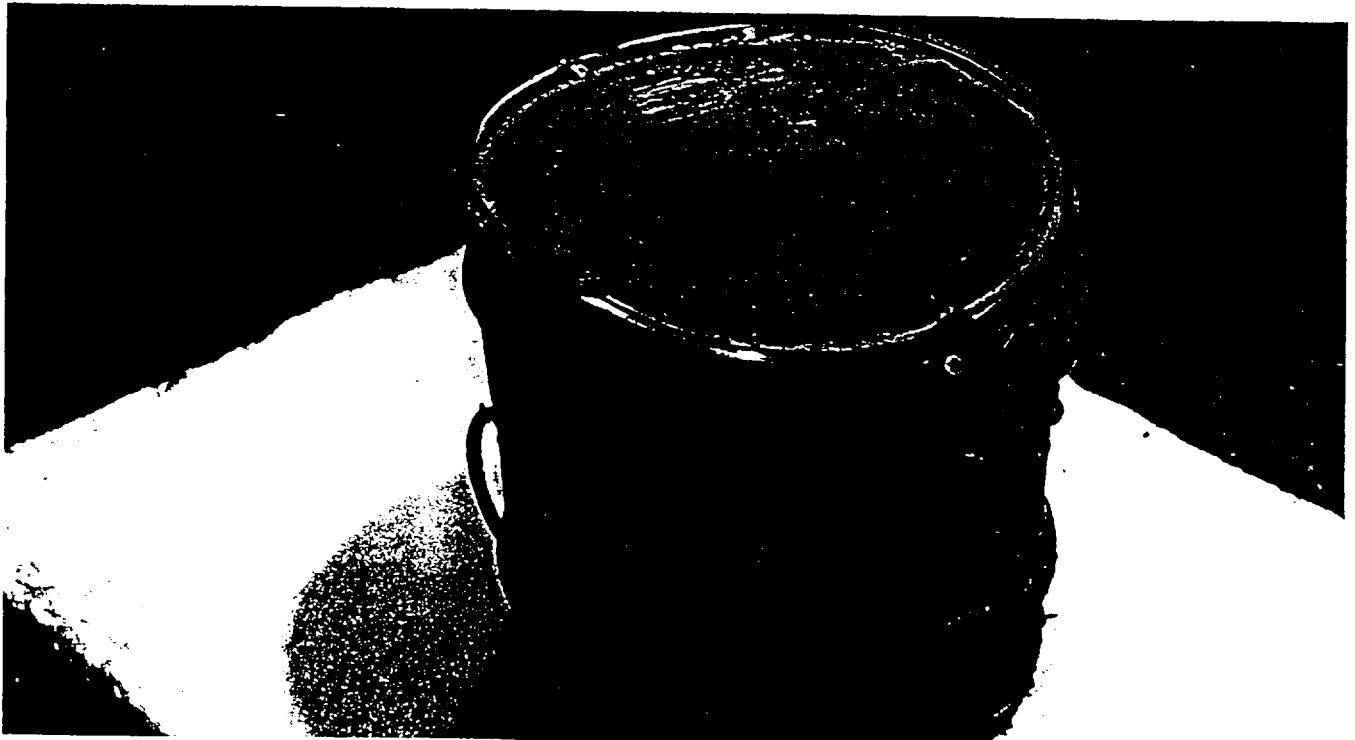


Figure 23
1863/11 - Assembly A - Exterior after thermal test

Test reference 1863 / 12 (Thermal test, assembly C)

<u>Check</u>	<u>Operation</u>	<u>Notes</u>
✓	Position support blocks and ambient thermocouples in the furnace. Ensure that there is a minimum of 150mm clearance underneath the drum at the start of the test	
✓	Organise lifting equipment to allow access for the package through the furnace roof	
✓	Light the furnace burners and allow the furnace to achieve a steady temperature of 820°C	
✓	Open the furnace roof and insert the package. Replace the roof section with the minimum of delay, and start the test timer when the ambient temperature shows a minimum of 800°C	
✓	Observe progress of the test with intermittent video records of the drum state and the ambient thermocouples output. Maintain an ambient of 800 - 820°C	
✓	After a test duration of 30 minutes, remove the package from the furnace and place on the laboratory floor to cool for not less than 18 hours	

Figures 24 - 25 refer

Test commentary

Package lowered into the furnace at 11.10h. Following a drop to about 750°C, the ambient temperature regained specification in 3 minutes. At 11.21h the lid appeared to have bowed up and the lower rolling ring had flattened - ie the drum had stretched down by more than 25mm. At 11.29h it became evident that extra damage was occurring to the under-side of the drum - at least one of the base sheet segments appeared to be bowing downwards. The drum was lifted out at 11.43h when it could be seen that all four base segments had distorted down by 50 - 75mm. The drum was laid on its side to cool to minimise any change in the resultant damage and to allow free air flow to the smouldering cork. The cork visible at the base was still glowing brightly at 12.00, finally extinguishing at about 12.07h.



Figure 24
1863/12 - Assembly C - Removal from furnace

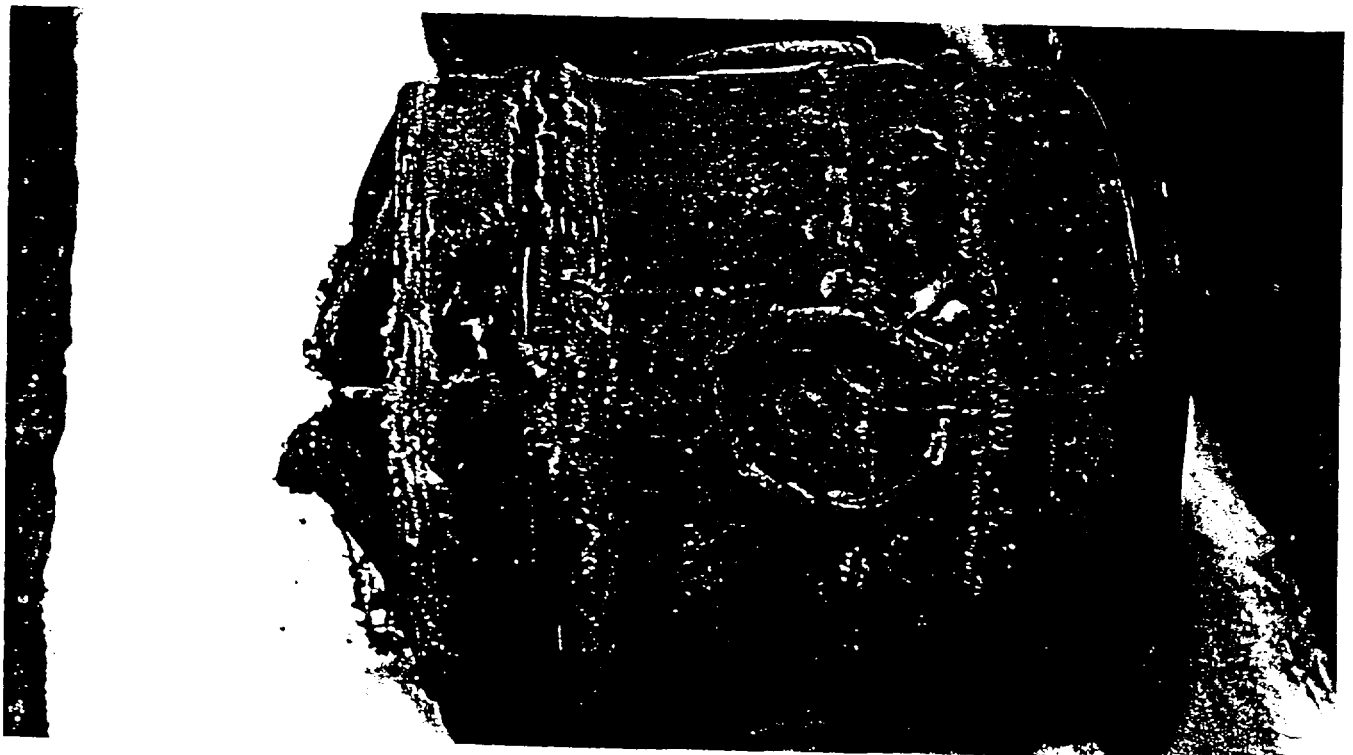


Figure 25
1863/12 - Assembly C - Exterior after thermal test

Approvals

Test Quality Plan comprises Parts A and B and the 'Operation' column of Parts C and D

Quality Plan prepared by S T Winfield, Packaging Design Group

Quality Plan agreed at issue 1 draft 2 by A R Webster, Department of Transport

Part E - Dismantling and discussion

1. Assembly B (3619/28) was shipped to Colston Manufacturing to carry out post-test leak detection. The inner pot, 3668/01, was seen to be substantially undamaged (see figure 37). It was leak tested by helium mass spectrometer connected to the O ring interspace. The cavity contained helium injected for the pre-delivery leak test at manufacture and the outer rim of the closure plate was sprayed with helium. A leak rate of 1×10^{-6} mbar.l/s was detected (compared with 2×10^{-7} mbar.l/s before drop test).
2. Figure 26 shows the furnace test on assembly C in progress
3. Figures 27 - 30 show assemblies A and B in direct comparison. It may be seen that the damage to the two assemblies was very similar in all respects. It is therefore concluded that the performance of these assemblies would also be similar had assembly B been subjected to the thermal test.
3. The base of assembly A (3619/29) had bowed down by about 12mm, both base sheet and reinforcement bars being bent. The closure bolt unscrewed without undue effort, allowing the clamp and the drum lid to be prised off. The char at the centre top of the liner measured 25mm deep. The cork lid was levered off as a single piece. The current pot temperature (23 hours after removal from the furnace) was 35°C. The steel cover plate was unbolted and the sensor strips on the under-side examined for the maximum temperature indication (figure 36) - two strips indicated a temperature in excess of 99°C but less than 104°C. The O ring was visually undamaged despite significant quantities of resin condensate and smoke deposition. The lead pot was undamaged. The base of the cork cavity contained about 20 - 50ml of liquid, presumably resin condensate. The cork cavity was generally undamaged, except for a recess at the base of about 2mm deep across the diameter of the lead pot base.
4. The lid of assembly C (3619/24) showed doming some 20mm high across the whole diameter. The maximum distortion at the drum base (to the inner corners of the four sheet segments) was 75mm. The overall height of the drum body (above clamp to base reinforcement rim) was 500 - 515mm (about 470mm before thermal test). The sheet segments had moved to about 40mm below the centre of the reinforcement bars (15mm before thermal test). The closure bolt unscrewed without undue effort, allowing the clamp and the drum lid to be prised off. The char at the centre top of the liner measured 22mm deep and showed a flatter form than assembly A. The cork lid was levered off as a single piece, but with difficulty, showing the lower level of damage to this component. The current

pot temperature (23 hours after removal from the furnace) was 25°C. The steel cover plate was unbolted and the sensor strips on the under-side examined for the maximum temperature indication (figure 44) - two strips indicated a temperature in excess of 54°C but less than 60°C. The O ring was visually undamaged. The lead pot showed trivial bruising to the under-side. The base of the cork liner had broken away from the sides, leaving a gap of about 40mm. Within this gap, the cork had granulated, but showed smoke damage only with no charring. The centre base of the cork cavity showed permanent deformation of about 10mm. • There was generally less smoke and resin damage, the temperature strips, cover plate and O ring being noticeably cleaner than assembly A.

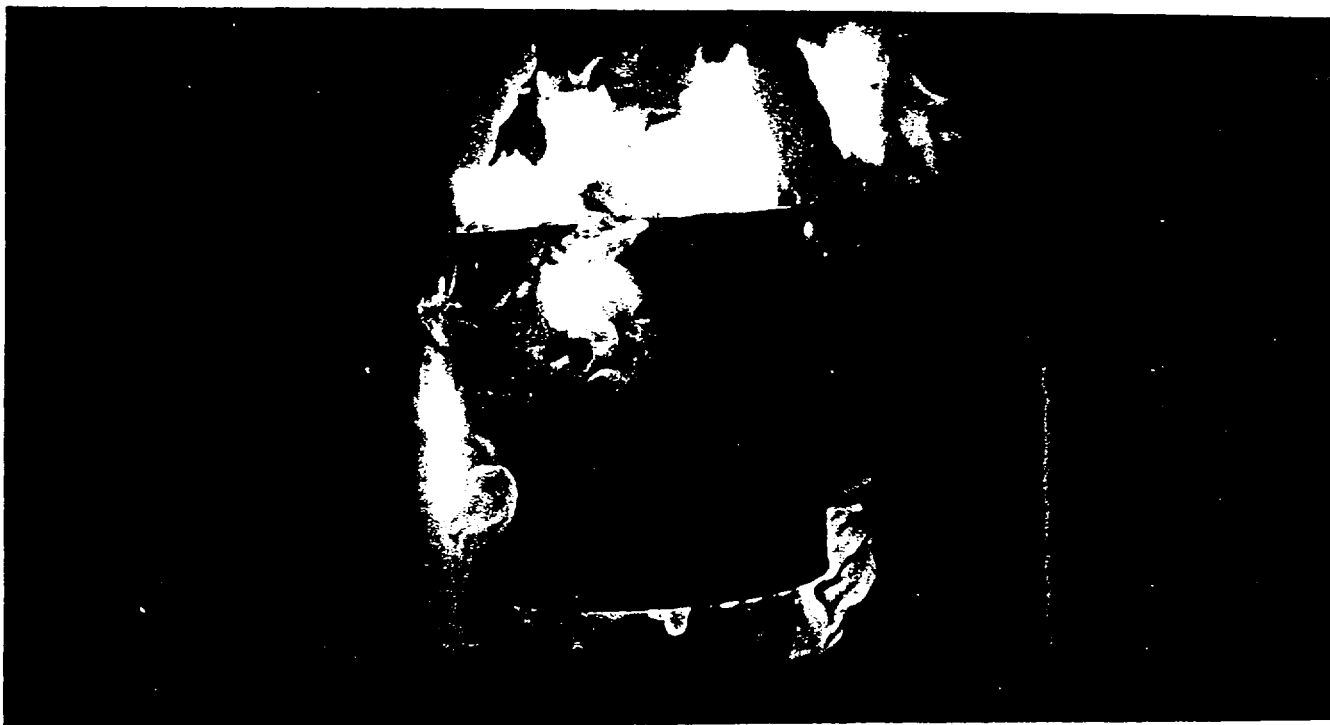


Figure 26
Assembly C - furnace test in progress

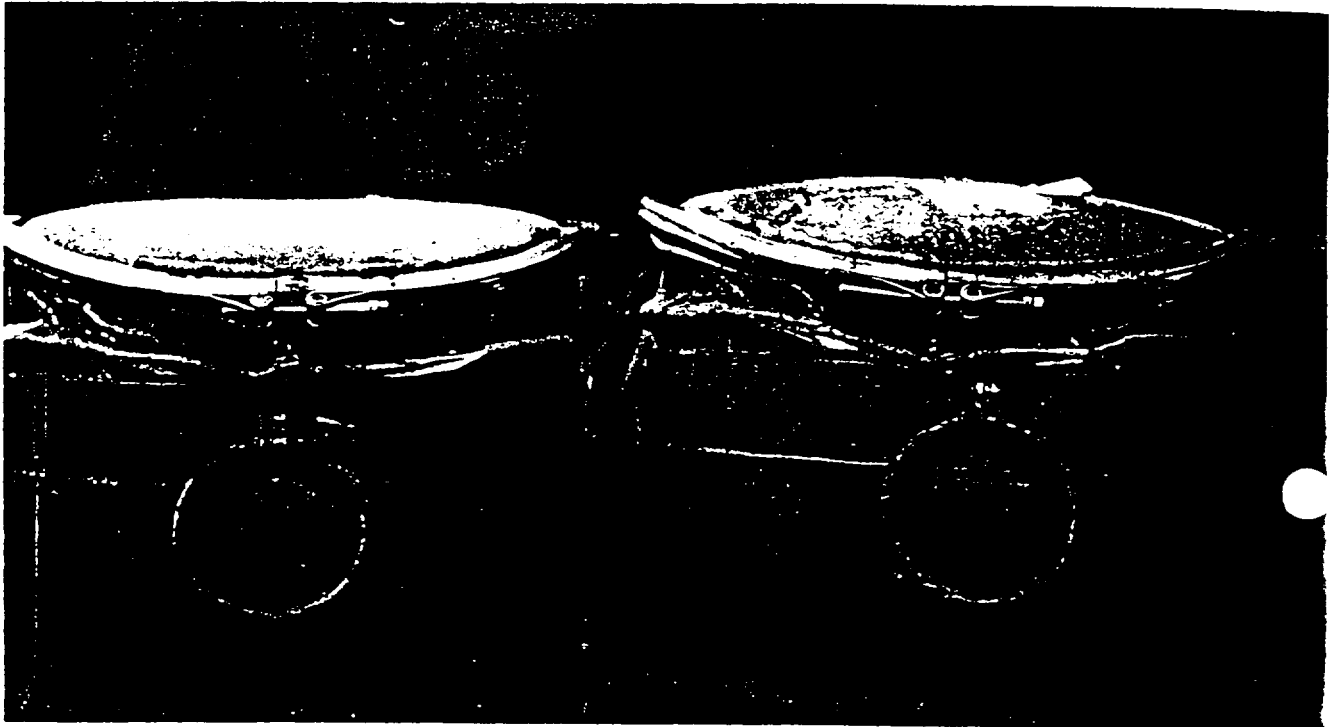


Figure 27
Assemblies A and B - front comparison

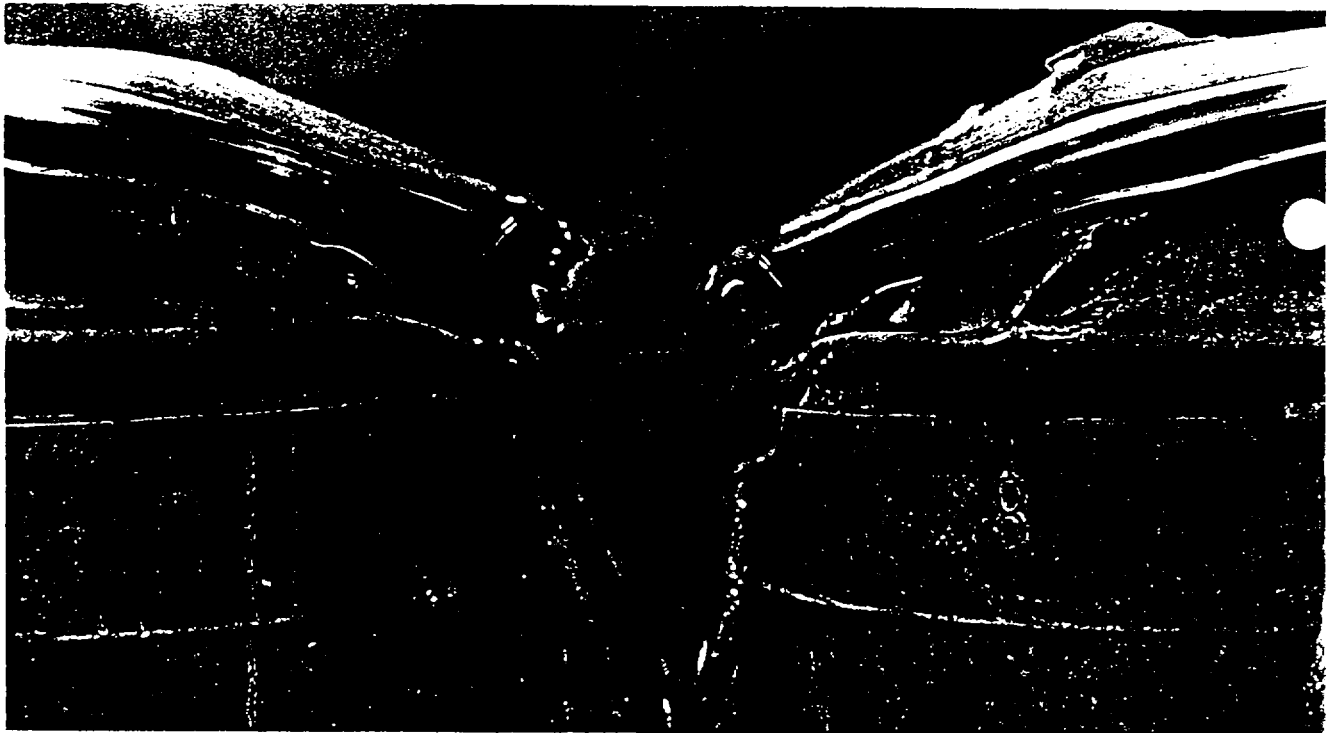


Figure 28
Assemblies A and B - side comparison

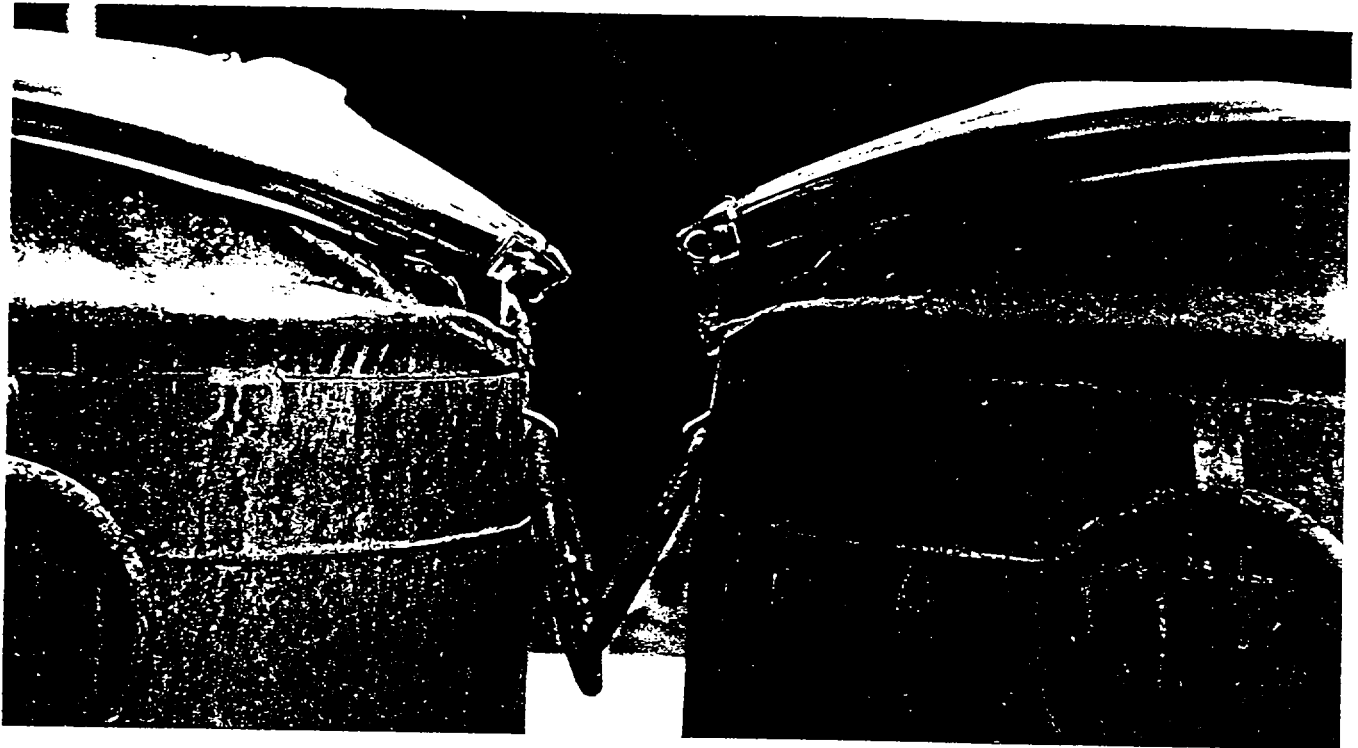


Figure 29
Assemblies A and B - side comparison

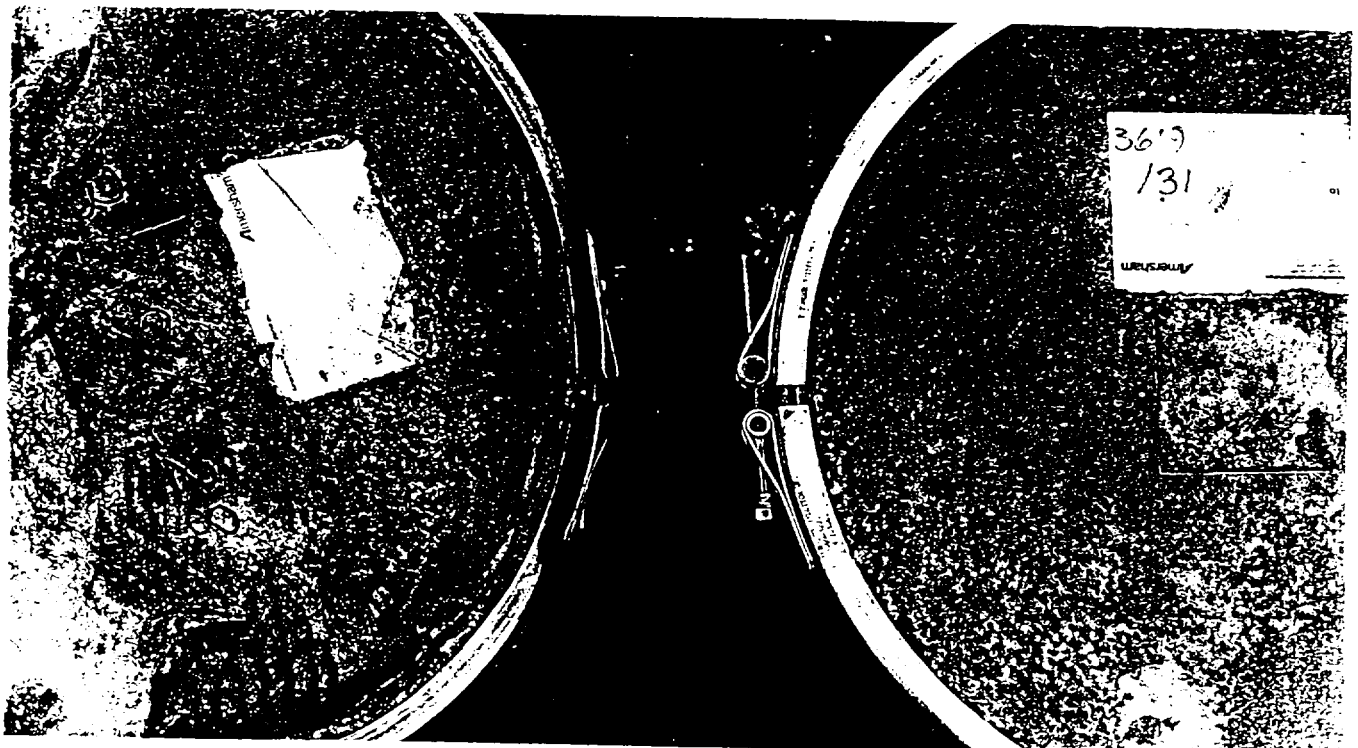


Figure 30
Assemblies A and B - top comparison

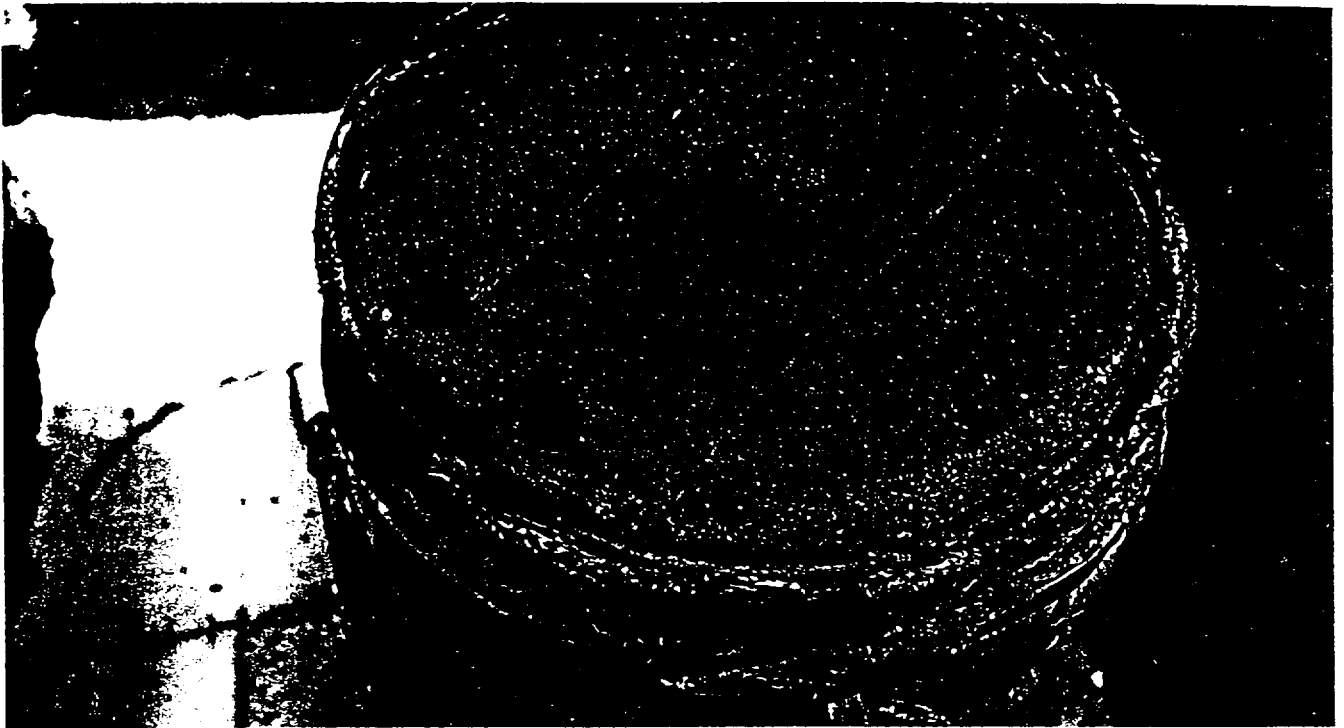


Figure 31
Assembly A - drum lid off



Figure 32
Assembly A - cork cover removed

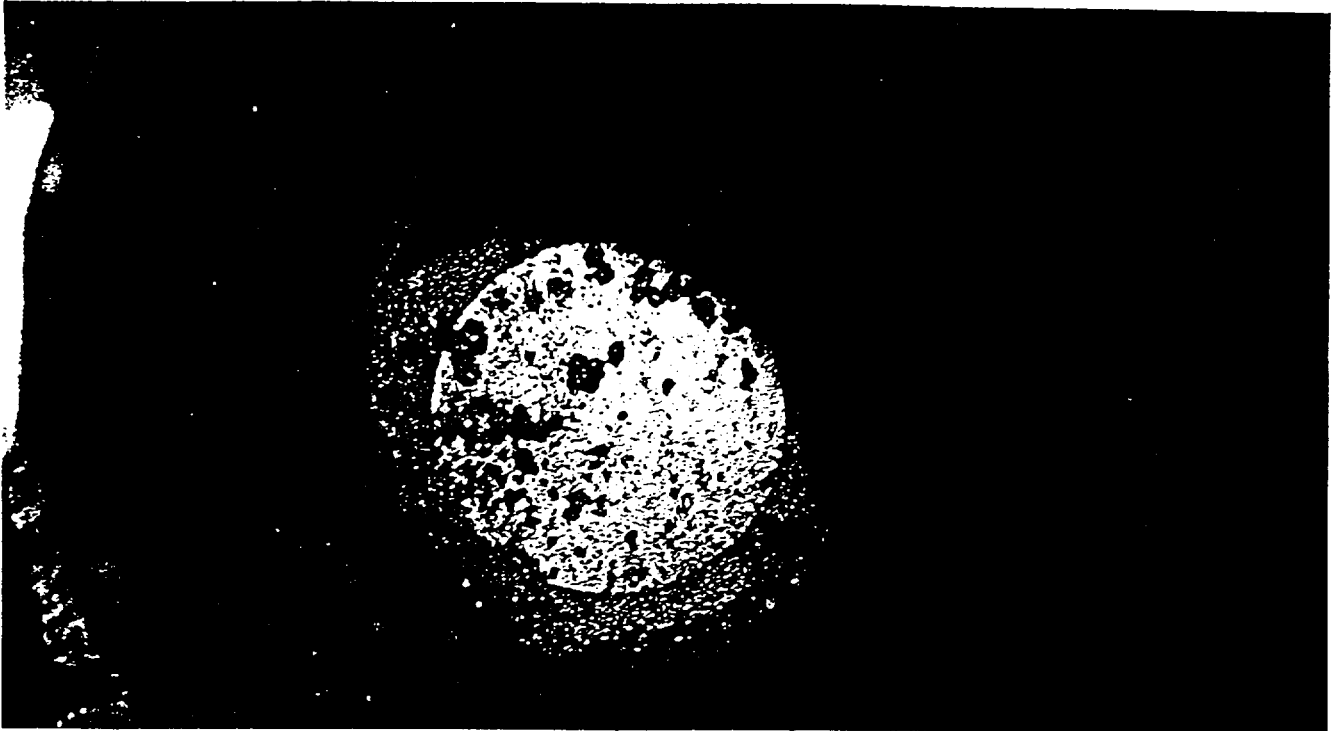


Figure 33
Assembly A - cork cavity, pot removed



Figure 34
Assembly A - components after test

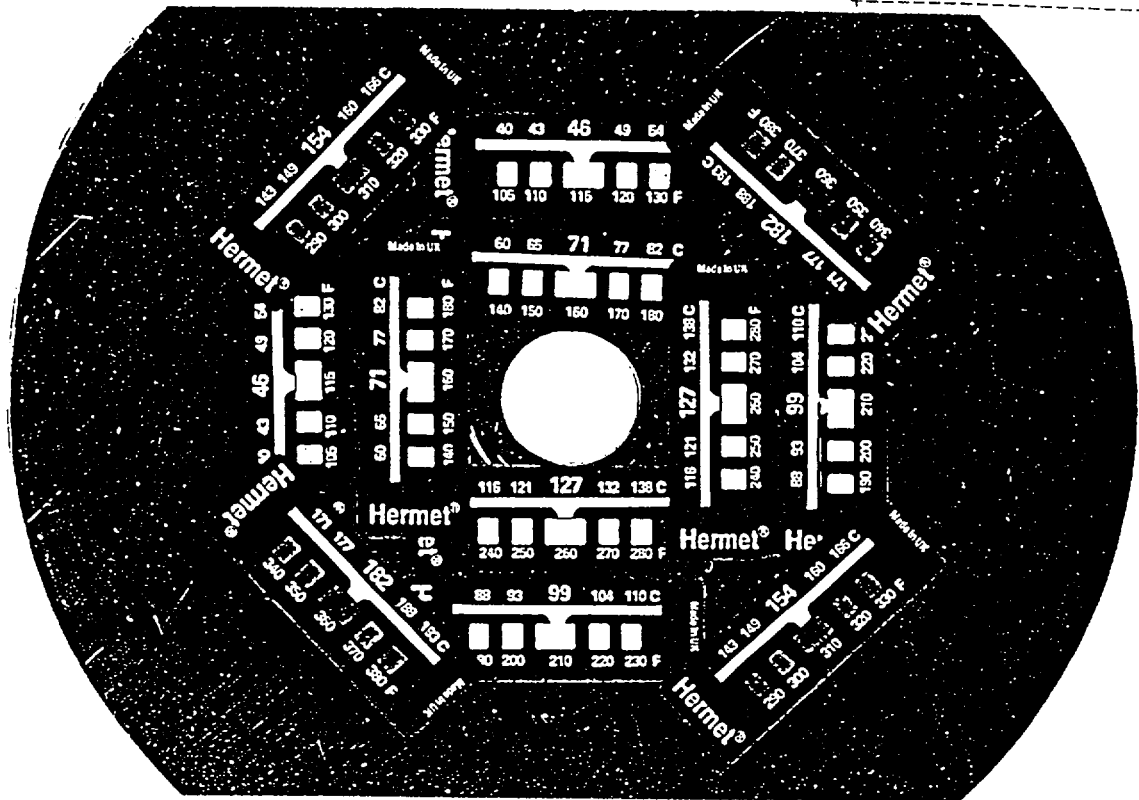


Figure 35
Assembly A - temperature strips before test (reduced)

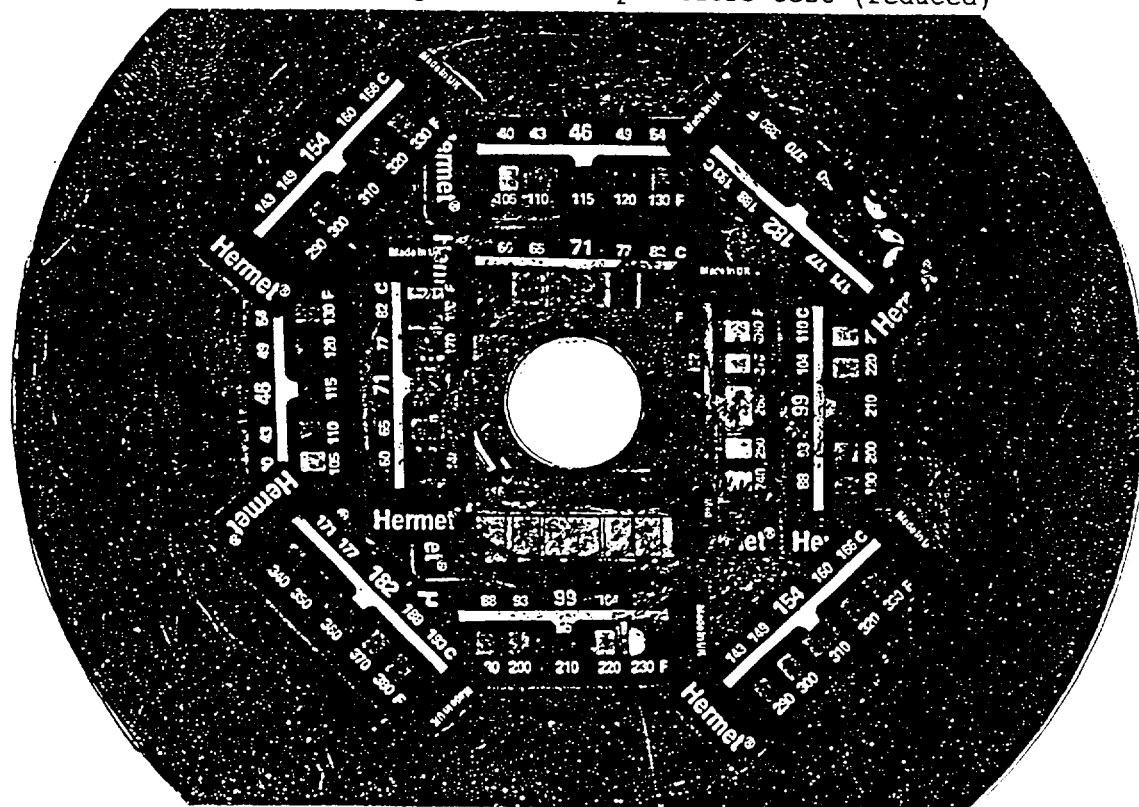


Figure 36
Assembly A - temperature strips after test (reduced)



Figure 37
Assembly C - damaged base, 15 minutes after removal from furnace

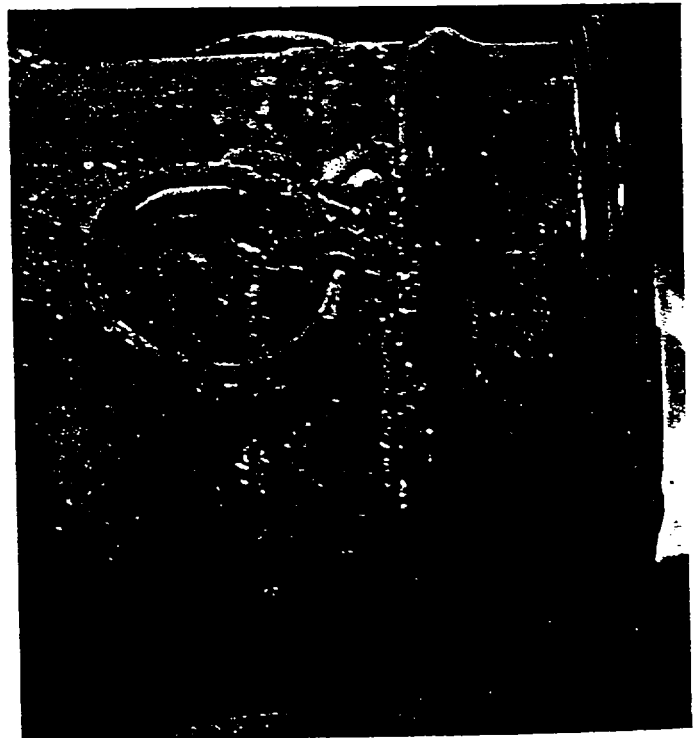


Figure 38
Assembly C - base and lid damage



Figure 39
Assembly C - drum lid removed

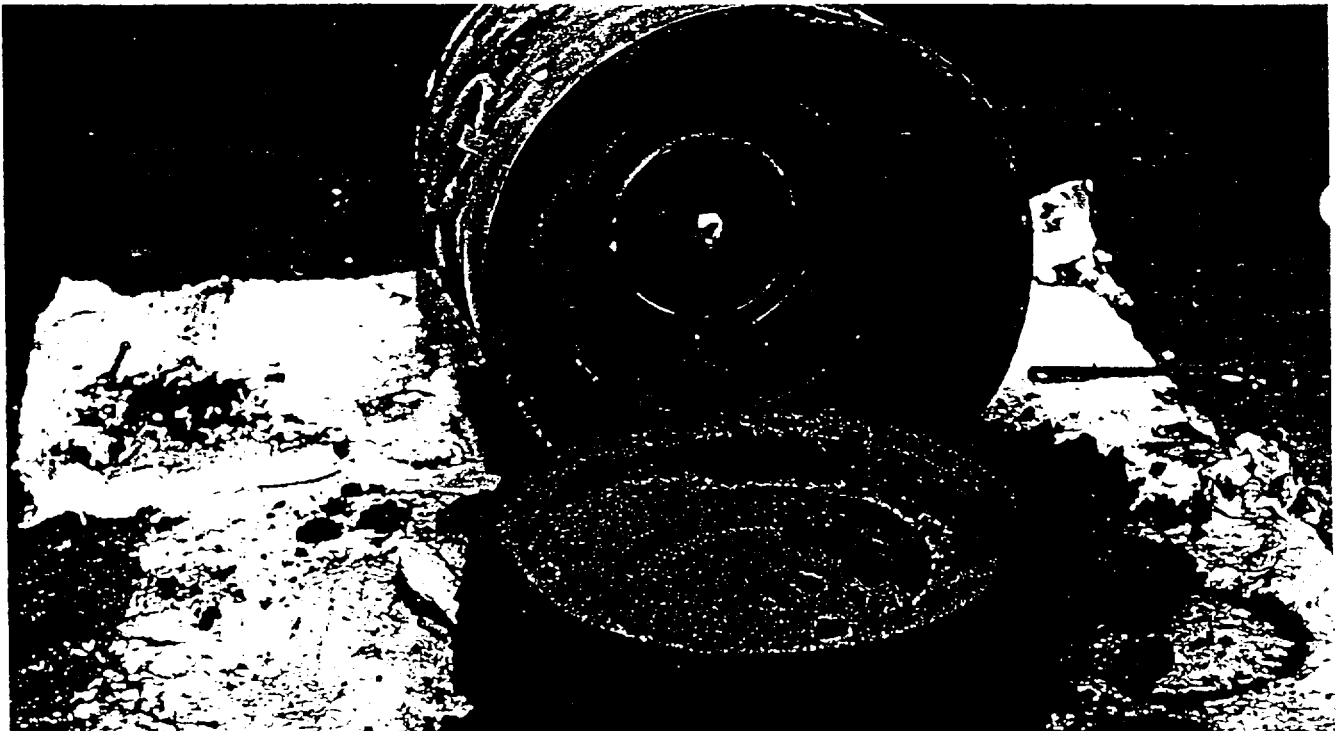


Figure 40
Assembly C - cork cover removed

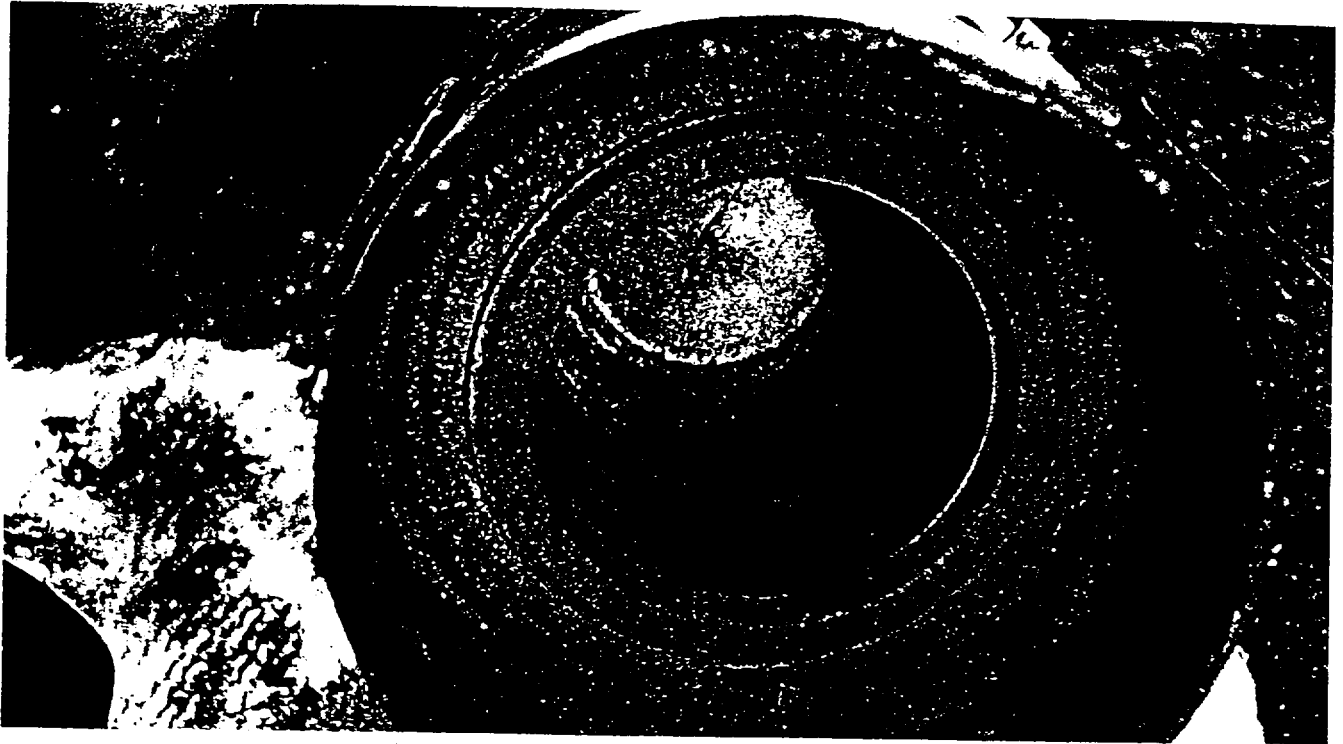


Figure 41
Assembly C - cork cavity, pot removed



Figure 42
Assembly C - components after testing

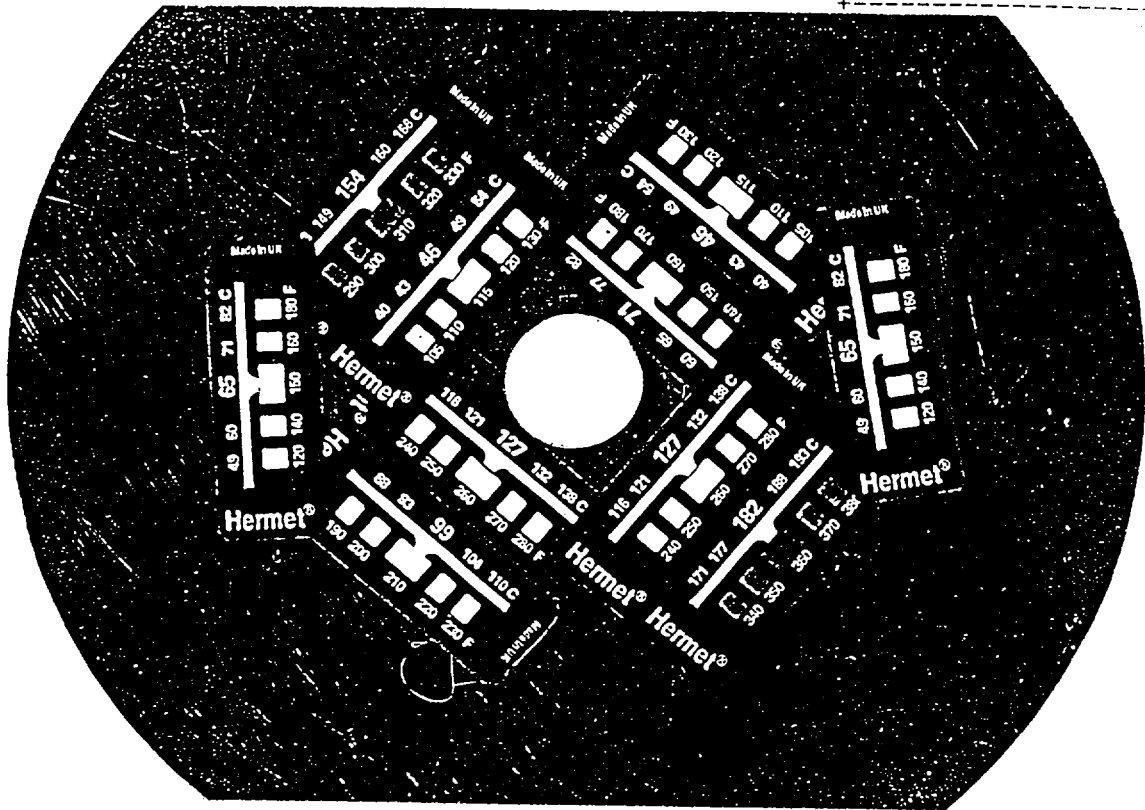


Figure 43
Assembly C - temperature strips before test (reduced)

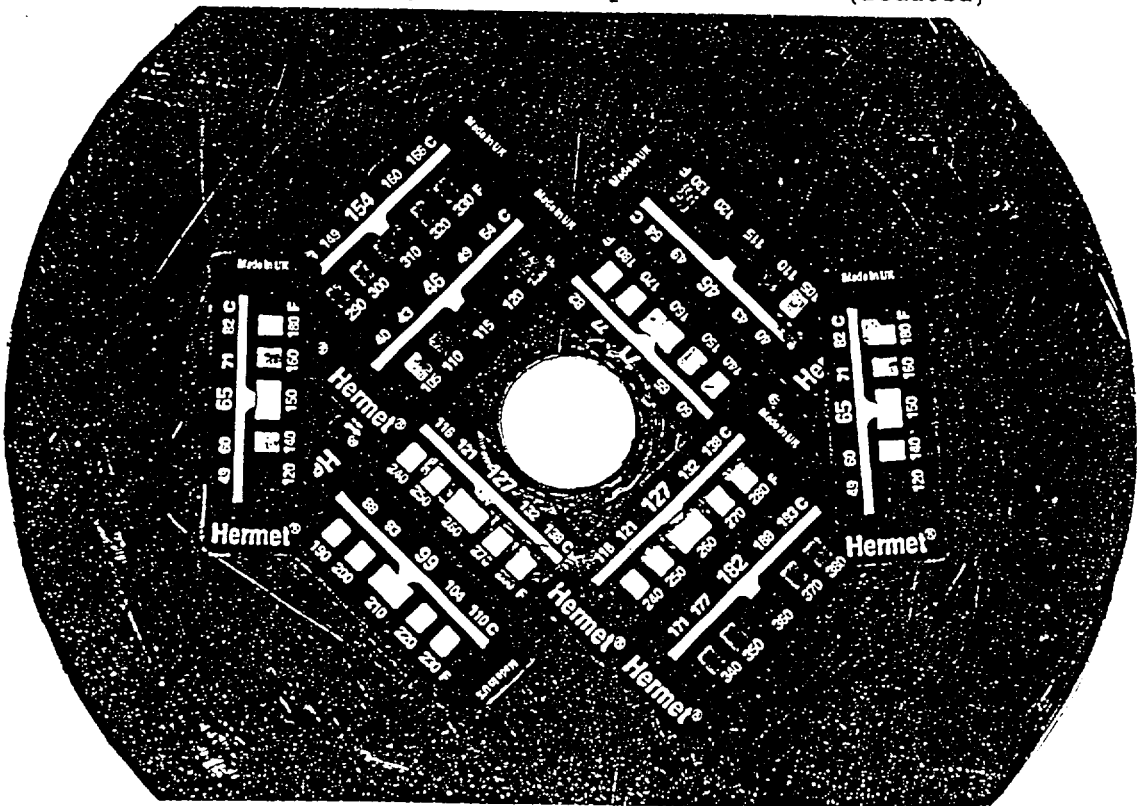


Figure 44
Assembly C - temperature strips after test (reduced)

ILLUSTRATION OMITTED.

Figure 45
Assembly B - 3668/01 pot after mechanical testing

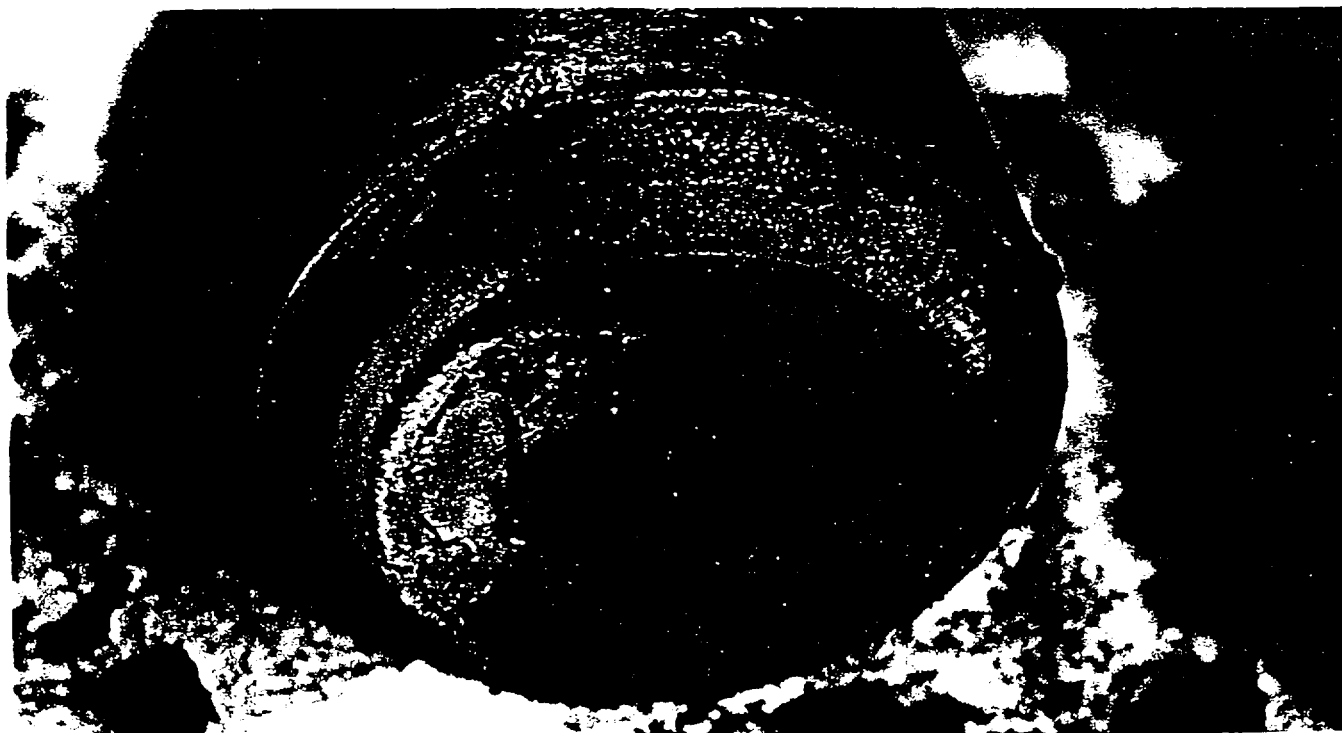


Figure 46
Assembly C - dummy inner pot after all testing

Part F - Conclusions

F1 Assemblies A, B and C have been shown to comply with the pass/fail criteria of paragraph B8:

All lids remained securely attached to the drum bodies

The outer surface of the drums remained functionally intact

Damage to the 3619C and the dummy, assembly A, was nearly identical

The pot in assembly B was shown to be leak tight to 10^{-6} mbar.l/s

Assemblies A and C remained essentially intact

The inner pot of assembly A showed a maximum temperature of less than 104°C and that of assembly C showed less than 60°C

F2 Package design number 3619C has been shown to comply with the requirements of IAEA Safety Series 6 in regard to the mechanical testing, comprising a 1.2m free drop test (paragraph 622), Drop I (paragraph 627 (a)) and Drop II (paragraph 627 (b)) and thermal testing (paragraph 628)

Tests supervised by S T Winfield

S T Winfield
24 November 1994

Witnessed by A R Webster

AMERSHAM INTERNATIONAL plc

PACKAGING DESIGN GROUP

Stacking test on drum design number 0924

1 Introduction

In order to establish its stacking capacity in excess of the 750kg reported in IPM184, an 0924 drum containing two P489 cork packing pieces, has been subjected to a controlled stacking load for 24 hours.

2 Specification of test assembly

Drum serial number 0924/1661 was taken from production stock.
Cork packing pieces P489 batch number

Lloyds British load link number 1951, plant number LCW0943, calibrated 17 March 1995 to be better than 0.5% in error in the range 0 - 2.0 tonne.

3 Test specification

IAEA Safety Series 6 paragraph 623 - Stacking test

4 Test description

The height of the drum from the base rim to the top of the clamp band was checked in several positions. The drum was placed on a firm concrete area and 15mm plywood board placed on top. A 3280A container was weighed to confirm the stacking load to be applied. The 3280A on a wooden pallet was placed centrally on top of the drum and safety barriers set up. 24 hours later, the 3280A was removed and the drum drum height was rechecked.

5 Results

The measured height of the drum was unchanged by the test - 492/491mm before and after. No damage was identifiable and the drum was returned to production stock. The 3280A assembly was measured to weigh 1240kg

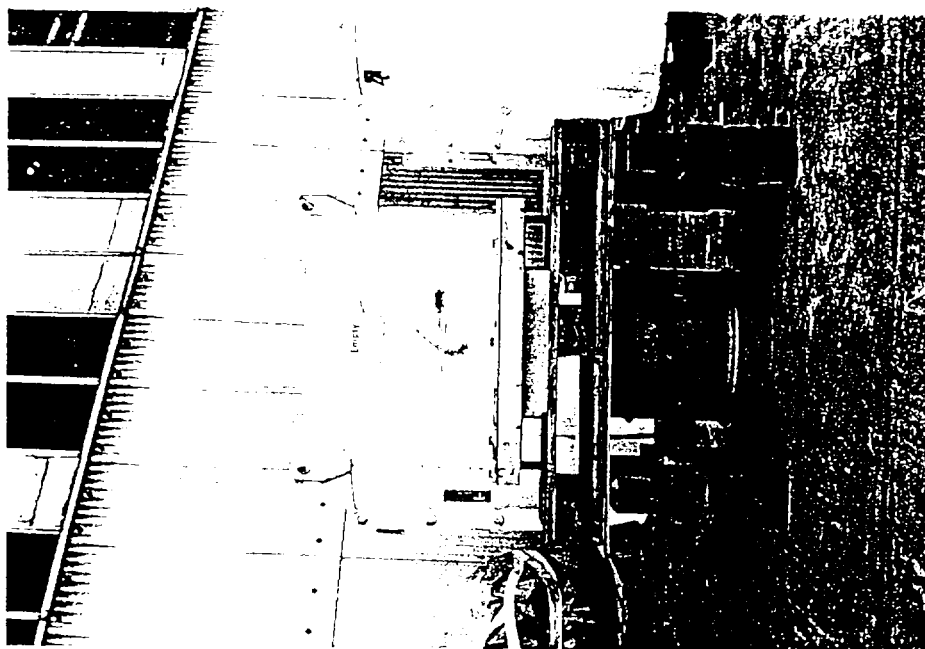


Figure 1 - Load applied at 0900h on 6 July 1995

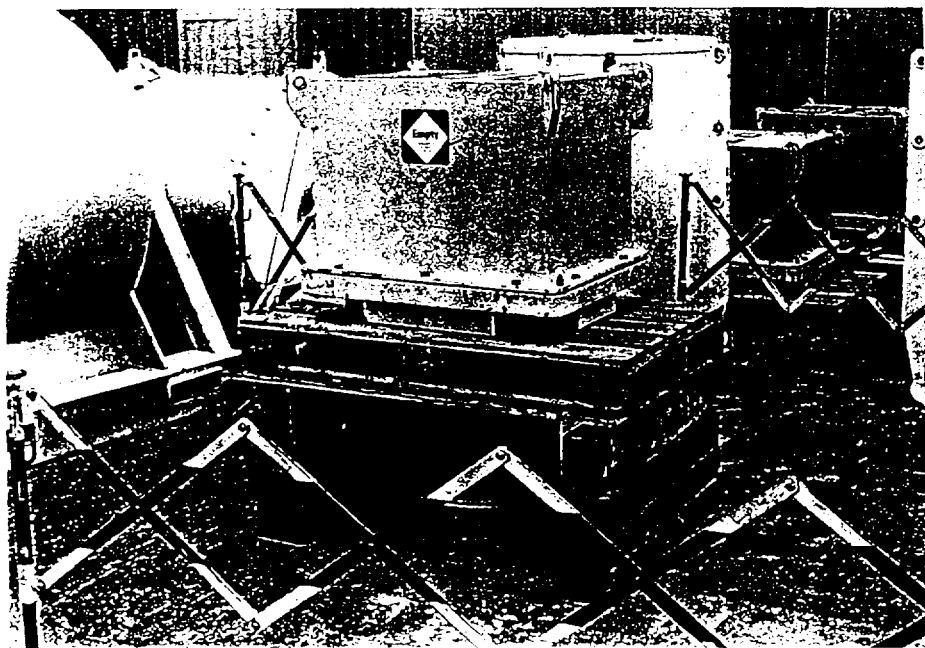
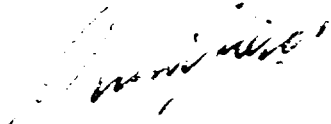


Figure 2 - Load removed at 1000h on 7 July 1995

6 Conclusions


Drum design number 0924 has been demonstrated to perform satisfactorily in the IAEA stacking test at a load of 1240kg. The maximum acceptable package weight, constrained by stacking capacity alone, is therefore in excess of 248kg.

Tested by


7 July 1995

S T Winfield

Witnessed


7 July 1995

G Benning

AMERSHAM INTERNATIONAL plc

PACKAGING DESIGN GROUP

'Dynamic punch test' on 0924 type drum closure

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Introduction

The closure of 0924 and 3619 has been shown to be inadequate without modifications to the clamp band end fittings. These fittings have been proved at 63kg package equivalent weight (Test TCT1872), but need to be proved at 175kg equivalent to include the 3619C package.

Part A: Specification of test assemblies

A1 Design description Drum design number 0924 with cork packing

A2 Design drawings Drum to DL50733 issue C
Cork packing to A22269 issue C

A3 Quality assurance

<u>Item</u>	<u>Drawing</u>	<u>Batch / serial number</u>
Drum body and lid	DL50733 issue C	0924 / 0998
Clamp	A24899 issue C	Aeroquip batch 11144
Cork insert, P489	A22269 issue C	Not marked
Assembly weight		25 kg
Clamp band closure torque		13 kgf.m (10 lbf.ft)

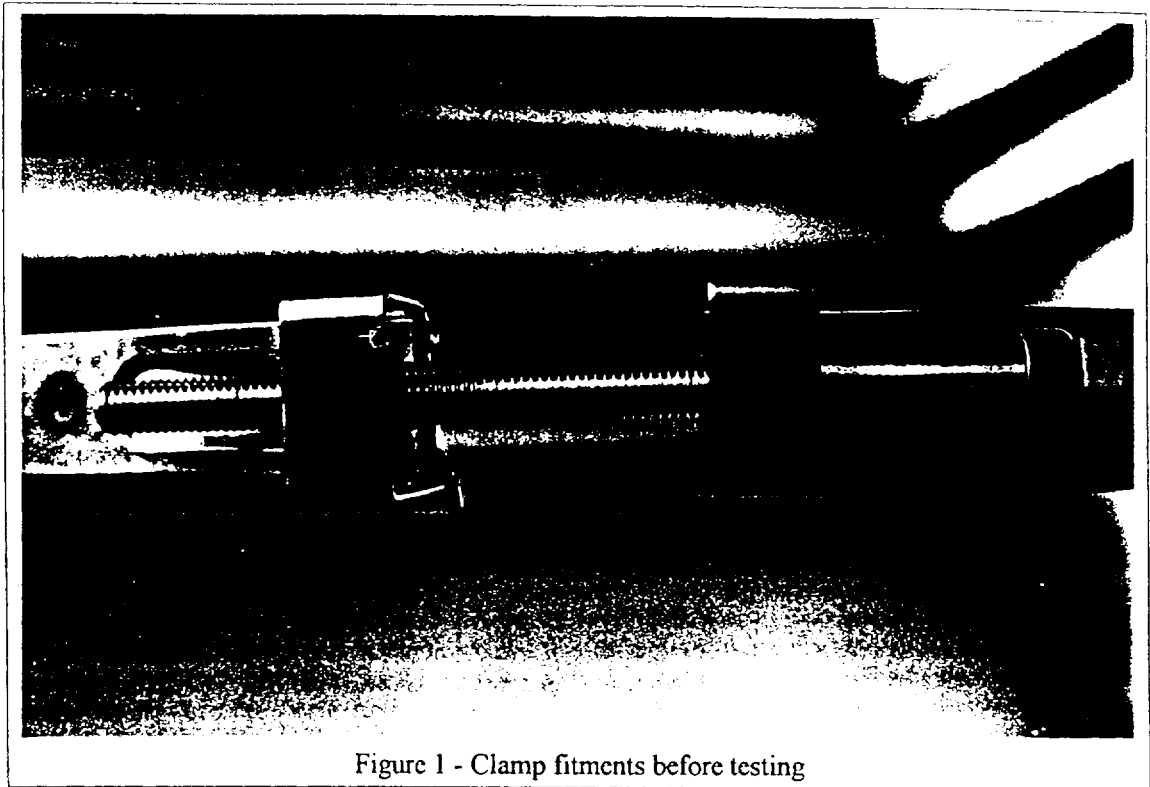
If repeat tests are to be made, the same drum and corks will be used, replacing the clamp band and positioning the closure to be at undamaged sectors of the drum upper rim.

A4 Variations from design specification

The drum and clamp bands were to specification.

A5 Package contents

There were no contents in the cork inserts.



Part B: Tests and test procedures

B1 Regulatory description

IAEA Safety Series 6 paragraph 627b - Drop II (1m punch test) - modified to ensure extreme accuracy of impact position.

B2 Standard procedures

No standard procedure has been written for this test. The following procedure will be followed:

Safety As location of the impact is as important as the orientation in the punch test, it is not practical for the operator to leave the test compound. To ensure his safety and to provide a well controlled access to the release mechanism to ensure impact as planned, he should stand on a suitable strong platform (an 0924 drum is ideal).

Follow PGP15 , excepting paragraphs 4.3 - 4.6:

Position the guide rig so the punch bar hangs freely in the plastic tube.

Support the drum with the bolt uppermost under the punch bar, positioned such that the edge of the punch bar impacts the shroud between the straps of the basic clamp design. The impact position should be vertically above the base rim corner on the target plate to maximise the effect of the impact.

Raise the guide tube to allow access to the release mechanism when the punch is suspended at the specified height and to ensure guidance down to the point of impact.

(This test is to simulate a Safety Series 6 Drop II (1m drop) on a 175kg package (3619C). The punch bar weighs 68kg, so to achieve the same impact energy, a $175 / 68 = 2.57\text{m}$ drop height is required)

Raise the punch bar to give a 2.6m drop.

While taking suitable safety precautions for the release operator, allow the punch bar to fall onto the drum clamp shroud.

B3 Maintenance

No maintenance is to be carried out on the packages between tests.

B4 Inverted punch test facility

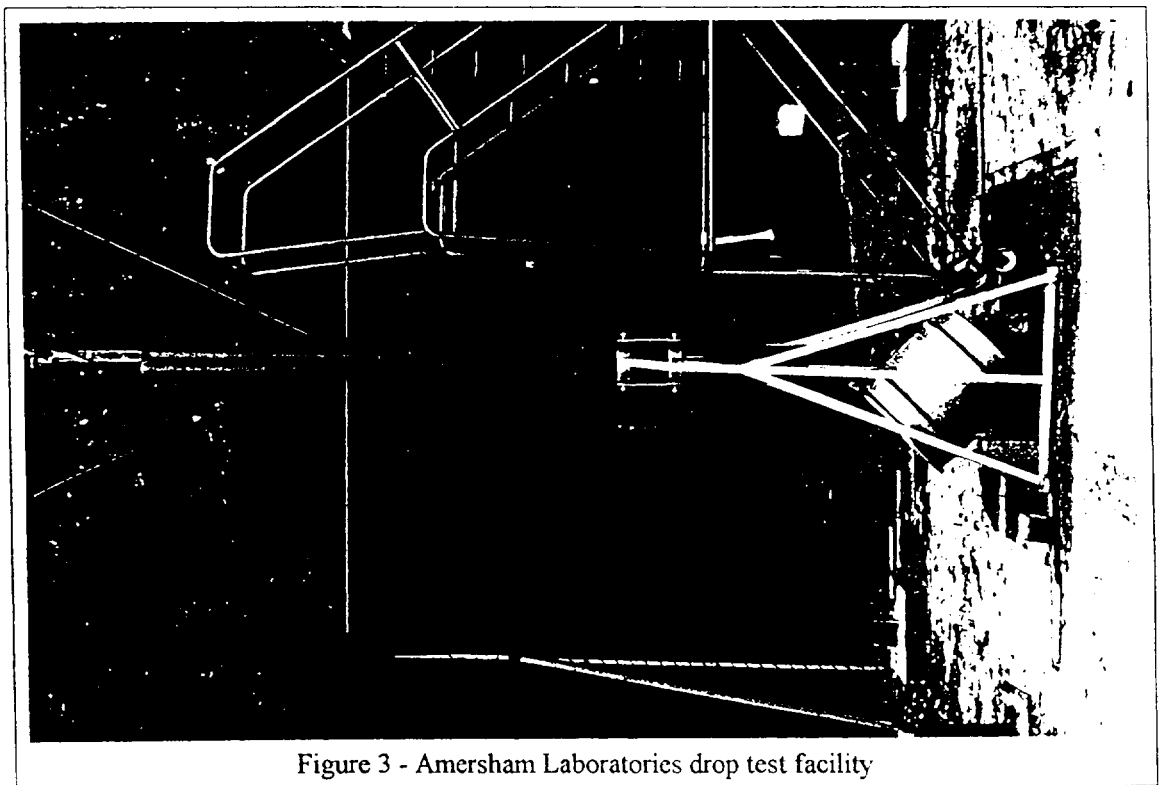


Figure 3 - Amersham Laboratories drop test facility

Drawing A25187 (Target detail, drop test facility) shows the general layout of the target, which has a total weight of 10.1 tonnes. The punch bar is $\phi 148 \times 520\text{mm}$, weighing 68kg (drawing A25070). An aluminium alloy framework (drawing A25071) supports a plastic tube with a $\phi 150\text{mm}$ bore which guides the punch to the intended impact position.

B5 Recording and instrumentation

The tests will be recorded on video tape and by photography. The tape will be available for viewing and will be used for analysing the impact orientations if necessary. Only the photographs will be appended to this report. No instrumentation is to be installed.

B6 Impact attitudes

As described above in B2

B7 Pass / fail criteria

The drum clamp shall not be removable by manual force alone

The drum lid shall be retained on the drum body for at least one half of its circumference

Part C - Test schedule

Date:	18 July 1995
Condition of test equipment	Drop test rig - Good Cameras - Good
Personnel present	A R Webster, Department of Transport S T Winfield, Amersham International B Wheatley, Amersham International C Carrington, Amersham International

Test reference 1887 / 1

Check	Operation	Notes
✓	Position the guide rig to ensure free movement of the punch bar when hanging freely from the hoist	
✓	Lower the punch to be just clear of the test drum when supported on a base corner.	
✓	Position the drum so the edge of the punch aligns with the basic clamp straps under one shroud	
✓	Photo and video record the intended impact position. Leave the video running	
✓	Raise the punch to 2.6m height above the impact position.	
✓	Gently twist the release lever until the punch bar drops. Stop the video record.	As it fell, the upper lifting sling struck the top of the guide tube causing much damage but not affecting the punch impact on the clamp fitment.
✓	Record details of the damage	

Damage report

There was clear evidence of a hard impact on the clamp fitment shroud followed by impact down the side of the drum. It could be seen that the impact on the shroud had dented it into the space between the straps of the basic Acroquip clamp. The shroud remained securely attached to the clamp, which could not be removed by manual force.

Analysis of damage against criteria of B8

Accept		✓
Accept	Continue to second test as planned	
Accept	Continue to second test, revised	
Fail		

Test reference 1887 / 1

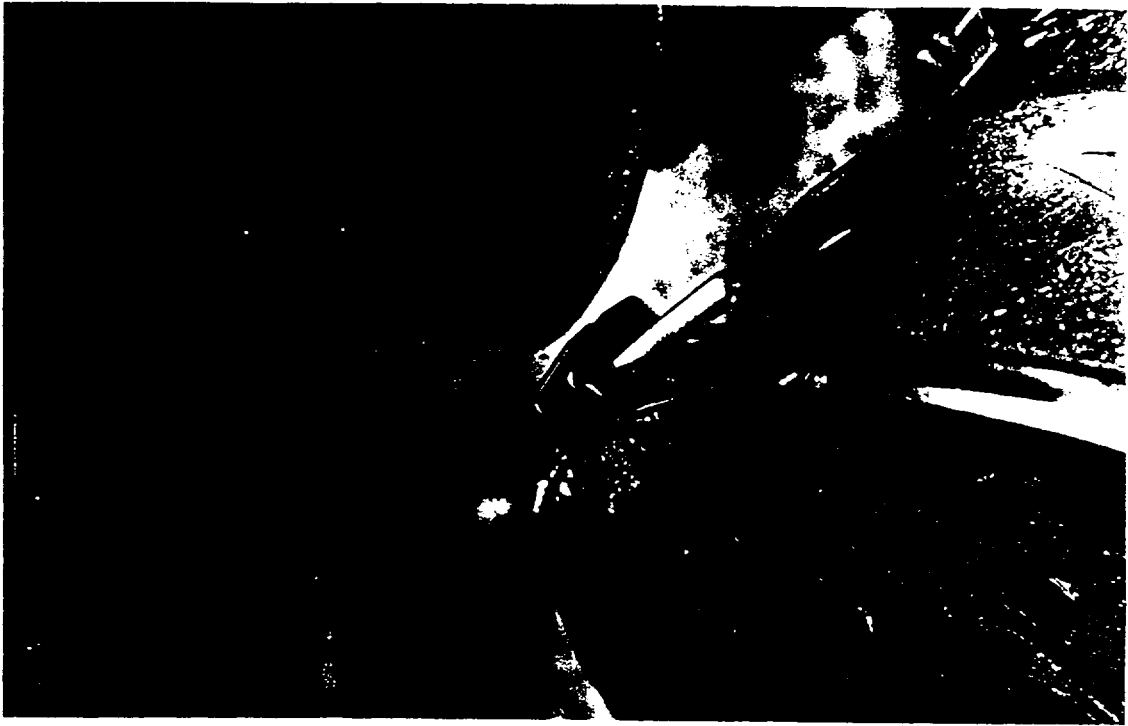


Figure 4 - Pre-test orientation

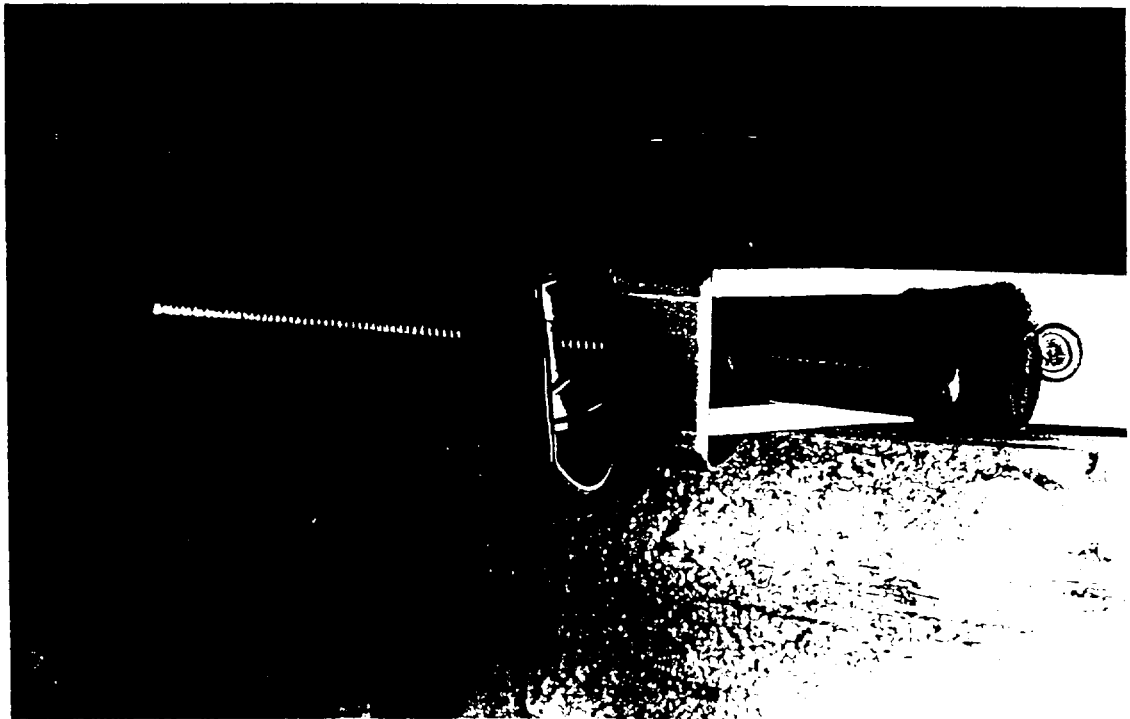


Figure 5 - Detail of damage after test

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Test reference 1887 / 2

Assessment at the time of test may require repeat tests to the above procedure, adjusted to suit the results of test 1887/1

Approvals

The test Quality Plan comprises Parts A and B and the 'Operations' column of Part C

Quality Plan prepared by S T Winfield, Packaging Design Group

Agreed by (Department of Transport) A R Webster (Signed on 18 July)

Part D - Dismantling and discussion

The assembly was not dismantled as the test was to investigate the effectiveness of an external feature. By examination, all present agreed that the shroud modification to the 0924 / 3619 clamp was effective at the higher impact energy of this test.

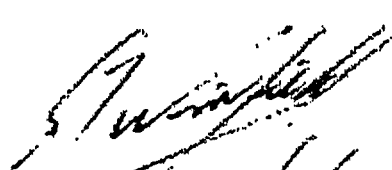
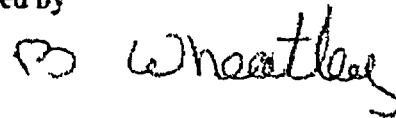
Part E - Conclusions

The clamp fitment shroud was not significantly affected by the impact of the 68kg punch falling from 2.6m, equivalent in energy terms to 175kg falling from 1m, as required by Safety Series 6. It is concluded that with this modification, drums using this clamp are satisfactory at gross weights up to at least 175kg

Test carried out by

Witnessed by

S T Winfield


20 July 1995

Amersham plc

Packaging Design Group

Mechanical testing of package design number 3692B

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Paragraph	Title	Orientation	Page
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9	1.2m free drop	Flat side	16
10	1.2m free drop	Base corner	18
11	Type A testing evaluation		20
12	Drop I - 9m free drop	Flat base	22
13	Drop I - 9m free drop	Flat side	24
14	Drop I - 9m free drop	Lid corner	27
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2. Package Quality Assurance

2.1 Package specification

Package	Design number 3692B	Drawing list	DL28086	issue B
Drum	Design number 3692	Drawing list	DL27504	issue C
Drum clamp	Part number P1500	Drawing	A24899	issue A
Clamp bolt	Part number P1331	Drawing	A24899	issue A
Pot	Design number 3056	Drawing list	DL21773	issue D
Packing insert	Part number P3192	Drawing	A28087	issue A
Cover	Part number P3193	Drawing	A28088	issue A

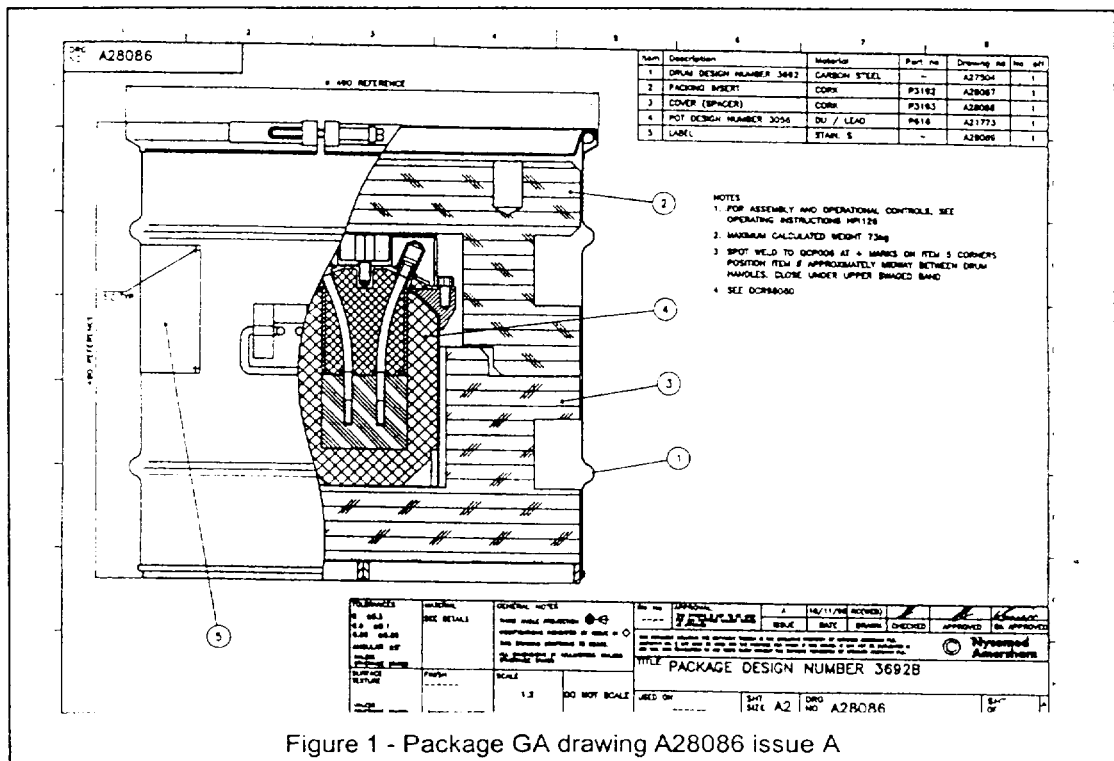


Figure 1 - Package GA drawing A28086 issue A

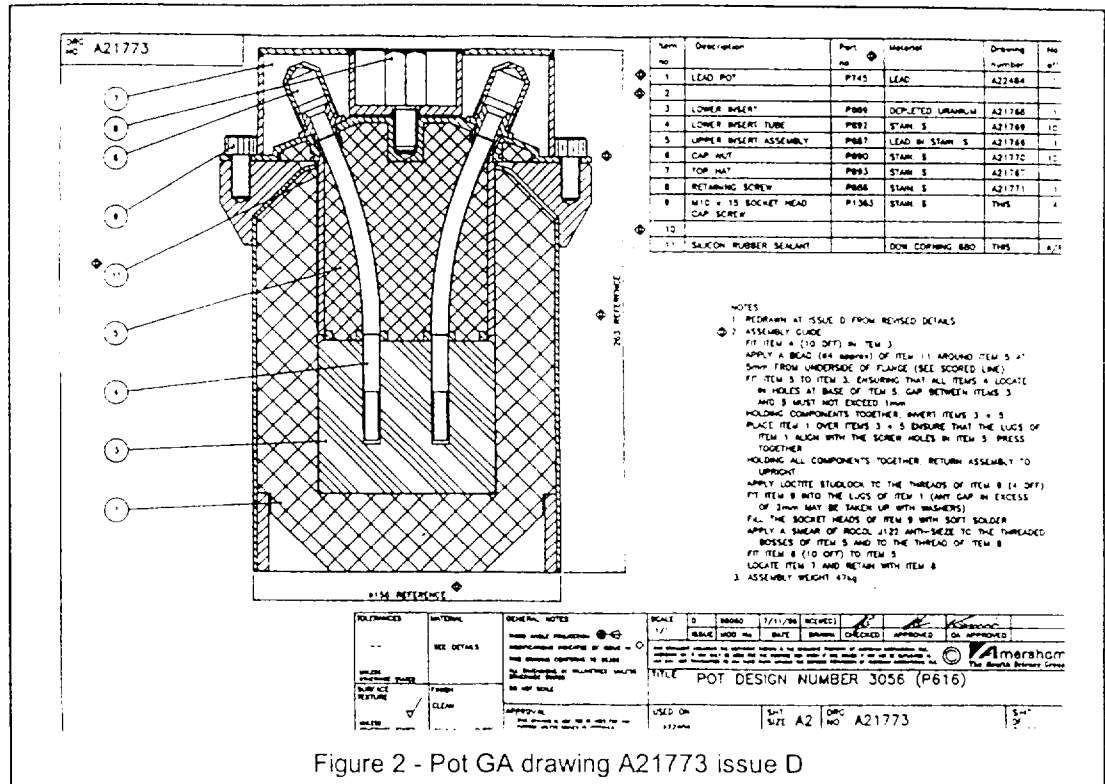


Figure 2 - Pot GA drawing A21773 issue D

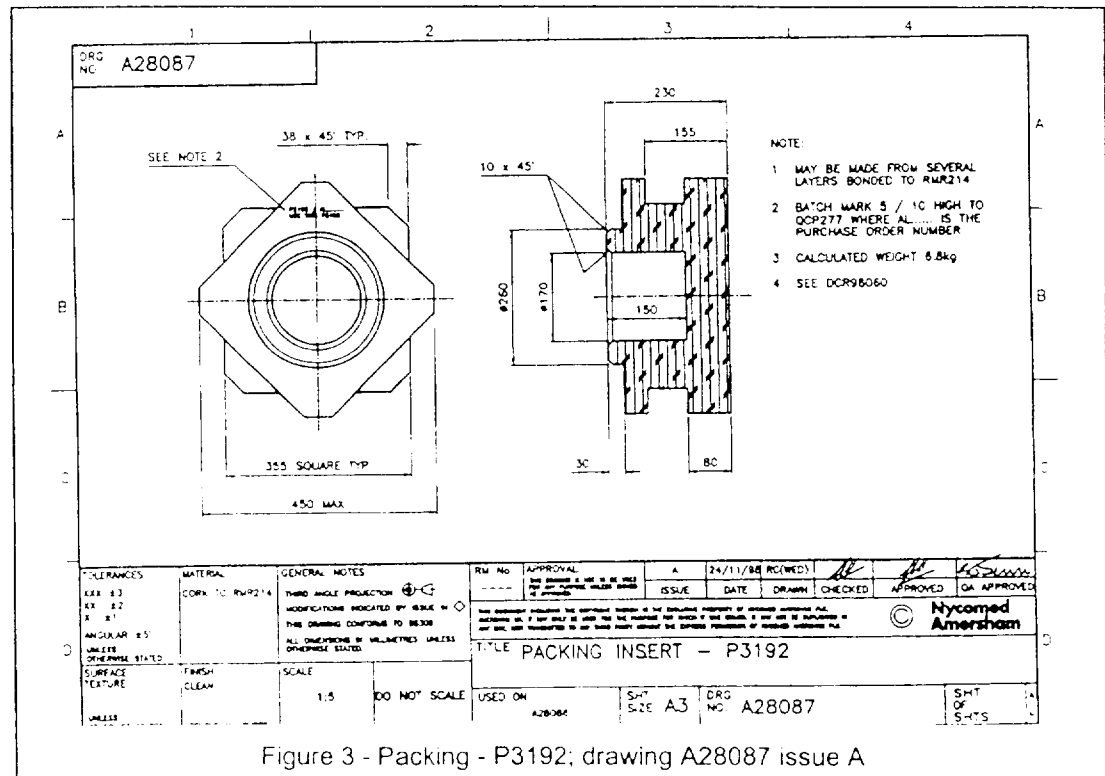


Figure 3 - Packing - P3192; drawing A28087 issue A

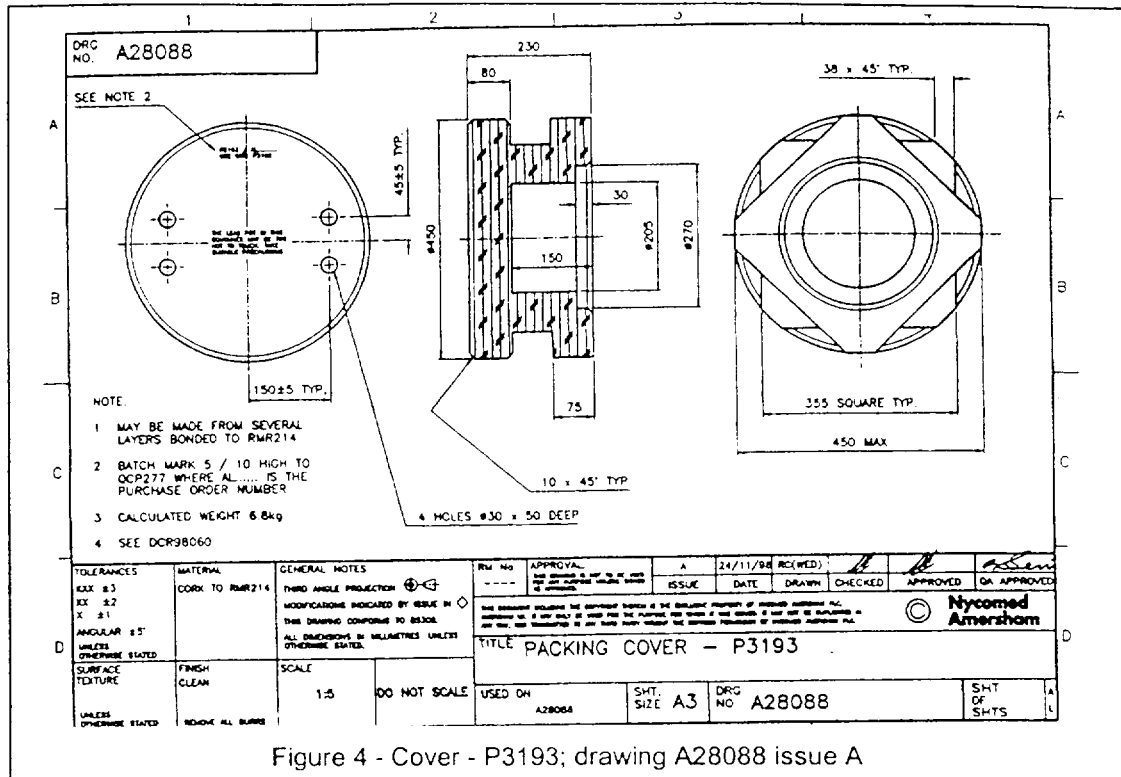








Figure 4 - Cover - P3193; drawing A28088 issue A





2.2 Quality Assurance record

Component	Record	Initials / date
Lead pot	Serial number P745 / 209; GRN L2397	 21.9.01
Drum	Serial number Batch number Lid: 0924 / 945 Body: Batch 6/95; Van Leer 5C95	 21.9.01
Clamp	Batch number L2232 / BN 234770	 21.9.01
Closure bolt	Size / grade (Type A testing) M8x135 (Type B testing) M8x135 Grade A2-70	 21.9.01
Cork	GRN - P3192 (base) GRN - P3193 (cover)	 21.9.01

2.3 Deviations from specification

Deviation from specification	Notes	Initials / date
Pot	None. Lifting links will not lift fully - design of upper insert flange needs revision to enlarge cut-outs	 3.10.01
Drum	No package label	
Cork	No identity or warning markings. Additional chamfers 30×45°×50 wide added to P3192 to accommodate lifting links in the 'down' position.	


3. Test equipment

	Tool number	Calibration date	Initials / date
Hoist	35	1.2.02	 3.10.01
1 m height rod	31	1.2.02	
1.2 m height rod	32	1.2.02	
6 kg penetration bar	28	1.2.03	
Tape	016	1.2.03	 3.9.01
Large callipers	Not used	--	
Digital callipers	502	18.9.03	 3.9.01
Torque wrench	30	30.10.01	
Scales	7741/48028	Jun01 valid to Dec01	 3.9.01

4. Package preparation


4.1 Datum line

Mark a datum line around the drum at 250 mm up from the base rim, measured with a tape. Mark around the datum at 180 mm intervals (45°) with A through to H, where A is approximately central between the handles; C and G under the handles. Fit the drum lid and the clamp band. Using a tape, measure the dimension from the base and from the clamp top edge to the datum at each position. Note that this dimension will not be an accurate measure of this dimension, but provides a repeatable measure which may be used to quantify the distortion of the drum during drop testing; see sections 8, 10, 12 and 14.





Position	A	B	C	D	E	F	G	H	Init/date
Base to datum, mm	250	255	250	248	250	251	244	248	 24.9.01
Top to datum, mm	244	238	243	242	240	237	247	246	

4.2 Drum diameter

Measure the diameter (mm) of the drum at representative positions; estimated accuracy ± 1 mm

Datum position	A - E	B - F	C - G	D - H	Init'l / date
Upper swaged band	486	486	486	486	
Datum	454	455	459	458	
Lower swaged band	484	484	487	485	

4.3 Inner components

Component	Dimension location	Dimension	Init'l / date
Pot Design number 3056	Overall diameter Overall height Across lugs under handles Across other pair of lugs	184 270 180 180	 3.10.01
Cork packing insert P3192	Across corners Overall height Cavity diameter Cavity height	448 / 449 230 170 152	 21.9.01
Cork cover P3193	Overall diameter Across corners Overall height Cavity diameter Cavity height	450 450 231 206 122 (ϕ 206) + 30 (ϕ 269)	 21.9.01
Cork packing insert P3192	Across flats	354 / 354	 21.9.01

4.4 Base reinforcement location




The location of the ends of the drum base outer reinforcements was at / between datum positions:

40 mm clockwise from:	A	C	E	G
-----------------------	---	---	---	---

4.5 Test orientation

Mark the planned impact positions on the drum. PGM1353 describes the justification for the chosen impact orientations.

5. Package assembly

Action	Measure	Photo	Check
1 Confirm shielding insert is secure in the pot body			✓
2 Record pot components; check weight; assemble pot	45.26 kg	Fig 5, 6	
3 Record cork sub-assembly; check weight	P3192 6.34 kg	Fig 7, 8	
	P3193 7.02 kg		
4 Measure inner depth of drum body 455 (centre), 462 mm (max)	460 mm		
5 Measure depth of P3192 cavity base below drum rim	375 mm		
6 Measure depth of upper face of P3193 below drum rim	21 mm		
7 Check weight of empty drum (body, lid, clamp band) Lid 1.58 kg; body 9.62 kg; clamp 1.10 kg	12.30 kg		
8 Record package components (cork insert, pot ass'y, cork spacer, drum lid, clamp band)		Fig 9, 10	
8a Assemble package; arrange sides of lower segment of P3192 in line with drum handles; arrange lower segment of P3193 at 45° to upper segment of P3192; align pot lugs with datum A-E; position clamp closure above datum A			 3.10.01
8b Corners of P3192 aligned with base cruciform; sides of lower segment of P3193 aligned with sides of upper segment of P3192			 3.10.01
9 Torque clamp bolt to 1.5 ± 0.1 kgf.m	120 lbf.in		
9a It is noted that this value is incorrect. The clamp specifies 120 lbf.in which equates to 1.38 kgf.m or 13.6 N.m			 3.10.01
10 Measure package; overall diameter	488 mm		
overall height	488 mm		
11 Total package weight	70.9 kg		

Section 5 - Illustrations

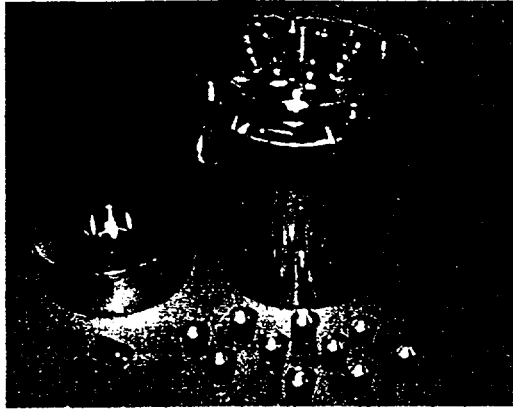


Figure 5 - Pot components

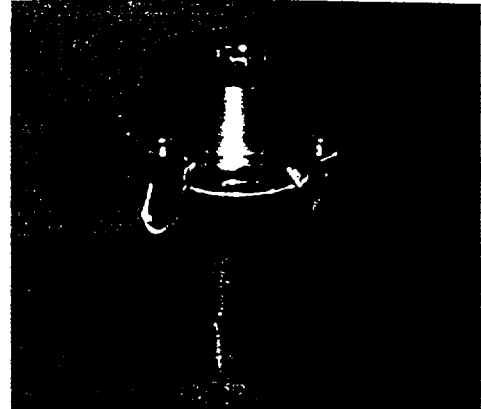


Figure 6 - Pot assembly



Figure 7a - Cork parts: P3192

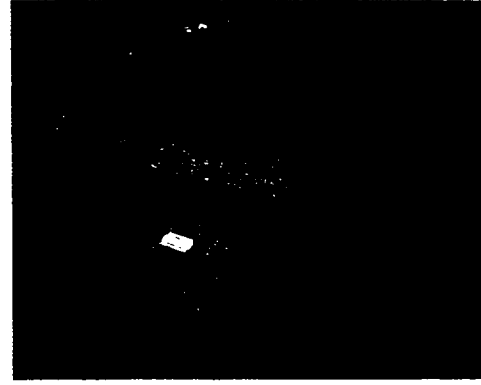


Figure 7b - Cork parts: P3193

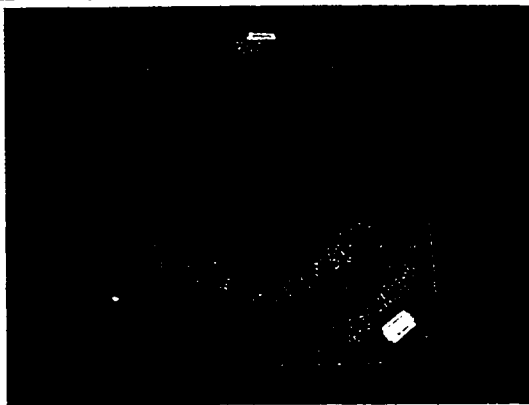


Figure 7c - Cork parts: Modification to P3192

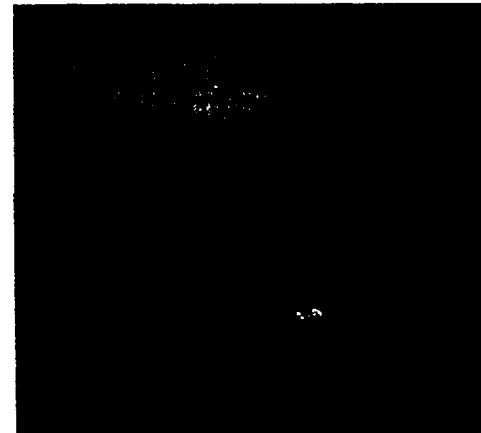


Figure 8 - Cork sub-assembly

Section 5 - Illustrations

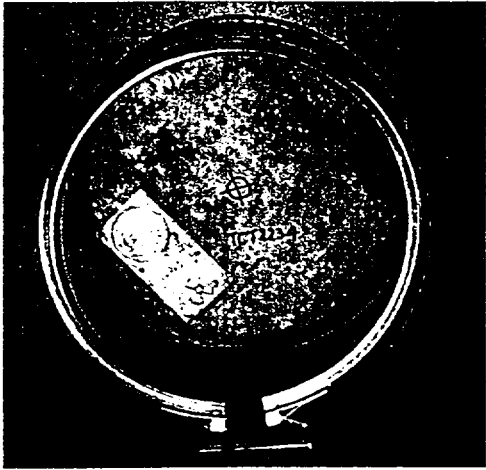


Figure 9a - Drum lid, clamp and clamp bolt

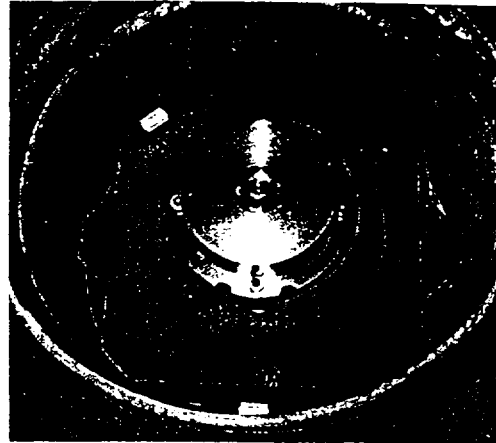


Figure 9b - Packaging components with pot in lower cork

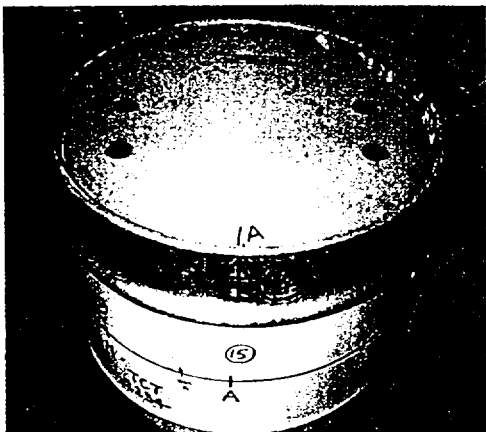


Figure 9c - Package assembly before fitting drum lid

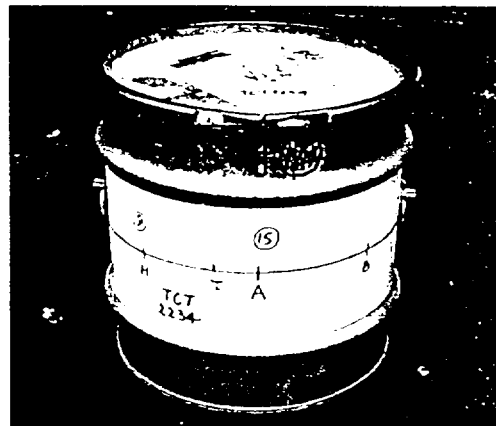


Figure 10 - Package assembly

6. Package design number 3692B


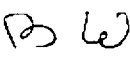
Penetration test (centre lid)

IAEA regulatory specification

Safety Series 6 paragraph 624
Safety Standard ST-1 paragraph 724

Test procedure

PGP17 issue 3

Action	Measure	Photo	Check
1 Position package erect on the target with the centre of the lid directly under the hoist			✓
2 Using a short sling, fit the 6 kg penetration bar to the release hook on the hoist.			✓
3 Confirm the bar hangs over the centre of the drum (slightly off centre is appropriate if there is a label at the centre)		Fig 11	
4 Raise bar to 1 m above the drum lid	1.0 m	Fig 12	
5 Release bar and record post-test positions		Fig 13	
6 Record and measure depth of damage	4.9 mm	Fig 14	
7 Damage commentary No significant damage; simple small dent, no splits in drum skin			
		Initial / sign / date	
Confirm that the package is satisfactory to continue to the next test		Yes / No	
Tested by		 3.10.01	
Actions checked by		 3.10.01	

Section 6 - Illustrations

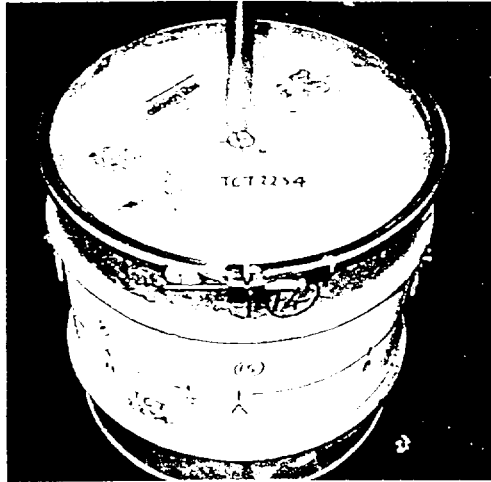


Figure 11 - Centre lid penetration location



Figure 12 - Centre lid penetration pre-test

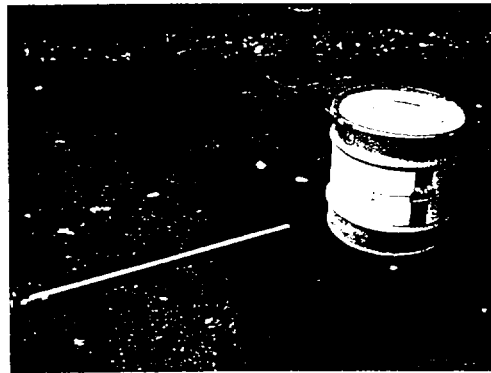


Figure 13 - Centre lid penetration post-test

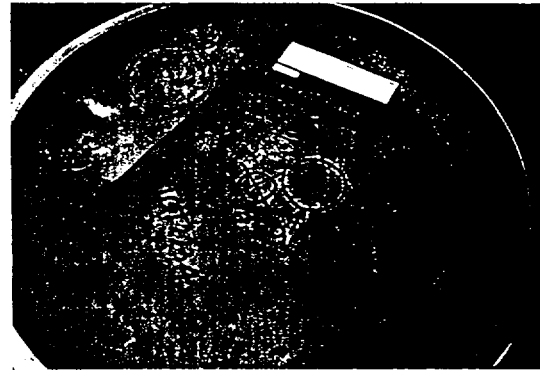


Figure 14 - Centre lid penetration damage

7. Package design number 3692B


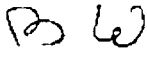
Penetration test (centre side)

IAEA regulatory specification

Safety Series 6 paragraph 624
Safety Standard ST-1 paragraph 724

Test procedure

PGP17 issue 3

Action	Measure	Photo	Check
1 Position package laid on its side on the target with the centre of the side at datum E directly under the hoist			✓
2 Using a short sling, fit the 6 kg penetration bar to the release hook on the hoist.			✓
3 Confirm the bar hangs over a point close to datum E		Fig 15	
3a Impact point offset towards D to avoid drum seam weld which gives additional strength		Fig 15	
4 Raise bar to 1 m above the drum side	1.02 m	Fig 16	
5 Release bar and record post-test positions		Fig 17	
6 Record and measure depth of damage	3.8 mm	Fig 18	
7 Damage commentary In addition to the localised dent, there was a general distortion about 180 × 150 mm high; the drum 'diameter' into the local dent was 439 mm			
		Initial / sign / date	
Confirm that the package is satisfactory to continue to the next test		Yes / No	
Tested by		 3.10.01	
Actions checked by		 3.10.01	

Section 7 - Illustrations

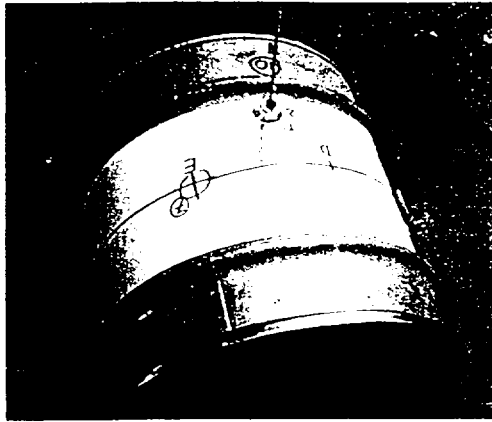


Figure 15 - Centre side penetration location



Figure 16 - Centre side penetration pre-test

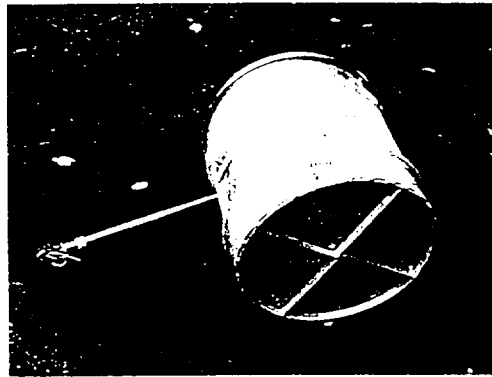


Figure 17 - Centre side penetration post-test

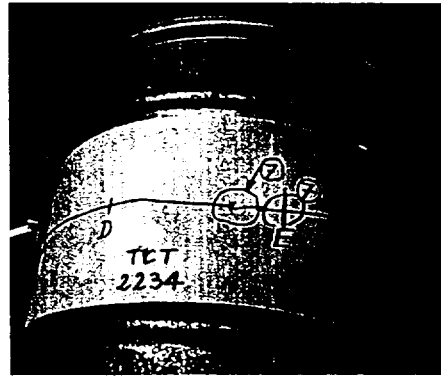


Figure 18 - Centre side penetration damage


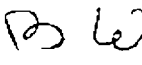
8. Package design number 3692B 1.2 m free drop test (flat base)

IAEA regulatory specification

Safety Series 6 paragraph 622a
Safety Standard ST-1 paragraph 722a

Test procedure

PGP15 issue 5

Action	Measure	Photo	Check					
1 Arrange slings so package is suspended with the base horizontal - no more than 15mm out of horizontal between the base rim and the target (2°)			✓					
1a Height to target at quadrants 1.212m (A), 1.203 (C), 1.205 (E), 1.215 (G)	✓							
2 Record free hanging orientation		Fig 19						
3 Raise package to 1.2m above target	1.2 m	Fig 20						
4 Release package and record post-test positions		Fig 21						
5 Record damage		Fig 22						
6 Measure damage	✓							
Position	A	B	C	D	E	F	G	H
Top of clamp to datum, mm	245	240	244	242	240 *	238	249	247
Base rim to datum, mm	249	253	248	248	252	252	243	245
7 Damage commentary * Dimension E measured into damage from penetration indentation								
					Initial / sign / date			
Confirm that the package is satisfactory to continue to the next test					Yes / No			
Tested by					 3.10.01			
Actions checked by					 3.10.01			

Section 8 - Illustrations



Figure 19 - 1.2m flat base drop orientation



Figure 20 - 1.2m flat base drop pre-test



Figure 21 - 1.2m flat base drop post-test

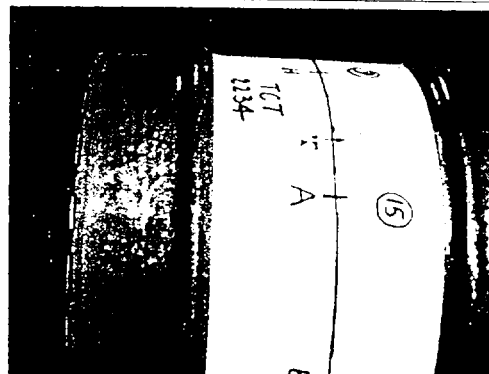


Figure 22 - 1.2m flat base drop damage

9. **Package design number 3692B 1.2 m free drop test (flat side)**


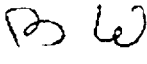
IAEA regulatory specification

Safety Series 6 paragraph 622a

Safety Standard ST-1 paragraph 722a

Test procedure

PGP15 issue 5

Action	Measure	Photo	Check									
1 Lie the package on the target with the clamp band closure uppermost. Arrange slings so package lifts in this orientation			X									
1a To avoid overlapping damage in later tests, the impact point was rotated from datum E to datum H		Fig 26	✓									
2 Record free hanging orientation		Fig 23										
3 Raise package to 1.2m above target	1.205 m	Fig 24										
4 Release package and record post-test positions		Fig 25										
Record damage		Fig 26										
6 Measure damage	✓											
Position	A - E	B - F	C - G	D - H	Min. pos'n							
Top swaged band diameter mm	485	485	486	479	See D-H							
Datum diameter, mm	453 *	449	458	460								
Lower swaged band diameter, mm	486	484	487	475								
7 Damage commentary												
* A - E measured into the penetration damage at E.												
Clamp band ϕ 485 mm (D - H), ϕ 489 mm (B - F)												
				Initial / sign / date								
Confirm that the package is satisfactory to continue to the next test				Yes / No								
Tested by				 3.10.01								
Actions checked by				 3.10.01								

Section 9 - Illustrations

See figure 24

Figure 23 - 1.2m flat side orientation



Figure 24 - 1.2m flat side pre-test

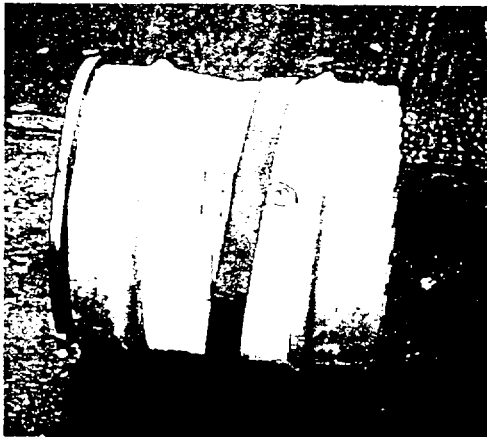


Figure 25 - 1.2m flat side post-test

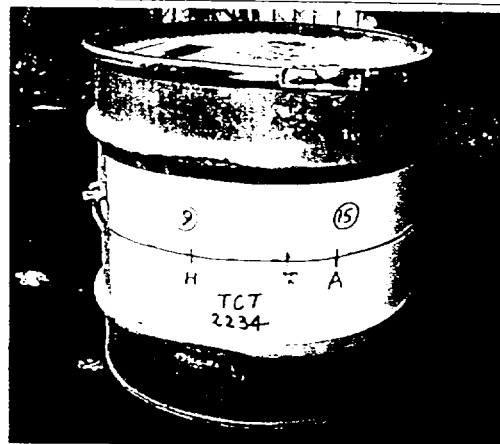


Figure 26 - 1.2m flat side damage

10. Package design number 3692B 1.2 m free drop test (base corner)

IAEA regulatory specification

Safety Series 6 paragraph 622a
Safety Standard ST-1 paragraph 722a

Test procedure

PGP15 issue 5

Action	Measure	Photo	Check									
1 Arrange slings so package is suspended with the centre of gravity above base corner under datum G			X									
1a Impact set to be below datum D with a 40 mm offset to ensure impact between limbs of the base reinforcement cruciform			✓ <i>SW</i>									
2 Record free hanging orientation		Fig 27										
3 Raise package to 1.2m above target	1.2 m	Fig 28										
4 Release package and record post-test positions		Fig 29										
5 Record damage		Fig 30										
6 Measure damage	✓											
Position	A	B	C	D	E	F	G	H				
Top of clamp to datum, mm	248	240	243	243	239	237	249	248				
Base rim to datum, mm	251	252	245	240	243	252	243	248				
6a Base rim diameter												
Before test; overall diameter	H - D 460 mm				B - F 459 mm							
After test; overall diameter	H - D 459 mm				B - F 463 mm							
inside rim reinforcement	H - D 433 mm				B - F 439 mm							
7 Damage commentary												
Some distortion of the base reinforcement was evident (see figure 30a), showing a maximum bow of between 6 and 8 mm												
					Initial / sign / date							
Confirm that the package is satisfactory to continue to the next test					Yes / No							
Tested by					<i>SW</i> 3.10.01							
Actions checked by					<i>BW</i> 3.10.01							

Section 10 - Illustrations

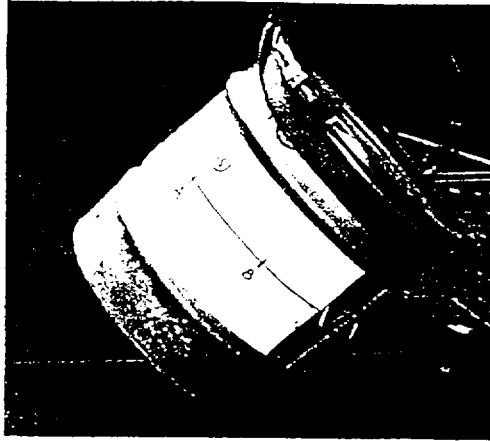


Figure 27 - 1.2m base corner orientation

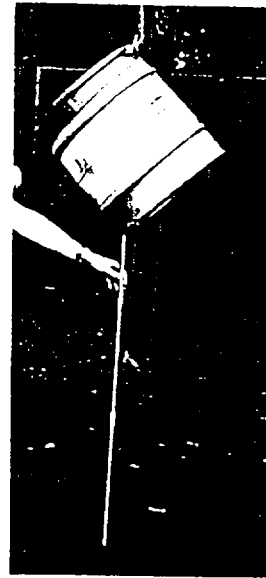


Figure 28 - 1.2m base corner pre-test



Figure 29 - 1.2m base corner post-test

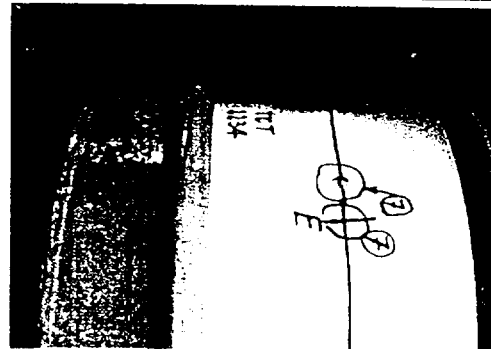


Figure 30 - 1.2m base corner damage (at point indicated by '10')

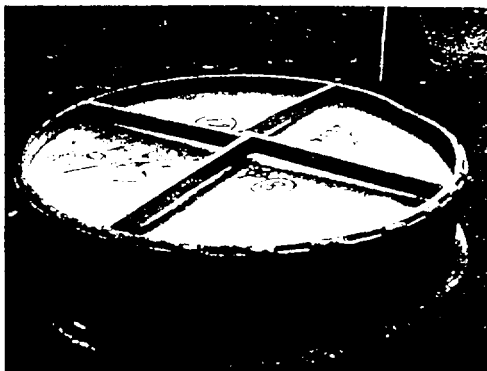











Figure 30a - Distortion of cruciform

11. Type A test sequence evaluation

Action	Measure	Photo	Check
1 Remove the drum clamp and lid; Measure the depth of the upper face of P3193 below the drum rim	21 mm	Fig 31	
2 Remove P3193; record pot location within P3192; measure minimum achievable pot to drum side distance	130 mm	Fig 32, 33	
3 Remove the pot; measure the depth of the P3192 cavity below the drum rim	380 mm	Fig 34	
4 Reassemble package; arrange sides of lower segment of P3192 in line with drum handles; arrange lower segment of P3193 at 45° to upper segment of P3192; align pot lugs with datum A-E; position clamp closure above datum A			 3.10.01
5 Torque clamp bolt to 1.5 ± 0.1 kgf.m See Section 5 (9a)	120 lbf.in		
6 Damage commentary Small bending of the clamp bolt was noted, so a new bolt was fitted for the following Type B test sequence; grade noted to be A2-70 (see also 2.2) The pot was seen to have rotated by about 25 mm relative to the lower cork; no damage noted to the pot. Package reassembled with the pot in the original position with the lifting links aligned with the conceded cut-outs in P3192.			
		Initial / sign / date	
Confirm that the package is satisfactory to continue to the next test		Yes / No	
Tested by		 3.10.01	
Actions checked by		 3.10.01	

Section 11 - Illustrations

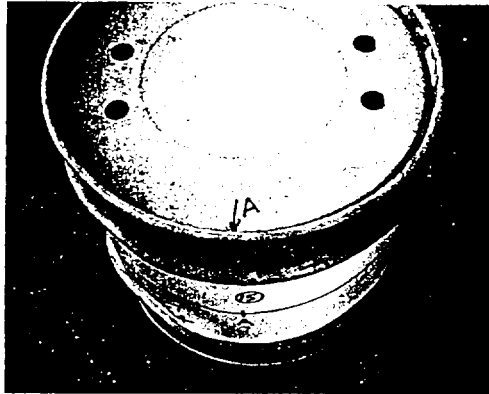


Figure 31 - P3193 after Type A testing

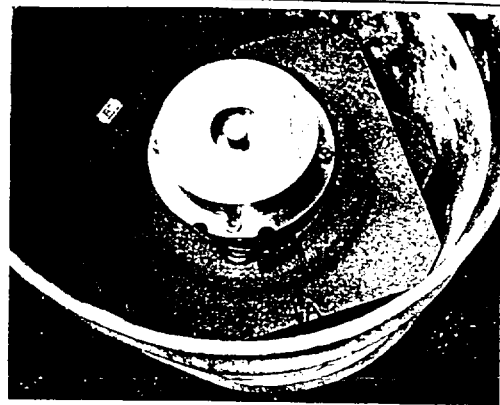


Figure 32 - Pot in P3192 after Type A testing

See Figure 32

Figure 33 - Minimum pot to drum side after
Type A testing

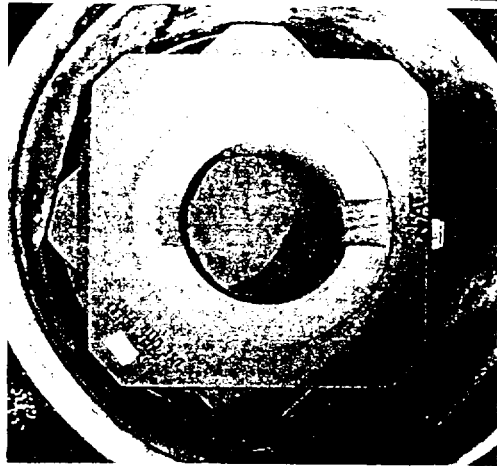


Figure 34 - P3192 after Type A testing

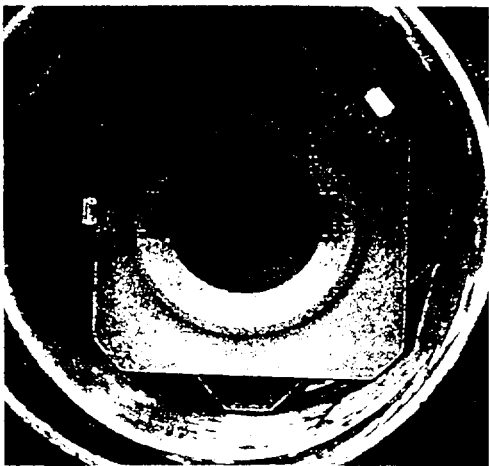


Figure 34a - P3192 after Type A testing

12. Package design number 3692B 9 m free drop test (flat base)



IAEA regulatory specification

Safety Series 6 paragraph 627a

Safety Standard ST-1 paragraph 727a

Test procedure

PGP15 issue 5

Action	Measure	Photo	Check					
1 Arrange slings so package is suspended with the base horizontal - no more than 15mm out of horizontal between the base rim and the target (2°)	✓							
2 Record free hanging orientation		Fig 35						
3 Raise package to 9m above target	9 m							
4 Release package and record post-test positions		Fig 36						
5 Record damage		Fig 37, 38						
6 Measure damage	✓							
Position	A	B	C	D	E	F	G	H
Top of clamp to datum, mm	248	240	246	244	242	240	251	249
Base rim to datum, mm	232	237	235	232	237	237	226	226
7 Damage commentary Witness of secondary impact on the drum side at D; Extensive flattening of lower swaged band (figures 37, 37a, 38, 38a, 38b); previous bowing of base cruciform repaired (figures 38a, 38b compared with figure 30a (copied in here))								
7a Lower swaged band diameter (mm) : A - E 493; B - F 491; C - G 498; D - H 480 Drum height at centre: 482 mm Height of drum side: A 480 mm; C 475 mm; E 477 mm; G 476 mm								
				Initial / sign / date				
Confirm that the package is satisfactory to continue to the next test				Yes / No				
Tested by				 4.10.01				
Actions checked by				 4.10.01				

Section 12 - Illustrations



Figure 35 - 9m flat base orientation

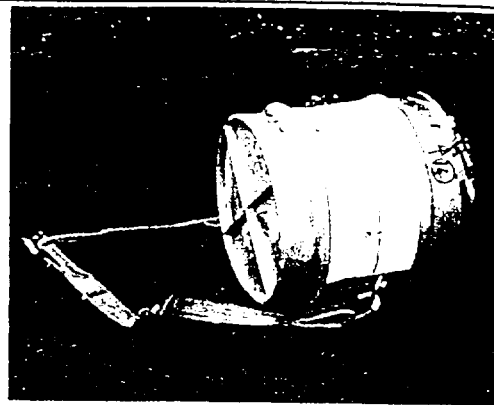


Figure 36 - 9m flat base post-test

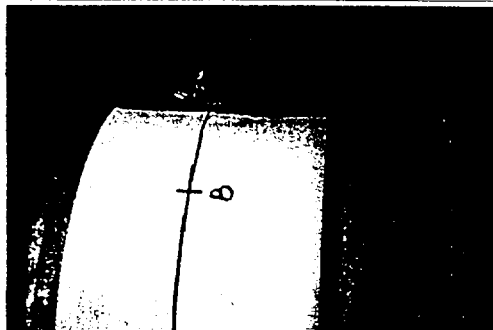


Figure 37 - 9m flat base damage (note profile of lower swaged band compared with upper)

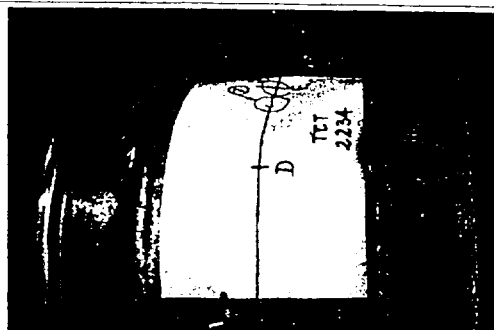


Figure 37a - 9m flat base damage (note profile of lower swaged band compared with upper)

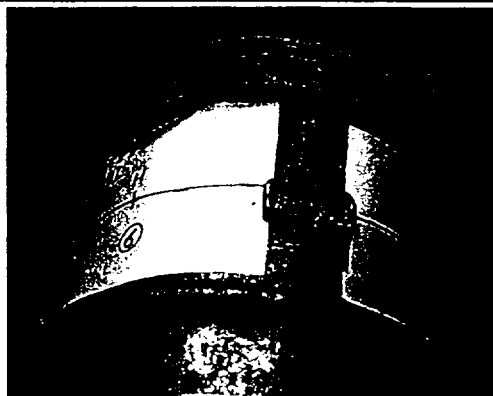


Figure 38 - 9m flat base damage

Section 12 - Illustrations

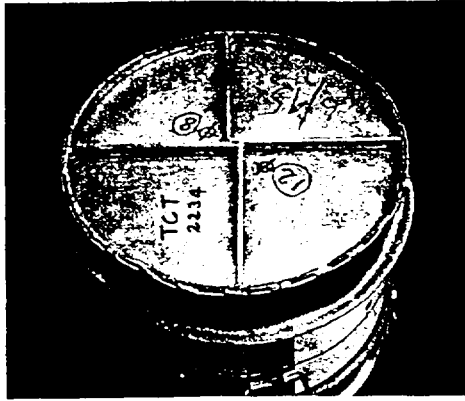


Figure 38a - 9m flat base damage

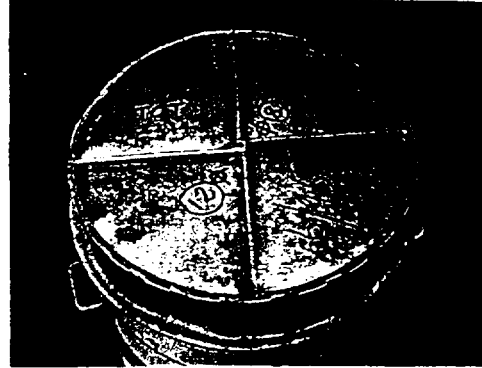


Figure 38b - 9m flat base damage

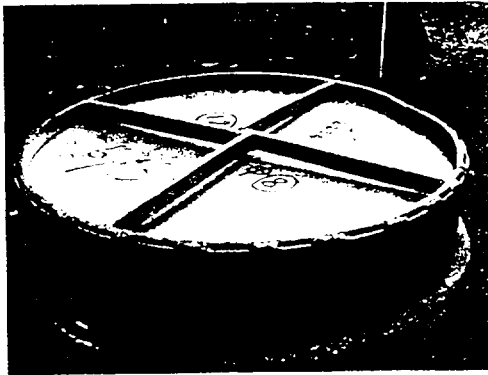


Figure 30a (repeated for convenient
comparison with figures 38a and b) -
Distortion of cruciform after
1.2m base corner drop


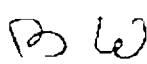
13. Package design number 3692B 9 m free drop test (flat side)

IAEA regulatory specification

Safety Series 6 paragraph 627a
Safety Standard ST-1 paragraph 727a

Test procedure

PGP15 issue 5

Action	Measure	Photo	Check			
1 Lie the package on the target with datum G uppermost. Arrange slings so package lifts in this orientation			✓			
1a Drum axis horizontal to better than 1 mm						
2 Record free hanging orientation		Fig 39				
3 Raise package to 9m above target	✓					
3a Measured to underside of lower handle, hanging freely downwards	9 m					
4 Release package and record post-test positions		Fig 40				
5 Record damage		Fig 41, 42				
6 Measure damage	✓					
Position	A - E	B - F	C - G	D - H	Min. pos'n	
Top swaged band diameter	483	486	467	482	-	
Datum diameter	450	463	447	462	-	
Lower swaged band diameter	494	497	467	483	-	
6a Base diameter overall	464	465	445	462	-	
Base diameter inside rim	441	443	421	439	-	
Clamp overall diameter	496	490	468	491	-	
7 Damage commentary	A small split was visible under the handle reinforcement plate at the point of impact					
Initial / sign / date						
Confirm that the package is satisfactory to continue to the next test		Yes / No				
Tested by		 4.10.01				
Actions checked by		 4.10.01				

Section 13 - Illustrations

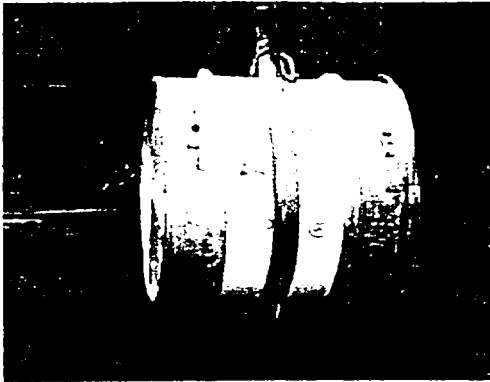


Figure 39 - 9m flat side orientation



Figure 40 - 9m flat side post-test

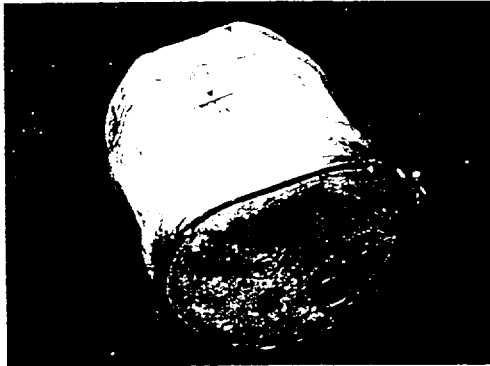


Figure 41 - 9m flat side damage

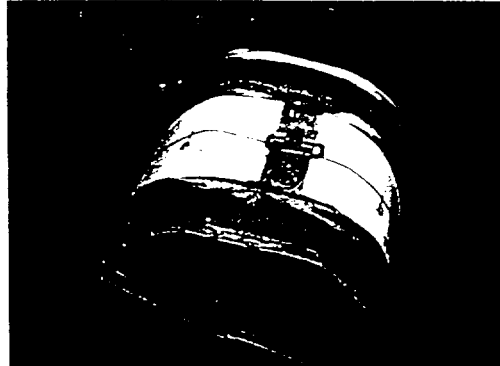


Figure 41a - 9m flat side damage



Figure 42 - 9m flat side damage

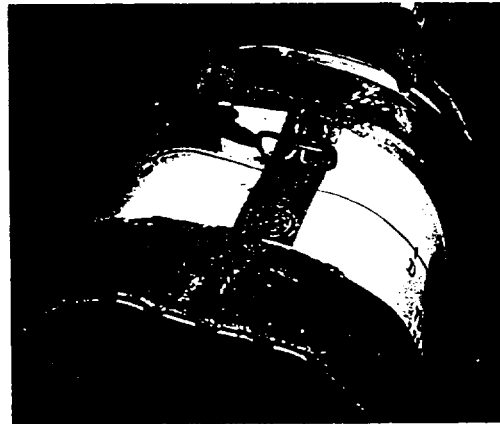


Figure 42a - 9m flat side damage

Section 13 - Illustrations

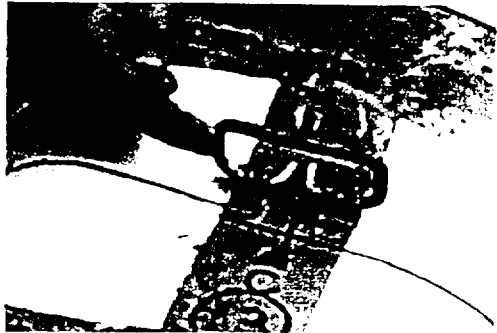


Figure 42b - Damage under handle (enlarged from figure 42a)



Figure 42c - 9m flat side impact: damage to lid rim

14. Package design number 3692B 9 m free drop test (lid corner)


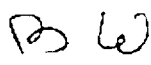
IAEA regulatory specification

Safety Series 6 paragraph 627a

Safety Standard ST-1 paragraph 727a

Test procedure

PGP15 issue 5

Action		Measure	Photo	Check					
1	Arrange slings so package is suspended inverted with the centre of gravity above the clamp closure			✓					
2	Record free hanging orientation		Fig 43						
3	Raise package to 9m above target	9 m							
4	Release package and record post-test positions		Fig 44						
5	Record damage		Fig 45, 46						
6	Measure damage	✓							
	Position	A	B	C	D	E	F	G	H
	Top of clamp to datum, mm	200	240	263	245	240	238	248	223
	Base rim to datum, mm	239	238	230	231	231	233	221	228
	Maximum damage	Position		--	Lid edge to datum		--	mm	
6a	Position (see 7a)	H		1	A	2	3	B	
	Overall drum side height before test	473	473	475	478	477	483		
	Overall drum side height after test	449	436	433	442	450	475		
6b	Position	A - E		B - F		C - G		D - H	
	Clamp overall diameter before test	496		490		468		491	
	Clamp overall diameter after test	494		491		467		490	
7	Damage commentary Two spot welds toward the outer end of one strap had snapped. Small difference in diameters results from measurement along distorted lid surface.								
7a	H - as marked; 1 - to clamp band just outside left hand strap; A - as marked, up to left hand strap; 2 - as A, right hand strap; 3 - as 1, right hand strap; B - as marked (these markings may be seen post test in figure 43a)								
						Initial / sign / date			
Confirm that the package is satisfactory to continue to the next test						Yes / No			
Tested by						 4.10.01			
Actions checked by						 4.10.01			

Section 14 - Illustrations

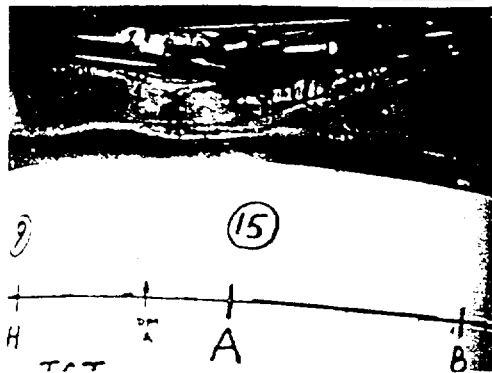


Figure 43a - Detail height markers



Figure 43 - 9m lid corner orientation



Figure 43b - 9m lid corner orientation



Figure 44 - 9m lid corner post-test



Figure 45 - 9m lid corner damage

Section 14 - Illustrations

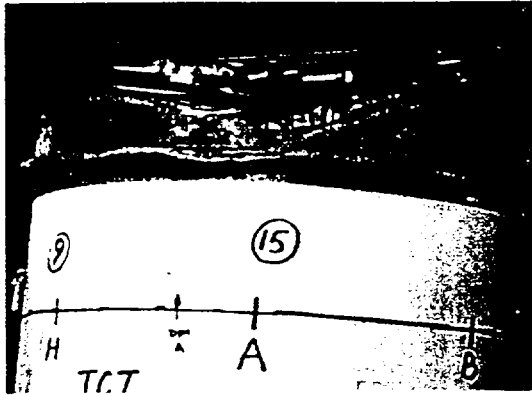


Figure 46 - 9m lid corner damage

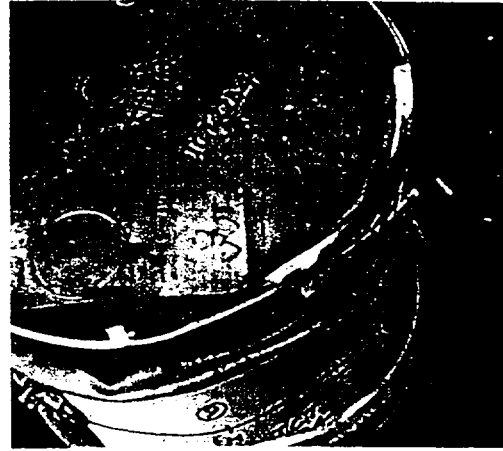


Figure 46a - 9m lid corner damage


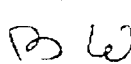
15. **Package design number 3692B 1 m punch test (inverted into drum side)**

IAEA regulatory specification

Safety Series 6 paragraph 627b
Safety Standard ST-1 paragraph 727b

Test procedure

PGP55

Action	Measure	Photo	Check
1 Bolt the punch bar to the target plate Due to a misalignment of the mounting holes, the punch could only be bolted at one corner and chocked at one side.		See figure 47a	✓
2 Use the same slinging as in test 14. Attach a 1m long plumb line to the crumpled zone of the drum side in order to align a hard damaged region of the drum side with the edge of the punch bar.			✓
3 Record free hanging orientation		Fig 47	
4 Raise package to 1m above punch. Ensure the plumb line indicates impact on the side of the punch	1.0 m	Fig 48	
5 Release package and record post-test positions		Fig 49	
6 Record damage		Fig 50	
7 Measure damage	X		
8 Damage commentary Third spot weld (towards clamp closure on right hand strap) now seen to be broken			
Initial / sign / date			
Confirm that the package is satisfactory to continue to the next test		No further test required	
Tested by		 4.10.01	
Actions checked by		 4.10.01	

Section 15 - Illustrations

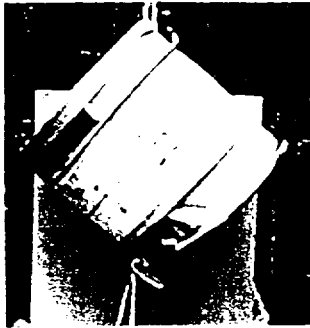


Figure 47 - Punch test orientation

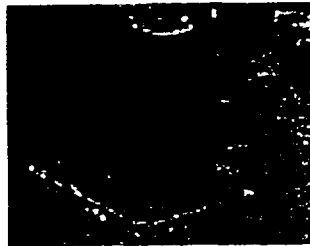


Figure 47a - Punch mounting



Figure 48 - Punch test, pre-test



Figure 49 - Punch test, post test



Figure 50 - Punch test damage







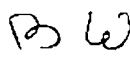
Figure 50a - Punch test damage



Figure 50b - Punch test damage

16. Type B test sequence evaluation

Due to the nature of this testing and the unpredictable extent of damage, this section gives only general guidance as to the dismantling procedure.

Action	Comment (required)	Photo
1 Unscrew the closure bolt	Unscrewed cleanly / sheared Hack-sawed through	
2 Remove the drum lid	Manual $\frac{1}{2}$ with mechanical assistance / cut	Fig 51
3 Remove cork cover, P3193	Removed as a piece / large segments / chipped out Drum sides sliced down to free cork cover	Fig 52
4 Measure thickness of P3193	80 mm	
5 Measure and record the final minimum pot to drum side distance	No change from original	Fig 53
6 Lift pot out and record any damage	No damage visible / damage was:	Fig 54
7 Record damage to packing insert, P3192	No damage visible / damage was: Two cracks running from cavity to outside of insert top segment. Not sufficient to cause a thermal short path.	Fig 55
8 Measure depth of P3192 from the plane of an undamaged drum rim (deduced from the line of the datum as necessary)	153 mm (sides); 155 mm (centre)	
9 Damage commentary	<p>No significant damage resulted from the mechanical testing.</p> <p>A small dent was observed on the side of the lead pot, but it was evident that this was a result of damage in storage before the test and not due to this test procedure.</p>	
Tested by	<p>Initial / sign / date</p> <p> 4.10.01</p>	
Actions checked by	<p> 4.10.01</p>	

Section 16 - Illustrations

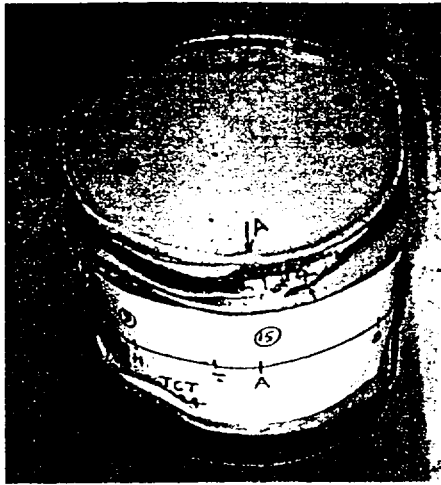


Figure 56 - After Type B testing, drum lid removed

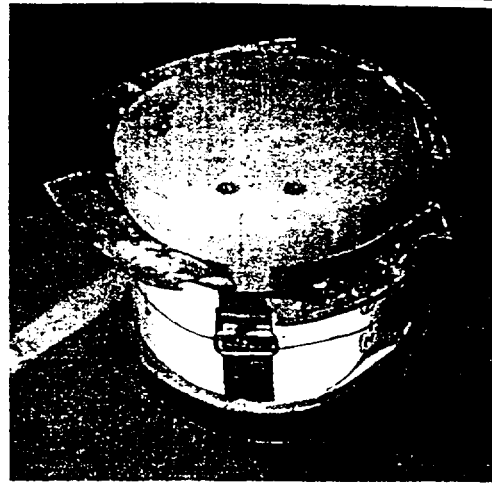


Figure 57 - After Type B testing, preparation to remove P3193



Figure 51 - P3193 after Type B testing

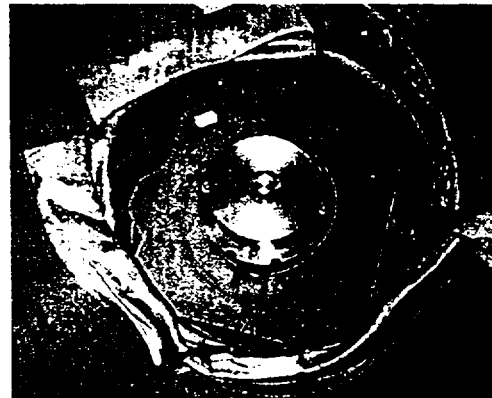


Figure 52 - Pot in P3192 after Type B testing

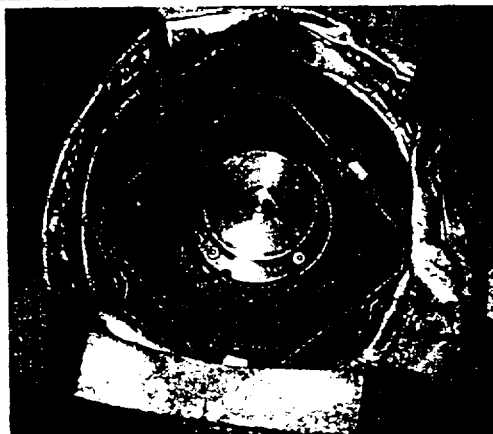


Figure 53 - Minimum pot to drum distance after Type B testing

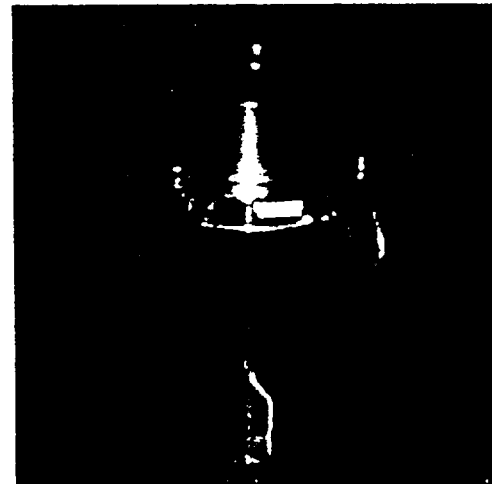


Figure 54 - Damage to pot after Type B testing

Section 16 - Illustrations

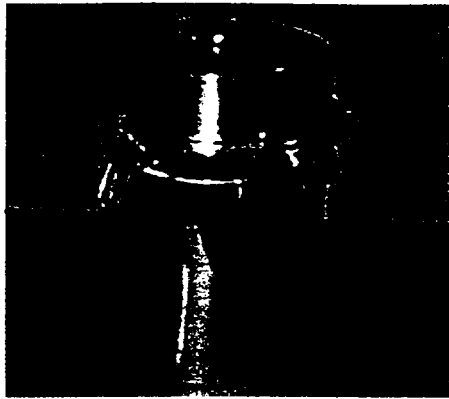


Figure 54a - Damage to pot after Type B testing

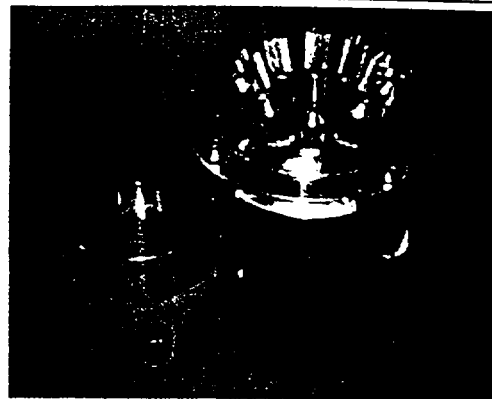


Figure 54b - Damage to pot after Type B testing

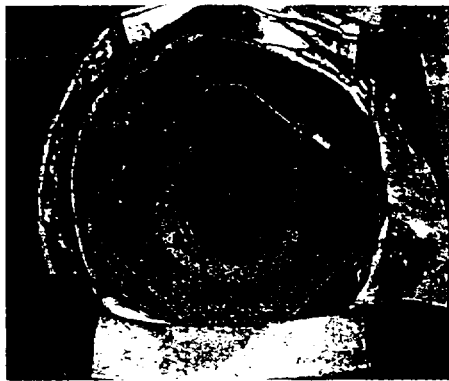


Figure 55 - Damage to P3192 after Type B testing

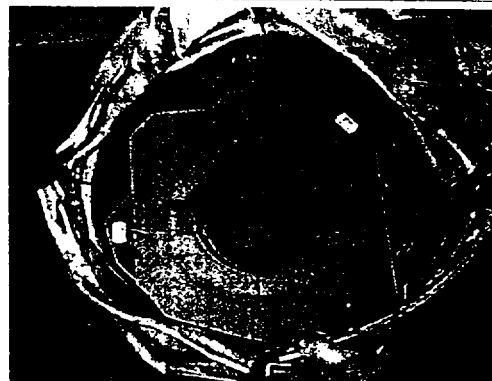


Figure 55a - Damage to P3192 after Type B testing

17. Test illustrations

The test illustration were moved to the individual sections for ease of reference at Issue 3 (Report)

18. Commentary

18.1 Formal witness

This testing was witnessed by Mr D Vince of the UK Department of Transport.

18.2 Packaging data

18.2.1 Dimensions $\phi 488 \times 488$ mm (see Section 5; rounded to $\phi 490 \times 490$ mm elsewhere)

18.2.2 Weight 70.92 kg (drum, 12.30 kg; P3192, 6.34 kg; P3193, 7.02 kg; 3056 pot, 45.26 kg - see Section 5)

18.3 Type A penetration testing

The maximum localised indentation was found to be 4.9 mm in the flat lid, with a 2 mm gap between the underside of the drum lid and the upper face of the cork cover. It is evident that this indentation required a small permanent distortion of the cork face. The local indentation in the side of the drum was comparable (3.8 mm), but was associated with more general damage amounting to a 15 mm flattening of the drum side over an area about 180 × 150 mm high. This may be seen internally in figures 34 and 34a, which clearly show this to have occurred in a region of minimal internal cork support for the drum skin.

18.4 Type A free drop tests

The maximum distortion measured after the 1.2 m free drop tests was 10 mm (lower swaged band after the flat side drop).

18.5 Type B free drop tests

The 9m free drop tests produced significant axial flattening of the lower swaged band (from the flat base drop), flattening of the drum side and of the lid corner at the clamp closure. The skin of the drum was unbroken, and no cork was visible around the drum closure. The noted breakage of the spot welds at the clamp closure did not release the strap from the clamp and so did not permit manual removal of the clamp from the drum. The package was in a fit condition to continue to a Thermal test (should this have been proposed) with complete confidence of a satisfactory result.

18.6 Upon opening the drum, the pot was seen to be completely undamaged.

19. Conclusions

- 19.1 The maximum increase in surface radiation level in the Type A tests would be associated from the general flattening of the drum in the side penetration test. The initial diameter at this point (A-E) on the datum line, see 4.2) was 454 mm, which reduced to 439 mm (see 7.7). As all of this reduction was in one radius, the minimum mean source to surface distance reduced from 227 mm to 212 mm. By the inverse square law, the surface radiation level would increase by $(227 / 212)^2$ or 14.7%. This is within the 20% permitted by Safety Series 6.
- 19.2 The pass criterion in Safety Series 6 for Type B testing is 10 mSv/h at 1m from the package surface. The shielding pot was undamaged by the mechanical testing reported above. With no significant damage to the drum or insulation, no further damage will occur to the radiation shield in a Thermal test, so post test radiation levels will not differ noticeably from those pre-test, i.e. these will be less than 100 µSv/h, or 1% of that permitted.
- 19.3 As the package is designed for Special Form encapsulated material only, no evaluation is made with regard to leak tightness.

20. Summary of the progression of damage

20.1 Axial dimensions: Clamp to datum

Test	Position							
	A	B	C	D	E	F	G	H
5, Pre-test	244	238	243	242	240	237	247	246
8, 1.2m base	245	240	244	242	240	238	249	247
10, 1.2m corner	248	240	243	243	239	237	249	248
12, 9m base	248	240	246	244	242	240	251	249
14, 9m corner	200	240	263	245	240	238	248	223

20.2 Axial dimensions: Base rim to datum

Test	Position							
	A	B	C	D	E	F	G	H
5, Pre-test	250	255	250	248	250	251	244	248
8, 1.2m base	249	253	248	248	252	252	243	245
10, 1.2m corner	251	252	245	240	243	252	243	248
12, 9m base	232	237	235	232	237	237	226	226
14, 9m corner	239	238	230	231	231	233	221	228

20.3 Diameters: Overall (clamp band)

Test	Position			
	A - E	B - F	C - G	D - H
5, Pre-test	488	488	488	488
9, 1.2m side	--	489	--	485
13, 9m side	496	490	468	491
14, 9m corner	494	491	467	490

20.4 Diameters: Upper swaged band

Test	Position			
	A - E	B - F	C - G	D - H
5, Pre-test	486	486	486	486
9, 1.2m side	485	485	486	479
13, 9m side	483	486	467	482

20.5 Diameters: Datum line

Test	Position			
	A - E	B - F	C - G	D - H
5, Pre-test	454	455	459	458
7, Side penetration	439	--	--	--
9, 1.2m side	453	449	458	460
13, 9m side	450	463	447	462

20.6 Diameters: Lower swaged band

Test	Position			
	A - E	B - F	C - G	D - H
5, Pre-test	484	484	487	485
9, 1.2m side	486	484	487	475
12, 9m base	493	491	498	480
13, 9m side	494	497	467	483

20.7 Diameters: Base rim

Test	Position			
	A - E	B - F	C - G	D - H
9, 1.2m side	--	459	--	460
10, 1.2m corner	--	463	--	459
13, 9m side	464	465	445	462

21. Revisions

Issue	Date	Paragraph	Change
1	24 August 2001	All	Initial issue
2	12 September 2001	General	Minor editorial changes for clarity
		1	'Index' was 'Tests'
		2	Add sub-para numbers; add 2.1 (specification and figs 1-4) and 2.3 (deviations); renumber subsequent figures; add clamp and bolt record
		3	Add 'Large callipers', 'digital callipers', torque wrench
		4	Add 4.2 (diameter), 4.3 (inner components), 4.4 (reinforcement), 4.5 (orientation, PGM1353)
		4.1	Rewrite specifying tape and fit lid and clamp
		5.5, 5.6	Delete (now 4.2); add 'measure depth of ...'
		5.8, 5.8a	Add details of package assembly
		6.6, 7.6	Add measure depth of damage
		6.7, 7.7	Action 7 was 9
		8.6, 12.6, 14.6	Add Top of clamp to datum
		9.6, 13.6	Add dimensions table

Issue	Date	Paragraph	Change
		10	New test generally as test 8; <i>renumber</i> subsequent paragraphs
		11	New section; <i>renumber</i> subsequent paragraphs
		13.1	Revise orientation description
		14.6	Add 'Maximum damage'
		15.2	Clarify orientation
		15.8	Add sub-para number
		16	Add new section
		17	Add 'Test' to title; revise all figure numbers; add figures 27-34, 47-55
Issue	Date	Paragraph	Change
3	October 2001		General revision to add in results of testing (transcribed from manuscript notes); changes from the test plan (issue 2) are marked with 'mod' bars, but data entry or planned test records are unmarked
		5.9a	Note error in clamp torque value
		5.11	Add total package weight
		7.3a, 9.1a,	Change planned impact position
		10.1a	
		10.6a	Add base rim diameter
		12.7a	Add diameters and overall heights
		13.3a	Add note regarding hanging handle
		13.6a	Add base, rim and overall diameters
		14.6a, 14.6b,	Add detail data in order to dimension distortion
		14.7a	
		16 (Illustr'ns)	Add figures 56 and 57 (out of order)
		Section 17	Delete Section to reposition illustrations within test sections
		Section 18,	Add Commentary and progression of damage
		20	sections; revise subsequent section numbers

Prepared by

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11 October 2001

9 October 2001

Reviewed by

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11 October 2001