NRC FORM 313 (1-84)
10 CFR 30, 32, 33, 34, 35 and 40

U.S. NUCLEAR REGULATORY COMMISSION
APPROVED BY OMB 3150-0120
Expires: 5-31-87

APPLICATION FOR MATERIAL LICENSE

INSTRUCTIONS: SEE THE APPROPRIATE LICENSE APPLICATION GUIDE FOR DETAILED INSTRUCTIONS FOR COMPLETING APPLICATION. SEND TWO COPIES OF THE ENTIRE COMPLETED APPLICATION TO THE NRC OFFICE SPECIFIED BELOW.

FEDERAL AGENCIES FILE APPLICATIONS WITH:

U.S. NUCLEAR REGULATORY COMMISSION
DIVISION OF FUEL CYCLE AND MATERIAL SAFETY, NMSS
WASHINGTON, DC 20555

ALL OTHER PERSONS FILE APPLICATIONS AS FOLLOWS, IF YOU ARE LOCATED IN:

CONNECTICUT, DELAWARE, DISTRICT OF COLUMBIA, MAINE, MARYLAND, MASSACHUSETTS, NEW JERSEY, NEW YORK, PENNSYLVANIA, RHODE ISLAND, OR VERMONT, SEND APPLICATIONS TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION I
NUCLEAR MATERIAL SECTION B
631 PARK AVENUE
KING OF PRUSSIA, PA 19406

ALABAMA, FLORIDA, GEORGIA, KENTUCKY, MISSISSIPPI, NORTH CAROLINA, PUERTO RICO, SOUTH CAROLINA, TENNESSEE, VIRGINIA, VIRGIN ISLANDS, OR WEST VIRGINIA, SEND APPLICATIONS TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION II
MATERIAL RADIATION PROTECTION SECTION
101 MARIETTA STREET, SUITE 2900
ATLANTA, GA 30323

IF YOU ARE LOCATED IN:

ILLINOIS, INDIANA, IOWA, MICHIGAN, MINNESOTA, MISSOURI, OHIO, OR WISCONSIN, SEND APPLICATIONS TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION III
MATERIALS LICENSING SECTION
799 ROOSEVELT ROAD
GLEN ELLYN, IL 60137

ARKANSAS, COLORADO, IDAHO, KANSAS, LOUISIANA, MONTANA, NEBRASKA, NEW MEXICO, NORTH DAKOTA, OKLAHOMA, SOUTH DAKOTA, TEXAS, UTAH, OR WYOMING, SEND APPLICATIONS TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION IV
MATERIAL RADIATION PROTECTION SECTION
611 RYAN PLAZA DRIVE, SUITE 1000
ARLINGTON, TX 76011

ALASKA, ARIZONA, CALIFORNIA, HAWAII, NEVADA, OREGON, WASHINGTON, AND U.S. TERRITORIES AND POSSESSIONS IN THE PACIFIC, SEND APPLICATIONS TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION V
MATERIAL RADIATION PROTECTION SECTION
1450 MARIA LANE, SUITE 210
WALNUT CREEK, CA 94596

PERSONS LOCATED IN AGREEMENT STATES SEND APPLICATIONS TO THE U.S. NUCLEAR REGULATORY COMMISSION ONLY IF THEY WISH TO POSSESS AND USE LICENSED MATERIAL IN STATES SUBJECT TO U.S. NUCLEAR REGULATORY COMMISSION JURISDICTION.

1. THIS IS AN APPLICATION FOR *(Check appropriate item)*
   - [x] A. NEW LICENSE
   - [ ] B. AMENDMENT TO LICENSE NUMBER ________
   - [ ] C. RENEWAL OF LICENSE NUMBER ________

2. NAME AND MAILING ADDRESS OF APPLICANT *(Include Zip Code)*
   BP INTERNATIONAL LIMITED
   BP RESEARCH CENTRE
   CHERTSEY ROAD
   SUNBURY ON THAMES
   MIDDLESEX TW16 7LN ENGLAND

3. ADDRESS(ES) WHERE LICENSED MATERIAL WILL BE USED OR POSSESSED.
   STORAGE - STANDARD ALASKA PRODUCTION COMPANY
   900 EAST BENSON BOULEVARD
   ANCHORAGE
   ALASKA 99519-6612
   USE - STANDARD ALASKA PRODUCTION COMPANY
   PRUDHOE BAY
   ALASKA

4. NAME OF PERSON TO BE CONTACTED ABOUT THIS APPLICATION: TREVOR J. HILL
   TELEPHONE NUMBER: 011 44 932 763298

SUBMIT ITEMS 5 THROUGH 11 ON 8½ x 11" PAPER. THE TYPE AND SCOPE OF INFORMATION TO BE PROVIDED IS DESCRIBED IN THE LICENSE APPLICATION GUIDE.

5. RADIOACTIVE MATERIAL
   a. Element and mass number, b. chemical and/or physical form, and c. maximum amount which will be possessed at any one time.

6. PURPOSE(S) FOR WHICH LICENSED MATERIAL WILL BE USED.

7. INDIVIDUAL(S) RESPONSIBLE FOR RADIATION SAFETY PROGRAM AND THEIR TRAINING AND EXPERIENCE.

8. TRAINING FOR INDIVIDUALS WORKING IN OR FREQUENTING RESTRICTED AREAS.

9. FA

8801220630 870811
REG5 LIC30
50-23268-01 PDR

10. RADIATION SAFETY PROGRAM.

11. WASTE MANAGEMENT.

12. LICENSEE FEES *(See 10 CFR 170 and Section 170.31)*
    FEE CATEGORY 3P AMOUNT ENCLOSED $ 230

13. CERTIFICATION. *(Must be completed by applicant)* THE APPLICANT UNDERSTANDS THAT ALL STATEMENTS AND REPRESENTATIONS MADE IN THIS APPLICATION ARE BINDING UPON THE APPLICANT.

THE APPLICANT AND ANY OFFICIAL EXECUTING THIS CERTIFICATION ON BEHALF OF THE APPLICANT, NAMED IN ITEM 2, CERTIFY THAT THIS APPLICATION IS PREPARED IN CONFORMITY WITH TITLE 10, CODE OF FEDERAL REGULATIONS, PARTS 30, 32, 33, 34, 35, AND 40 AND THAT ALL INFORMATION CONTAINED HEREIN, IS TRUE AND CORRECT TO THE BEST OF THEIR KNOWLEDGE AND BELIEF.

WARNING: 18 U.S.C. SECTION 1001 ACT OF JUNE 25, 1948, 62 STAT. 749 MAKES IT A CRIMINAL OFFENSE TO MAKE A WILLFULLY FALSE STATEMENT OR REPRESENTATION TO ANY DEPARTMENT OR AGENCY OF THE UNITED STATES AS TO ANY MATTER WITHIN ITS JURISDICTION.

SIGNATURE—CERTIFYING OFFICER	TYPED/PRINTED NAME	TITLE	DATE
W. D. Rees	DR W.D. REES	SAFETY OFFICER	2.7.87

14. VOLUNTARY ECONOMIC DATA

a. ANNUAL RECEIPTS
- [ ] <$250K
- [ ] $250K-500K
- [ ] $500K-750K
- [ ] $750K-1M
- [ ] $1M-3.5M
- [ ] $3.5M-7M
- [ ] $7M-10M
- [ ] >$10M

b. NUMBER OF EMPLOYEES *(Total for entire facility excluding outside contractors)*

c. NUMBER OF BEDS

d. WOULD YOU BE WILLING TO FURNISH COST INFORMATION *(Dollar and/or staff hours)* ON THE ECONOMIC IMPACT OF CURRENT NRC REGULATIONS OR ANY FUTURE PROPOSED NRC REGULATIONS THAT MAY AFFECT YOU? *(NRC regulations permit it to protect confidential commercial or financial—proprietary—information furnished to the agency in confidence)*
- [ ] YES
- [ ] NO

FOR NRC USE ONLY

TYPE OF FEE	FEE LOG	FEE CATEGORY	COMMENTS	APPROVED BY
App	July - 2	3P / 9B	570605	M. Thomas

AMOUNT RECEIVED	CHECK NUMBER	DATE
$230 / $580	FD03077045 / FD0308802 / FD16090127	8/6/87

The sources will be transported to the Prudhoe Bay field in northern Alaska by a nominee of SAPC, but under the supervision of the licensee, and stored in SAPC facilities at Prudhoe Bay. On arrival at Prudhoe Bay the sources and density transmitters will be used for a period of 4 weeks to measure the density of oil and gas mixtures in the 24 inch pipelines at Prudhoe Bay operated by SAPC.

On completion of this test work the sources will be shipped back to Anchorage by the nominee and from there back to England. The sources are scheduled to be in the USA for a maximum period of six weeks (allow 8 weeks for unforeseen delays in the work).

7. Individuals Responsible For Radiation Safety Program Their Training And Experience

The following individuals will be jointly responsible for the radiation safety program during the proposed tests at Prudhoe Bay:-

Trevor J. Hill
Derek Brister
Philip P. Sugarman

Each of the above named has attended and completed the course titled 'RADIOLOGICAL HEALTH AND SAFETY - A Course For Radiation Protection Supervisors' given by staff of

The UK National Radiological Protection Board
Harwell
Didcot
Oxfordshire OX11 0RQ Telephone England 023-283 600
Contact Mr Brian Marsh

The subject material covered during this course is listed in Attachment 5. It was attended by the above named during October 22-26, 1984, when it was held at the Suffolk College of Higher and Further Education, Ipswich, Suffolk, England.

The above named have been responsible for the use, and safety, of the devices specified in this application during test work undertaken at UK oilfields both on land and offshore.

8. Training Provided To Other Users

The three people named above as those responsible for the radiation safety program will be the only staff who will use the density transmitters whilst they are in the USA. In addition they will be the only staff allowed inside the controlled area around each source.

9. Facilities and Equipment

The density gauges will be clamped to the outside of the 24 inch diameter crude oil pipelines in the Prudhoe Bay oilfield of Alaska. They will be powered by portable generator, and the measurements recorded on computer. The computing equipment will be located in a vehicle parked no more than 100 metres from the density gauges. The gauges will at all times be visible from the vehicle, in which the licensee's staff will be situated.

The Prudhoe Bay oilfield is not accessible by the general public. SAPC staff working in the oilfield will be warned by notice and radio announcement of the use of the density transmitters. Access to the immediate vicinity of the gauges will be restricted to the staff of the licensee named earlier. Barriers and warning signs will be erected around the sources at 1 metre distance (radiation level <0.25 mRem/hr).

When not in use the sources will be locked in the transport vehicle. In the times preceding and following the tests, whilst awaiting transport, the gauges will be locked in the facility set aside at Prudhoe Bay for storage of radioactive sources. Storage in Anchorage whilst awaiting transport back to the UK will be in the locked facilities of the SAPC-nominated transporting agent.

10. Radiation Safety Program

10.1 Personnel Monitoring Equipment

The staff using the density transmitter are already issued with film badges that are monitored once per calendar month by the UK National Radiological Protection Board. It is not anticipated that these staff will receive in excess of 0.3 Rem/calendar month.

10.2 Radiation Detection Instruments

During tests using the density transmitters a Berthold LB 133 portable radiation intensity meter is available to make surveys and set the position of the barriers.

10.3 Leak-Testing

Each of the three sources will be leak-tested in the UK by the National Radiological Protection Board, with the address previously specified (contact Mr Wiltshire), on July 14th, prior to shipment of the sources to the USA. As the sources will not be in the USA for more than eight weeks a further leak test should not be required whilst in the USA.

10.4 Maintenance

Maintenance, and relocation of the gauges on different pipes in the Prudhoe Bay field, will only be undertaken with the sourceholder locked shut. There will be no removal of any of the sources from the sourceholders at any stage whilst in the USA.

10.5 Transportation of Devices to Field Locations

As stated earlier the sources and sourceholders will arrive in the USA from the UK at Anchorage, Alaska. They will be packaged to IATA standards. For their shipment from Anchorage to Prudhoe Bay a suitable transporting agent is to be nominated by SAPC. This company will transport the sources according to the requirements of the US Department of Transportation for such sources.

10.6 Operating and Emergency Procedures

Each person using the density transmitters will be issued with a copy of the operating and emergency procedures related to radiation safety. In addition the management of the Prudhoe Bay oilfield will be provided with written instructions to be communicated to their staff regarding the observation of signs and barriers placed around the radioactive sources.

The operating and emergency procedures will include details on the following topics:-

Personal Safety	- use of film badges, and reporting of film badge readings.
Site Safety	- use of radiation survey meter to position signs and barriers, and instructions to be given to site staff.
Use of Device	- operating instructions for the transmitters as issued by the manufacturers.
Source Location	- viewing procedure for sources when in use, and storage procedures when not in use.
Source Transport	- procedures for on-site transportation of sources.
Leak Testing	- records of leak tests, and procedures for updating.
Emergencies	- procedures covering road accident, fire in storage facilities, loss of source, and will include a list of those to be notified in the USA and the UK.

11. Waste Management

At the conclusion of the test period the three radioactive sources will be returned to the BP Research Centre in the UK. Should these sources subsequently require disposal this would be undertaken through the National Disposal Service which is located at:

The United Kingdom Atomic Energy Authority
Industrial Chemistry Group
Building 175
AERE, Harwell
Didcot
Oxfordshire
England

ATTACHMENT 1

Caesium-137

Gamma sources

Sources contain the radionuclide as a pellet of caesium ceramic. Encapsulation is in welded stainless steel.

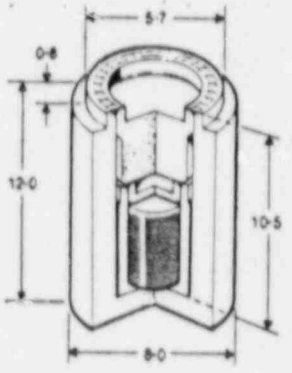
Nominal equivalent activity* mCi	Nominal air kerma rate at 1 metre µGy/hr	Double encapsulation Code
1	2·88	CDC.21601
3	8·64	CDC.21603
5	14·4	CDC.21604
10	28·8	CDC.21605
20	57·6	CDC.21606
30	86·4	CDC.21607
50	144	CDC.21603
100	288	CDC.21609
200	576	CDC.21610
300	864	CDC.21611

*Tolerance −0, +25%
for definition of equivalent activity, see page 55

Availability: within 4 weeks

Recommended working life: 15 years

X.2016



Safety performance testing

ISO classification	IAEA special form
C65515	GB/23/S

Nominal equivalent activity* mCi	Nominal air kerma rate at 1 metre µGy/hr	Double encapsulation Code
1	2·88	CDC.3101
3	8·64	CDC.3103
5	14·4	CDC.3104
10	28·8	CDC.3105
20	57·6	CDC.3106
30	86·4	CDC.3107
50	144	CDC.3108
100	288	CDC.3109
200	576	CDC.3110
300	864	CDC.3111

*Tolerance −0, +25%
for definition of equivalent activity, see page 55

This source can be supplied with handling rods and a shielded container.

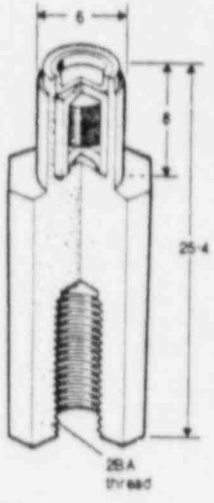
Availability: within 4 weeks

Recommended working life: 15 years

Quality Control
Wipe test A
Bubble test D
Immersion test M

Calibrated sources see page 24

X.31



Safety performance testing

ISO classification	IAEA special form
C54544	GB/23/S

Specifications:
Only typical sources are listed.
Enquiries invited for sources to other specifications.

Recommended working life, see page 60

Quality control:
Leakage and Contamination tests, see page 54
A Test Report is supplied with each source or batch of sources.

Safety performance testing, see page 59

Dimensions in mm

ATTACHMENT 2

Quality control

Quality control of radiation sources can be divided into four main parts:

1. Checks made routinely during production

Quality Assurance
Radiation sources are manufactured in accordance with a strict quality assurance programme, details of which can be obtained on request.

Testing for leakage and contamination
Stringent tests for leakage are an essential feature of radioactive sources production. The methods adopted depend on the design and intended application of the source, and also on statutory requirements. Where necessary, tests can be specially modified to meet particular requirements.

The standard methods used for testing radiation sources are listed below. The particular tests used for each type of source are given under the appropriate product entry.

Wipe test A
The source is wiped with a swab or tissue, moistened with methanol or water; the activity removed is measured.
Acceptance limit: 0·005μCi (0·18kBq).
(This test conforms to BS.5288/App D.2.1).

Wipe test B
The source is wiped with a swab or tissue, moistened with methanol or water; the activity removed is measured.
Acceptance limit: 0·05μCi (1·8kBq).

Bubble test D
The source is immersed in water or a suitable liquid and the pressure reduced to 100mm of mercury (13kPa).
No bubbles must be observed.
(This test conforms to BS.5288/App. D.3.1. and it has been demonstrated that this test is suitable for sources with free volumes greater than $10mm^3$ [Amersham International Technical Report No. 8]).

Immersion test L
The source is immersed in water or other suitable liquid at 50°C for 4 hours and the activity in the liquid measured. Acceptance limit: 0·005μCi (0·18kBq).
(This test conforms to BS.5288/App. D.2.3.).

Immersion test M
The source is immersed in water which is raised to 100°C and held at that temperature for 10 min. The water is then removed, the source cooled and rinsed using fresh water. These operations are repeated twice, boiling in the water from the previous rinsing operation. If the activity detected in all the liquid collected is less than 0·005μCi (0·18kBq) the source is considered to be leak-free.
(This test conforms to BS.5288/App. D.2.4.)

Helium leak test H
A mass spectrometer is used to detect helium leakage from sources helium filled prior to welding.
Acceptance limit 10^{-8} mbar l $s.^{-1}$
(This test exceeds the requirement of BS.5288/App. D.3.4)

Helium pressurisation test S
A mass spectrometer is used to detect helium leakage from sources previously pressurised in helium after encapsulation.
Acceptance limit 10^{-6} mbar $l\ s^{-1}$ for non-leachable solid inserts and 10^{-7} mbar $l\ s^{-1}$ for all others. (This test exceeds the requirement of BS.5288/App. D.3.5).

Radon emanation test K
The source is immersed in a solution of phosphor in an organic liquid under vacuum; the leakage of radon is measured by liquid scintillation counting.
(DWIGHT, D.J. Radiochemical Centre Report R176).
The acceptance limit corresponds to about 5×10^{-11} Ci per 24 hours (2Bq per 24 hours).
This test exceeds the requirement of BS.5288/App. D.2.6).

Krypton emanation test P
The source is held under reduced pressure for 24 hours. The contents of the chamber is analysed for Krypton by scintillation counting. The test is repeated after at least 7 days. Acceptance limit 0·1μCi (3·7kBq).

2. Special safety performance tests on prototypes

A radiation source must provide highest possible integrity together with minimum attenuation of the required radiation by the encapsulation materials. A compromise must sometimes be made, particularly for alpha, beta and low energy photon sources. However, safety must always be the prime consideration.

Standards for the testing of sealed radioactive sources have been specified by the British Standards Institution in BS.5288; 1976.

This classification system is modelled on USA standard USASI N5.10 which also gives a number of comparable leak test methods.

BS.5288 is in agreement with the following standards produced by the International Organization for Standardization (ISO):

ISO.1677 'Sealed radioactive sources – General'
ISO.2919 'Sealed radioactive sources – Classification'
ISO Technical Report 'Sealed radioactive sources – leak test methods' (ISO/TR.4826 – 1979(E)).

3. Measurements

Each source or batch of sources is checked to ensure that the strengths of the sources supplied are within the limits specified. Wherever possible the results of these checks are indicated on the test report. The methods of specifying the strengths of sources are discussed under the heading specification on page 55 and details are included in the appropriate sections of this catalogue.

4. Test reports

A test report is supplied with each source or batch of sources. Where appropriate the following information is given:
Product code
Product description
Capsule type
ISO classification
Special form certificate
Measurement check
Leakage check
Contamination check

Technical information

Specification – SI units

The strength of a radiation source may be specified either by its radiation output or by stating the radioactivity of its contents. For most applications the user is mainly interested in the source's radiation output, and requires information about content only for licensing or commercial reasons.

For many sources the radiation output is not simply related to the activity content because factors such as self absorption, and attenuation by the capsule cause a non-isotropic output distribution. For this reason we always measure the radiation output in a given direction, using the most appropriate method and do not rely on an estimate of the amount of radioactive material in the source.

A real source emits anisotropically, so it is necessary to specify the direction in which a measurement has been made, as well as the distance from the source. The distance is normally taken from the centre of the source and the direction is normally radial for cylindrical sources and axial for disc sources.

The relationship between equivalent activity and exposure rate is different for each radionuclide, depending on the type and quantity of radiation emitted in each nuclear transformation.

The accepted values for the most commonly used high energy gamma-emitting nuclides are given in the table below.

In the SI system, source strengths may be expressed in terms of air kerma rate at 1 metre* in gray per hour.

This changeover will not however be made until there is a complete change to SI units.

The equivalence between the old units and the new is shown below.

Nuclide	Equivalent activity	Exposure rate at 1 metre	Air kerma rate ($\dot{K}$)* in air at 1 metre (approx.)
^{137}Cs	1Ci	0·33R/h	2·8mGy/h
^{60}Co	1Ci	1·30R/h	11mGy/h

Where the source strengths are expressed in content activity, the curie values are given first with the becquerel values quoted alongside. In cases where the sources strengths are expressed in terms of equivalent activity, the curie values are given first with the air kerma rate at 1 metre ($\dot{K}$)* quoted alongside.

The output of sources is sometimes expressed in terms of photons per second per steradian where this is appropriate for the application.

*Exposure rate and air kerma rate are fully defined in ICRU Report No. 33.

The following SI units have been recommended by ICRU for radioactivity and absorbed dose.

Physical quantity	SI unit	Traditional unit	Relationship
Radioactivity	becquerel (Bq)	curie (Ci)	1Ci = 3·7 × 10^{10}Bq 1Bq = 2·70 × 10^{-11}Ci
Absorbed dose	gray (Gy)	rad	1 rad = 0·01Gy 1Gy = 100rad

1 Bq = 1 nuclear transformation per second

Conversion factors:
1kCi = 3·7 × 10^{13}Bq = 37 terabecquerels (TBq)
1Ci = 3·7 × 10^{10}Bq = 37 gigabecquerels (GBq)
1mCi = 3·7 × 10^{7}Bq = 37 megabecquerels (MBq)
1μCi = 3·7 × 10^{4}Bq = 37 kilobecquerels (kBq)

Calibration

Some of the sources listed in this catalogue can be accurately calibrated.

Certificates of measurement quote the results of calibration in exposure rate at a specified distance.

Calibration accuracy

The accuracy of measurement of the calibrated sources is expressed as the overall uncertainty in the measurement of the source.

The overall uncertainty is an estimate of the possible divergence of the quoted result from the (unknown) true value, assessed according to the recommendations in ICRU Report 12 (Certification of Standardized Radioactive Sources).

The overall uncertainty is defined as $\pm(tS_m + \delta)$ where S_m is the standard error of the mean result of the measurement and t (the Student 't' statistic) is chosen so that there is at least a 99·7% probability that the true result lies within a range $\pm tS_m$ about the mean result.

$\pm\delta$ are the limits of the estimated maximum uncertainty attributable to systematic uncertainties in the measurement.

Fuller information about the specification of accuracy will be supplied on request.

Source safety

ISO classification

The International Organization for Standardization (ISO) has produced a system of classification of sealed radioactive sources based on safety requirements for typical uses (see ISO.2919).

"This system provides a manufacturer of sealed radioactive sources with a set of tests to evaluate the safety of his products under working conditions. It also assists a user of such sealed sources to select types which suit the application he has in mind, especially where protection against the release of radioactive material is concerned".

The suitability and safety of a source will depend on the intended application and environment of use, of which there is a wide range. It is the customer's responsibility to ensure that the source and its specification are suitable and safe for his particular application and environment of use. This applies especially to non-standard or custom made designs as well as standard products. The information on these pages is designed to help the customer in his evaluation.

The tests to which prototype sources are subjected are listed in table 1.

Each test can be applied in several degrees of severity. Test results are expressed as a five figure code to indicate the severity of the tests.

These figures are preceded by the letter C or E to show whether the source activity is less than or greater than certain limits. These limits depend upon the toxicity, solubility and reactivity of the active component of the source.

C indicates that the activity level of the source does not exceed the prescribed limit and

E that the limit is exceeded.

Special safety performance tests on prototypes
A radiation source must provide highest possible integrity together with minimum attenuation of the required radiation by the encapsulation materials.

However, safety must always be the prime consideration.

Standards for the testing of sealed radioactive sources have been specified by the British Standards Institution in BS.5288:1976.

This classification system is modelled on USA standard USASI N5.10 which also gives a number of comparable leak test methods.

BS.5288 is in agreement with the following standards produced by the International Organization for Standardization (ISO):

ISO.1677 'Sealed radioactive sources – General'
ISO.2919 'Sealed radioactive sources – Classification'
ISO Technical Report 'Sealed radioactive sources – leak test methods' (ISO/TR 4826 – 1979(E))

Amersham International has facilities devoted solely to the testing of prototype sources according to ISO and similar recommendations.

The test data given in this catalogue are the latest available at time of preparation.

There is a continuous programme of product improvement and testing and details of the current status of particular sources will be supplied on request.

Table 1. Classification of sealed source performance standards

Test	Class 1	2	3	4	5	6
Temperature	No test	−40°C (20 min) +80°C (1 h)	−40°C (20 min) +180°C (1 h)	−40°C (20 min) +400°C (1 h) and thermal shock 400°C to 20°C	−40°C (20 min) +600°C (1 h) and thermal shock 600°C to 20°C	−40°C (20 min) +800°C (1 h) and thermal shock 800°C to 20°C
External pressure	No test	25kPa absolute to atmospheric pressure	25kPa absolute to 2MPa absolute	25kPa absolute to 7MPa absolute	25kPa absolute to 70MPa absolute	25kPa absolute to 170MPa absolute
Impact	No test	50g from 1m	200g from 1m	2kg from 1m	5kg from 1m	20kg from 1m
Vibrations	No test	30min 25Hz to 500Hz at 5g_n peak amplitude	30min 25Hz to 50Hz at 5g_n peak amplitude and 50Hz to 90Hz at 0·635mm amplitude peak to peak and 90Hz to 500Hz at 10g_n	90min 25Hz to 80Hz at 1·5mm amplitude peak to peak and 80Hz to 2000Hz at 20g_n		
Puncture	No test	1g from 1m	10g from 1m	50g from 1m	300g from 1m	1kg from 1m

Notes to Table 1

1 Details of the testing procedures are given in ISO.2919 and BS.5288. A further class X can be used where a special test procedure has been adopted.

2 **External pressure**
100kPa = 1 atmosphere (approximately)

3 **Impact test**
The source, positioned on a steel anvil, is struck by a steel hammer of the required weight; the hammer has a flat striking surface, 25mm diameter, with the edges rounded.

4 **Puncture test**
The source, positioned on a hardened steel anvil, is struck by a hardened pin, 6mm long, 3mm diameter, with hemispherical end, fixed to a hammer of the required weight.

Source safety

Performance requirements for typical uses

Minimum performance requirements are also given in ISO.2919 for the use of sealed radiation sources (see table 2 below).

These recommendations take into account normal usage and reasonable accidental risks, but do not include exposure to the risk of fire, explosion or corrosion.

Table 2. Sealed source performance requirements.

Sealed source use		Sealed source test and class				
		Temperature	Pressure	Impact	Vibration	Puncture
Gamma gauges (medium and high energy)	Unprotected source	4	3	3	3	3
	Source in device	4	3	2	3	2
Beta gauges and sources for low energy gamma gauges or X-ray fluorescence analysis (excluding gas-filled sources)		3	3	2	2	2
Portable moisture and density gauges (including hand held or dolly transported)		4	3	3	3	3
General neutron source application (excluding reactor start-up)		4	3	3	2	3

If the sealed source has a 'C' classification
Table 2 can be used directly to assess the suitability of the source for the proposed application provided that there is no significant fire, explosion or corrosion hazard.

If such a hazard does exist, the user and the manufacturer have to consider the following factors to determine whether additional testing is required:

1 consequences of loss of activity
2 quantity of active material contained in the source
3 radiotoxicity
4 chemical and physical form of the material and the geometrical shape
5 environment in which it is to be used
6 protection afforded to the source-device combination.

If the sealed source has an 'E' classification
Table 2 cannot be used directly.

To determine whether any additional testing is necessary, an evaluation of the fire, explosion and corrosion hazards must first be made and a separate evaluation of the use and design of the source.

Some of our source designs exceed the recommendations of Table 2 and may therefore be acceptable for the applications listed despite the 'E' classification.

IAEA special form

'Special form' is a test specification for sealed sources given in the IAEA transport regulations.
(IAEA Safety Series No. 6, 1973 revised edition.)

It is used in determining the maximum acceptable activities for various types of transport containers.

The required test are:
- impact test
- percussion test
- bending test (only for long, slender sources)
- heat test.

After each test the source must be subjected to leaching assessment tests.

The certificate (SFC) numbers given against approved items in the catalogue listing are those issued by the Department of Transport, the competent authority in the UK for administering the IAEA regulations.

Source working life

The 'recommended working life' (RWL) is our recommendation of the period within which the source should be replaced.

This information is given in the Test Report. The period has been assessed on the basis of such factors as, toxicity of nuclide, total initial activity, source construction (e.g. capsule design, source insert type, etc.), half-life of nuclide, typical application environments, operational experience, test performance data, etc.

The assessement of 'recommended working life' is based on the assumption that they are not used in adverse environments. It is the user's responsibility to inspect and test the source regularly in order to assess at what point during the 'recommended working life' the source should be replaced.

Advice should be sought regarding 'recommended working life' for sources that are used in adverse environments or for sources that having completed the 'recommended working life' appear satisfactory and may be suitable for an extended period.

Other information
Other information on source safety is contained in the product specification sheets, test reports, handling and unpacking instructions where applicable.

Packaging

Packaging of radioactive materials is generally controlled by the IAEA transport regulations (IAEA Safety Series No. 6, 1973 revised edition).

There are two categories of packaging:
Type A – designed to retain the integrity of containment and shielding under the normal conditions of transport.
Type B – designed to withstand the damaging effects of a transport accident.

Packages containing radioactive materials must conform to certain maximum external radiation levels according to the method of transport being used.

Under IAEA Category III-yellow, an exposure rate not exceeding 200 mrem/h at any point on the surface of the package is allowed.
The package must also have a Transport Index (TI) within the limits prescribed for the particular method of transport.
(The Transport Index is the number expressing the exposure rate in mrem/h at 1 metre from the surface of the package.)
For most passenger-carrying aircraft the TI must not exceed 3 or 4, but for freighter aircraft a TI up to 10 is generally allowed.

The IAEA transport regulations prescribe for each nuclide, maximum activities that may be transported in a type A package. The activity levels (A_1 and A_2 limits) depend on the ...city, etc., of the nuclide and may vary according to whether or not the nuclide is contained in a capsule for which a "Special Form" certificate has been issued.

Exempt packaging
Packages are exempt from the packaging regulations if they conform to the following requirements:
(i) the maximum activity of the contents is less than
$10^{-3}A_1$ (special form approval) or
$10^{-3}A_2$ (for other sources)
(ii) the exposure rate at any point on the surface of the package does not exceed 0·5 mrem/h.

Our transport containers are designed for maximum safety and economy in transport and conform to the appropriate international regulations.

Wherever possible lightweight non-returnable containers are used but shipments requiring more shielding may have to be packed in returnable containers. Some typical non-returnable and returnable containers are illustrated, see page 62.

Non-returnable containers
These usually consist of a lead shield in a sealed can packed either in a cardboard box or in an expanded polystyrene casing. Packages of this type meet the IAEA requirements for type A. Modified packaging to conform to type B is also available. The sealed can may be opened with a domestic can opener. Refer to unpacking instructions where applicable.

Returnable containers
Returnable containers usually consist of a heavy lead shield inside a steel drum. In the steel drum there may also be a cork or fibre liner to give protection in case the container is involved in a fire. Returnable containers must be returned promptly at the customer's expense, otherwise a charge will be made. Some large containers may be subject to a hire charge.

Specially designed containers incorporating source transfer systems are used for loading high activity and high energy gamma and neutron sources into customers' equipment.

Customers' containers
Customers' own containers will be used on request, provided that they meet the relevant transport regulations; formal evidence of this is required before shipments can be arranged.

Packaging

Examples of non-returnable packaging

01W1POP assembly

W1 lead pot
(sealed with adhesive tape)

Sealed 'P' can

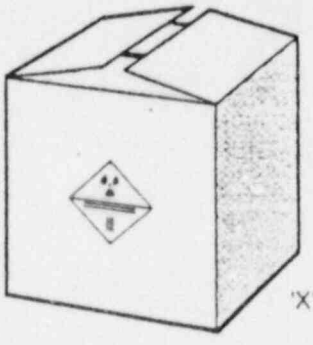
'P' carton

300mm

01W4 PSX assembly

W4 lead pot
(sealed with adhesive tape)

Sealed 'P' can

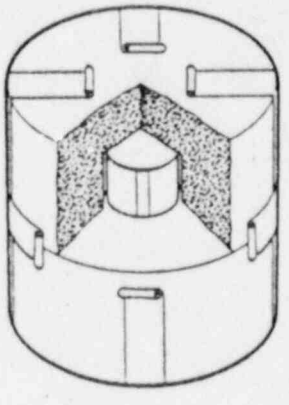


'X' carton

01WCROW assembly

WC lead pot
(sealed with adhesive tape)

Sealed 'R' can

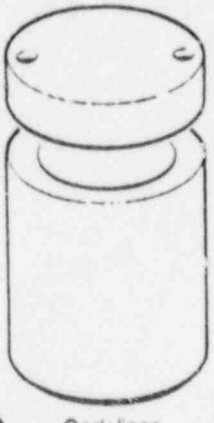


Expanded
Polystyrene
'W' drum

Examples of returnable packaging

JOILMCF assembly

Lead pot

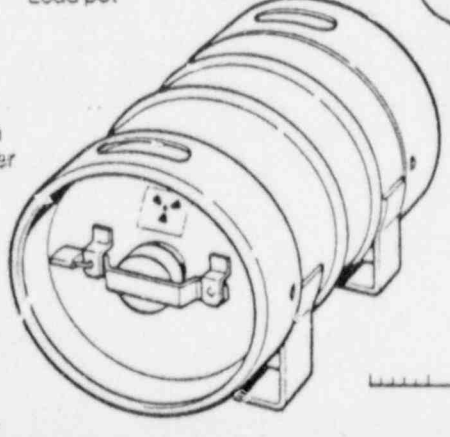


Cork liner

Steel drum

300mm

3206B
Neutron
container



300mm

Packaging

Container information

The information in the following table is given to help customers estimate freight costs and anticipate handling problems.

The values given are for α, β, γ-emitters only – see separate table for neutron sources on page 64

Non-returnable packaging

Nuclide	Max. allowed in type 'A' package (IAEA regs)		Amersham code	0000POP	01W1POP	01W4PSX	01WCNOW
			Lead thickness (mm)	0	3	13	38
	A_1 special form	A_2 others	IAEA type	A	A	A	A
			Weight kg	0·4	0·5	2·9	11·6
			T.I. value	0·5	0·5	3	3
				Max. permitted contents			
^{241}Am	8Ci 296GBq	8mCi 296MBq		8mCi (37mCi) 296MBq (1·37GBq)	8mCi (8Ci) 296MBq (296GBq)		
^{109}Cd	1kCi 37TBq	70Ci 2·59TBq		5·5mCi 207MBq	+		
^{133}I	30Ci 1·11TBq	20Ci 740GBq		1·6mCi 59MBq	2·2mCi 81MBq	40mCi 1·48GBq	650mCi 24GBq
^{57}Co	90Ci 3·33TBq	90Ci 3·33TBq		5·9mCi 218MBq	870mCi 32GBq	2Ci 74GBq	+
^{60}Co	7Ci 259GBq	7Ci 259GBq		210μCi 7·8MBq	275μCi 10MBq	360μCi 13MBq	20mCi 740MBq
^{244}Cm	10Ci 370GBq	10mCi 370MBq		10mCi (10Ci) 370MBq (370GBq)			
^{153}Gd	200Ci 7·4TBq	100Ci 3·7TBq		22mCi 814MBq	+		
^{125}I	1kCi 37TBq	70Ci 2·59GBq		3·5mCi 130MBq	+		
^{55}Fe	1kCi 37TBq	1kCi 37TBq		+			
^{85}Kr	1kCi 37TBq	1kCi 37TBq		420mCi 15·5GBq	640mCi 23·7GBq	18Ci 666GBq	
^{63}Ni	1kCi 37TBq	1kCi 37TBq		+			
^{239}Pu	3Ci 111GBq	3mCi 111MBq		3mCi (3Ci) 111MBq (111GBq)			
^{147}Pm	1kCi 37TBq	80Ci 2·96TBq		1·2Ci 44GBq	+		
^{90}Sr	10Ci 370GBq	400mCi 14·8GBq		28mCi 1GBq	92mCi 3·4GBq	2·2Ci 81GBq	
^{204}Tl	300Ci 11·1TBq	30Ci 1·11TBq		160mCi 5·9GBq	4Ci 148GBq	30Ci 1·11TBq	

Notes

1. + indicates that maximum contents are limited by $A_1/_2$ values, not by surface dose-rate.
2. Values in brackets show the advantage to be gained by using Special Form approved sources.

Packaging

Returnable packaging

Nuclide	max. allowed in type 'A' Package (IAEA regs)		Amersham code	Returnable J00CSYL (0924BY)	Returnable J01LMCF
	A_1 special form	A_2 others	IAEA Type	A	B(U)
			Weight kg	85	51
			T.I. value	6·9	3·5
				Maximum permissible content	
^{60}Co	7Ci 259GBq	7Ci 259GBq		175mCi 6·5GBq	30mCi 111MBq
Cs	30Ci 1·11TBq	20Ci 740GBq		24Ci 0·82TBq	1·3Ci 48GBq

Neutron sources

Nuclide	max. allowed in type 'A' Package (IAEA regs)		Amersham code	Non-returnable 01W1POP	Non-returnable 01W1PYX	Non-returnable 01Q1ROW	Returnable† ·1943A (320N)	Returnable† ·1825A (A50N)	Returnable† ·1940A (B50N)	Returnable† ·3009A	Returnable† ·3206B
	A_1 special form	A_2 others	IAEA type	A	A	A	B(U)	A	B(U)	A	A or B(U)
			Weight kg	0·5	1·7	3·5	201	27	600	1060	75
			T.I. value	0·5	3·3	6·1	7	8	10	8	6
				Max. permitted contents							
^{241}Am	8Ci 296GBq	8mCi 296MBq		0·25Ci 9·25GBq	2·0Ci 74GBq	4·0Ci 148GBq	19Ci 703GBq	—	78Ci 2·89TBq	—	18Ci 666GBq
^{252}Cf	2Ci (3·7mg) 74GBq	2mCi (3·7µg) 74MBq		0·2µg 4MBq	1·5µg 30MBq	3·0µg 60MBq	35µg 0·7GBq	225µg 4·5GBq	250µg 5GBq	1500µg 30GBq	23µg 0·5GBq

†Returnable containers are available for purchase. Details on request.

n Laboratories
n Road Amersham
amshire England HP7 9LL
telephone Little Chalfont (024 04) 4488
cables Activity Amersham telex
telex 83141 ACTIVA G

Radioactive source test report

code	description	nominal activity	customer
11	CAESIUM-137 GAMMA SOURCE	3 300 MILLICURIE (11.10 GIGABQ)	RIADATA A/S OESTERBROGADE 95 DK-2100 COPENHAGEN DENMARK
2	SEALED SOURCE		

classification •	special form certificate no.	recommended working life		customer's order no.
4	23	15 YEARS	902 2	003753-070-1

umber	measurement check MILLICURIES	measurement check date	leakage test	date passed	leakage test	date passed	contamination test	date passed
R	341.3	6 DEC 85	D	6 DEC 85	M	6 DEC 85	A	10 DEC 85
R	335.2	6 DEC 85	D	6 DEC 85	M	6 DEC 85	A	10 DEC 85
R	[illegible]	6 DEC 85	D	6 DEC 85	M	6 DEC 85	A	10 DEC 85

signed

date
11 DEC 85

assification complies with BS.5288:1976, which is in agreement with ISO.2919 (see overleaf for definition and description of tests)

ATTACHMENT 3

Amersham

...International plc
...Road Amersham
...mshire England HP7 9LL
telephone Little Chalfont (024 04) 4444
cables Activity Amersham telex
telex 83141 ACTIVA G

Radioactive source test report

...de	description	nominal activity	customer
11	CAESIUM-137 GAMMA SOURCE	3 300 MILLICURIE (11.19 GIGABQ)	RIA DATA A/S OESTERBROGADE 95 DK-2.00 COPENHAGEN DENMARK
...ncy 5	SEALED SOURCE		

...classification *	special form certificate no.	recommended working life		customer's order no.
4	23	15 YEARS	802 2	003098-070-1

...mber	measurement check	measurement check date	leakage test	date passed	leakage test	date passed	contamination test	date passed
	MILLICURIES							
3 GR	314.4							
4 GR	305.1							
5 GR	296.9	10 JUNE 85	D	11 JUNE 85	M	11 JUNE 85	A	12 JUNE 85

signed: Sanderson

date: 12 JUNE 8...

...assification complies with BS.5288:1976, which is in agreement with ISO.2919 (see overleaf for definition and description of tests)

Amersham

m International plc
Road Amersham
mshire England HP7 9LL

telephone Little Chalfont (024 04) 4444
cables Activity Amersham telex
telex 83141 ACTIVA G

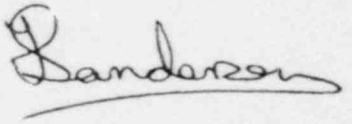
Radioactive source test report

code	description	nominal activity	customer
11	CAESIUM-137 GAMMA SOURCE	5 300 MILLICURIE (11.13 GIGABQ)	RIA DATA A/S OLSTEPBROGADE 95 DK-2100 COPENHAGEN DENMARK
no.			
1	SEALED SOURCE		

classification *	special form certificate no.	recommended working life		customer's order no.
4	23	15 YEARS	902 1	002590-070 -1

number	measurement check	measurement check date	leakage test	date passed	leakage test	date passed	contamination test	date passed
	MILLICURIES							
24 GR	313.3							
35 GR	307.2							
42 GR	324.6	13 DEC 84	D	13 DEC 84	M	13 DEC 84	A	17 DEC 84
52 GR	307.2							
57 GR	317.4							

signed



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ssification complies with BS.5288:1976, which is in agreement with ISO.2919 (see overleaf for definition and description of tests)

Amersham

ATTACHMENT 4

NATIONAL INSTITUTE OF RADIATION HYGIENE

Østerndalen 25, P.O.Box 55, N-1345 Østerås, Norway - Tel. (02) 17 00 92

Eur-Control Gamma A/S
Vitbank
3400 LIER

Your ref.	Our ref.	Date
	2569/06/81.0/ALR/ut	1986.12.08

TYPE APPROVAL

The Density Transmitter DT-6092/DT-6092F/DT-6092EX with source holder NOR 4079/14 has been subject to a type test at our institute

From the results of this test, we have given the sourceholder approval for up to 20 GBq (540 mCi) Cs-137.

Yours sincerely

for
Leiv Berteig

Anne Liv Rudjord

CERTIFICATE OF SAFETY
IONIZING RADIATION GAUGING DEVICE

Type: NOR 4079/14 with 6092
Charge: 300 mCi Cs-137
Classification: ANSI 54-554-554-R2

Manufacturer: *EUR-Control Gamma A/S*
Classification standard: ANSI N538
Signature: E. S. Date: 27 Nov 1986

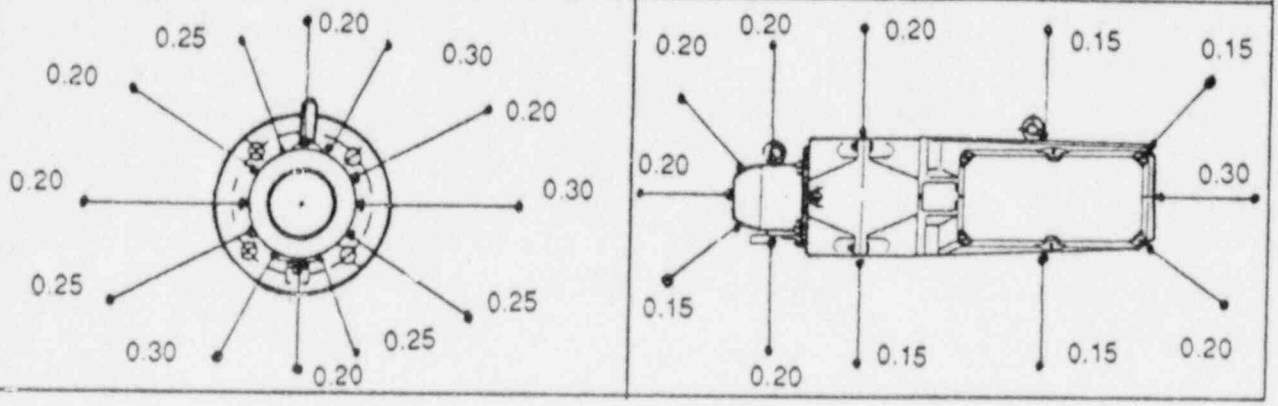
The device has been tested according to ANSI N538 and N542 and found in good order.

Safety functions: Checked before, during and after temperature test **OK!**

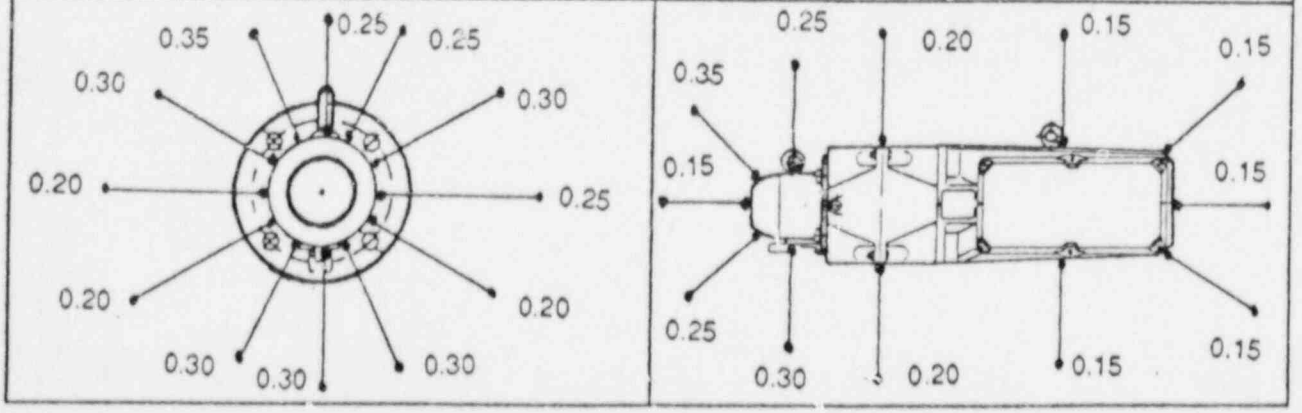
Maximum radiation intensity in mrem/h, Source ON and Source OFF

	Before temperature test		After temperature test	
Distance (cm)	ON	OFF	ON	OFF
5	8.0	9.0	8.0	8.5
30	1.1	1.3	1.1	1.2
100	0.30	0.35	0.30	0.35

Radiation intensity (mrem/h) at 100 cm distance from surface, Source ON



Radiation intensity (mrem/h) at 100 cm distance from surface, Source OFF



Test programme

The stray radiation of the source has been measured both in OFF and ON position followed by a temperature test after which the stray radiation again has been measured in OFF and ON position. These tests have been carried out in agreement with ANSI N538 by the Center for Industrial Research , Oslo , Norway.
The leak test as described in ANSI N542 has been carried out by the Institute for Atomic Energy, Kjeller, Norway.

Stray radiation measurement procedure

The background radiation in the laboratory has been insignificant and has, therefore, not been subtracted from the measured values. Standard conditions as specified in ANSI N538 , table 2, have been established. All accessible surfaces have been scanned with the survey meter at 5, 30 and 100 cm from the source's surface for the source in OFF and ON position. This has been done both with and without filter. The location of maximum stray radiation has been determined in each case and then measured over 1 minute. The procedure is in agreement with ANSI N538, chapter 7.3.2.1.
After this, measurements at 100 cm distance along two chosen principal axes have been done at 30 degrees measuring intervals. These isodistance doses are graphically presented.
The maximum doses given are either the doses measured without filter divided by 6, or the doses measured with filter, whichever is greater. This is in agreement with ANSI N538, chapter 7.3.3.1.

Temperature test procedure

The source has been operating with its normal heat load during the temperature cycling (N538, chapter 7.2.1). It has been exposed to -40 °C and 105 °C, accuracy ±2 °C. The temperature stabilization time has been experimentally determined to 3 hours. We have allowed 7 hours for stabilization which gives a safety margin of 4 hours. The safety functions have been checked as described in ANSI N538, chapter 7.3.2. After the temperature test, the source has been inspected for visual defects.

Stray radiation measurement Equipment

Survey meter :	Type: PDM 1, Nuclear Enterprises	
	Calibrated mass per unit area window:	8.0 mg/cm^2
	Window area:	100 cm^2
Filter:	Build-up slide:	300 mg/cm^2

The survey meter and filter have been calibrated with the calibration chamber on 6 October 1986.

Calibration chamber specifications

Type:	Air ionization chamber , Nuclear Enterprises, Ionex dose rate meter 2500/3
Energy response:	flat within ±15%, 10 keV to 3.0 MeV.
Window area:	100 cm^2

Basic window mass per unit area: 1mg/cm^2 aluminized Melinex
Window mass per unit area for calibration of survey meter : 1mg/ cm^2 Melinex + 7mg/cm^2 polyethylene
Window mass per unit area for calibration of survey meter with filter: Perspex, 300 mg/ cm^2
Calibration date: 7 July 1986

ATTACHMENT 5

National Radiological Protection Board

Summary of Course for Radiation Protection Supervisors

1. Concepts and Production of Ionising Radiation
2. Legislation (UK and Europe)
3. Dose and Contamination Units
4. Maximum Permissible Doses and Derived Working Limits
5. Biological Effects of Radiation
6. Administrative Requirements of the UK Regulations
7. Radiation Instruments
8. Personal Monitoring