Department

berthold

Nuclear Instrumentation

BERTHOLD INSTRUMENTS, INC.
136 Bradford Avenue
Pittsburgh, PA 15205
412-922-2635 Telex: 812527

June 20, 1984

U. S. Nuclear Regulatory Commission
Region I
631 Park Avenue
King of Prussia, PA 19406-1498

ATTN: JACK DAVIS

CONTROL NO. - 02478 (POSSESSION)

Dear Sir:

Our license application (Control # 02478) dated May 24, 1984, was submitted with discrepencies. It appears that some information was provided that does not really apply and conversely some information was deleted that does apply.

Would you please remove and dispose of all the information between attachment #1 and #2 (four sheets that contain specifications and drawings plus 1 brochure on the TOL/E ratemeter).

Would you please add attachments #4 and #5 (not provided in the original application) and additional information requested indicated by attachment #6 and #7.

This now makes the attachments agree with the application Form 313 and original cover letter.

I appreciate your attention to this matter and regret any inconvenience.

Sincerely,

James A. Welsh

James A. Welsh
Industrial Product Manager

Enclosures:

Attachments:
- #4 RADIATION PROTECTION PROGRAM
- #5 FORMAL TRAINING IN RADIATION PROTECTION
- #6 PROCEDURE FOR AUTHORIZATION TO SERVICE DEVICES
- #7 OUTLINE OF ADDITIONAL TRAINING TO BE PROVIDED TO JAMES A. WELSH

(2 copies)

*ATTACHMENT # 4
*ITEM # 15 - RADIATION PROTECTION PROGRAM.

I. EMPLOYEE TRAINING PROGRAM

A training program will be in effect for all employees handling or frequenting areas where radioactive sources will be used or stored.

The training of an employee in Radiation Protection is the responsibility of James Welsh, Industrial Product Manager, R.S.O.

The training program on the "Mechanics and Physical" properties of RAM for safe use and handling of will include the following topic. Note "D" refers to DIDACTIC and "P" refers to PRATICAL handling and demonstration.

(D) A. ELEMENT IDENTIFICATION
(D) B. ISOTOPE PRODUCTION
(D-P) C. ELECTROMAGNETIC & PARTICULATE RADIATION
(D) D. ENERGY SPECTRUMS
(D) E. DIRECT IONIZATION
(D) F. INDIRECT IONIZATION
(D) G. ACTIVITY UNITS & SUB-UNITS INCLUDING S.I. UNITS
(D-P) H. INVERSE Sq. LAW
(D-P) I. TIME, DISTANCE, AND SHIELDING
(D) J. MATHEMATICS
(D) K. ROENTGEN, RAD. & REM./S.I. UNITS
(D-P) L. CALCULATING DOSE FROM ELECTROMAGNETIC RADIATION USING 6 C.E.N. AND GAMMA RAY CONSTANT FORMULA.
(D) M. OCCUPATIONAL EXPOSURE LIMITS
(D) N. SOME BIOLOGICAL EFFECTS
(P) O. SURVEY EQUIPMENT
(D) P. 10 cfr 19.

II. It is a Health Physics judgement that bio-assays will not be necessary.

III. Film badge (whole body and ring) will be employed.

IV. Sources will be leak tested by a wipe test on a six month period and analyzed by a Berthold contamination monitor LB 1210B or C depending on type of activity.

V. Area wipe survey will not be necessary on a periodic basis. An area wipe survey will be performed if:

(a) A wipe test of sources indicates leakage.

(b) If Tritium or Carbon 14 is used to apply to TLC plates for testing.

VI. Areas where RAM is stored or used will be placarded as per 10 cfr 20.203.

Continuation

*ATTACHMENT # 4
*ITEM # 15 - RADIATION PROTECTION PROGRAM.

VII. Records of inventory, wipe test, exposures, waste disposal (if any) will be maintained in accordance to 10 cfr 20.

*ATTACHMENT # 5

*ITEM # 16 - FORMAL TRAINING IN RADIATION PROTECTION BY JAMES A. WELSH

a, b, c, d - Rutgers - Radiation protection for Physicians and Scieantists by Dr. R. Wynveen. Six (6) months.

b - Packard Instruments, Inc.

c - Rutgers - Basic Nuclear Physics Dr. F. Haughey Six (6) months.

*ITEM # 17 - EXPERIENCE

Instrumentation	(1)	Packard Instruments, Inc. 1964-1966.
Activities	(2)	^{3}H, ^{14}C, ^{32}P, ^{125}I, ^{131}I, mCi amounts.
Research	(1)	Ortho Diagnostics, Inc. (J & J) 1972 - 1982 Radiation Safety Officer
	(2)	Designed and managed Radiation Safety program including training of employees.
	(3)	Isotopes used - ^{3}H, ^{51}Cr, ^{90}Sr, ^{125}I, ^{14}C, Cs, 137, ^{32}P, ^{51}Cr - high millicurie amounts.
Sterilization Facility	(1)	International Nutronics, Inc. - 1983
	(2)	R. S. O.
	(3)	Isotope Co-60 - Kilocuries

*ATTACHMENT # 5

*ITEM # 16 - TRAINING IN RADIATION PROTECTION BY ALFRED McCABE

a, b, c,	North Carolina State University
a, b, c, d,	Philadelphia College Pharmaceutical Sciences
b, c,	Packard Instruments, Inc.
b, c,	LKB Instruments, Inc.
b, c,	Wallace, oy
b, c,	Laboratorium Prof. Dr. Berthold

*ITEM #17 - EXPERIENCE

Packard Instruments, Inc. - 13 Years
LKB Instruments, Inc. - 4 Years
Berthold Instruments, Inc.- 4 Years

Instrumentation: Liquid Scintillation Counters
Gamma Counters
Proportional Counters

Work Experience: Service, Sales, Product Management, Radiation Safety Officer, Sales Manager, Executive Vice-President.

Activities: ^{3}H, ^{14}C, ^{32}P, ^{60}Co, ^{99}Tm, ^{125}I, ^{131}I, ^{137}Cs, ^{226}Ra, ^{241}Am, Micro Curie quantities.

^{125}I - Demonstrate RIA kits and sealed sources to demonstrate system performance.

ATT # 5 cont

EMPLOYMENT RESUME

William F. Kausek, Jr. R.T.(A.R.R.T.)
302 Wylie Avenue
Strabane, PA 15363
B.D. 2-2-49 Ht: 5'9" Wt: 160

MAY 1983 --- Present

Berthold Instruments, Inc.
136 Bradford Avenue
Pittsburgh, PA 15205

Technical Representative

1981 --- APRIL 1983

Pharmatopes, Inc.
3402 Butler Street
Pittsburgh, PA 15201

Sales Representative

Pennsylvania, and West Virginia area sales representative. Supplied medical radioisotopes and accessory equipment to nuclear medicine facilities.

1974 --- 1981

Diagnostic Isotope Laboratory, Inc.
532 South Aiken Avenue
Pittsburgh, PA 15232

Cheif Nuclear Medicine Technologist

Gamma camera and scanner imaging, Radioimmunoassay, Diagnostic Ultrasound, lab management, billing, bookkeeping, equipment maintenance, office management, Radiation Safety Monitoring

St. Francis General Hospital
Pittsburgh, PA
Continuing Education Program
Radiological Physics & Radiation Biology
April 12 & 13, 1980

Allegheny General Hospital
Pittsburgh, PA
Society of Nuclear Medicine and Technologists
May 1 - 3, 1981

The Penn-Ohio Chapter of the American Asc. of Physicists in Medicine
November 21, 1981
Symposium on Current Topics in Nuclear Medicine

1978 --- 1980

Ultranuclear Imaging Laboratory, Inc.
220 Meyran Avenue
Pittsburgh, PA 15213

Cheif N.M. Technologist

Organized and initiated the operation of this lab.
Diagnostic Nuclear Cardiology and ultrasound procedures.

1978 --- 1979

Instrumentation Industries, Inc.
1121 Streets Run Road
Pittsburgh, PA 15263

Biomedical Repair Technician
Electronic construction of prototype devices

Area Service Rep. for:

Ortho Diagnostic Instruments, Inc.
"Hemac" Lazer Hematology Counter

Data Devices Int., Inc., Kybe Corp.
Computer tape cleaners, testers, and certifiers

Forma, Inc.
Incubation and environmental chambers

1969 --- 1973

United States Navy

Hospital Corps School
Great Lakes, Ill.

Great Lakes Naval Hospital
Great Lakes, Ill.

X-ray Special Procedures (2 yrs.)
Radiation Therapy (2 yrs.)
Routine Radiology (3 yrs.)
Nuclear Medicine (on the job training)
Radiation Safety Monitoring

NORTHWESTERN UNIVERSITY
The Medical School Clinical Training Division
Chicago, Illinois
Radiation Therapy Dosimetry Workshop
April 1, 1970 to June 3, 1970

Honorably Discharged (HM2, E5)

1967 --- 1969

Washington Hospital School of X-Ray Technology
Washington, PA

Two year on the job training in X-ray technology

Received Registry

High School

Canon-McMillan Senior High School
Canonsburg, PA

Acedemic Course
Graduated: 1967

Others:

Cleveland Institute of Electronics
Radiotelephone License and Electronics

National Technical Schools
Electronics
& Air Conditioning, Refrigeration, and Heating

Attachment # 6.

APPLICATION FOR SERVICING OPERATION

APPLICANT

Berthold Instruments
136 Bradford Avenue
Pittsburgh PA 15205
USA
Tel: 412-922-2635 Tlx: 812527

Application Date - April 16, 1984

1 Servicing Operations

a) Specific device:

Berthold level control systems

b) Operations to be performed:

i) To change or replace the sources for renewal or in case of an accident.

ii) Make an area radiation survey, if requested.

iii) Provide wipe test, if required.

c) Step by step procedure:

i) Rod source changing both Cs-137 and Co-60:

- Remove the upper flange by loosening the 4 specified screws.
- Remove the flange on the shielding cylinder.
- Take out the decayed source.
- Install the new source and replace the disassembled parts (flanges).
- The old (decayed) source, is then put into the shipping container and returned to Berthold Company in West Germany or given to a commercial nuclear waste disposal company.
- The time required to handle the unshielded source in the above procedure, approximately one (1) minute and an average distance between the body and source of 1/2 m (18"-20"):

Co-60 maximum source strength 50 mCi
whole body exposure 4.5 mrem

Cs-137 maximum source strength 500 mCi
whole body exposure 12 mrem

ii) Point source changing both Cs-137 and Co-60:

- Remove the upper flange by loosening the 4 specified screws.
- Remove the flange on the shielding cylinder.
- Take out the decayed source.
- Install the new source and replace the disassembled parts (flanges).
- The old (decayed) source, is then put into the shipping container and returned to the Berthold Company in West Germany or given to a commercial nuclear waste disposal company.
- The time required to handle the unshielded source in the above procedure, approximately one (1) minute and an average distance between the body and source of 1/2m (18"-20"):

Co-60	maximum source strength 200 mCi whole body exposure 18 mrem
Cs-137	maximum source strength 1000 mCi whole body exposure 24 mrem

The person doing the above will carry a pocket dose meter with which he notes the total exposure received during this operation. A special log book will be maintained.

d) Names of individuals:

James A. Welsh - Industrial Product Manager

e) Trainer's qualifications:

This training will be provided by the Berthold Company in West Germany, following procedures authorized by the German Government, and this training follows the radiological safety procedures described in Appendix 1.

f) No operations will require radiation surveys.

2 Leak Testing of Sealed Sources

Leak testing, if required, will be done by an authorized, licensed, other United States Organization.

3 Radiation Survey Instruments

We propose using the following instruments:

Dose rate meters: Berthold model LB 133 gamma ray measurement
Victoreen model 493 or 496 gamma ray measurement

These instruments would be returned to the manufacturer for re-calibration. The frequency of re-calibration will follow manufacturer's recommendations.

Attachment #7

INSTRUCTIONS FOR RADIOLOGICAL PROTECTION

C O N T E N T S

INSTRUCTIONS FOR RADIOLOGICAL PROTECTION

The inexpert use of radio-active substances may lead to excessively high doses of radiation which, in the extreme case, can be detrimental to the health of a person. To minimize the risks involved specific tolerance dose values have been stipulated internationally. To ensure their proper observation the use of radio-active substances in the Federal Republic of Germany is subject to the Strahlenschutzverordnung (StrlSchV) dated October 13, 1976.

According to these statutory provisions radio-active substances must, with a few exceptions, only be used after an official approval has been given. An important prerequisite for this approval being given is the appointment of a Radiation Safety Officer unless the holder of the approval as the person responsible for the radiological protection possesses the necessary expert knowledge.

The function of the Radiation Safety Officer essentially consists of making sure that the radio-active substances are handled in an expert manner, the provisions of the approval fully satisfied and the relative points of the StrlSchV strictly observed.

To meet the demands made on him the Radiation Safety Officer must be fully up-to-date with the latest requirements of radiological protection and possess adequate knowledge of both the legal and technical requirements of radiological protection to take the decisions expected of him.

1. Types and Properties of Radio-active Radiation

1.1 Alpha radiation involves particle radiation (alpha-particle = ionized helium nucleus) with a relatively large mass. Even at high energies the material penetration capacity is so small that, for instance, it can be completely shielded by paper less than 0.1 mm thick. Maximum reach in air is approximately 5 to 6 cm.

1.2 Beta radiation likewise involves particle radiation (beta-particle = electron) but with less mass. The penetration capacity is accordingly larger than for alpha-radiation. The penetration capacity also depends on energy and is roughly inversely proportional to the density of the substance. Maximum reach in air can be up to approximately 10 m. In paper it is 1 cm and in aluminium approximately 0.4 cm. If beta-radiation is suddenly braked due to its impact on a heavy element secondary radiation will result. This "Retarded Radiation" is one type of X-radiation referred to as soft gamma-radiation.

× 1.3 Gamma radiation involves electro-magnetic waves radiation (such as light) at high frequency. In contrast to particle radiation no maximum reach can be given. Since the quantums have no charge and no rest mass they have no pronounced interaction with other materials. For this reason, gamma quantums have a relatively large penetration capacity. Interactions with other materials are due to the effects of photo absorption, comptone scattering and pairing. Depending on the energy of gamma radiation these effects appear to a varying degree.

1.4 Neutron radiation, not unlike alpha and beta radiation, involves particle radiation. The particles are neutrons, i.e. electrically neutral nucleus components. Since they have no charge they readily penetrate any substance. The interaction with material primarily depends on the energy (velocity) involved and is based on the scattering of atomic cores and absorption (intake). With fast neutrons those scattering processes are predominant which develop according to the laws of the elastic shock known in mechanics. Since the neutron has roughly the mass of a hydrogen core it is substantially scattered on heavy elements without suffering a major loss of energy. However, upon the impact with hydrogen cores, it will discharge about fifty percent of its energy so that after a very brief period of time (after approx. 18 shocks) it is retarded to a low (thermal) velocity which corresponds with the Braun molecular movement.

2. Dosimetric Evidence

Ionization chambers, Geiger counters/halogen quench Geiger tubes and scintillation counters are the more common detectors for documenting alpha, gamma and neutron radiation. Radiation measuring instruments for the most varied applications such as dosemeters are commercially obtainable.

Since alpha and beta radiation have a low penetration capacity only the radiation windows of the detectors must be accordingly thin. With alpha and

beta radiation detector evidence is produced by the filler gas in the counting tube being ionized or a scintillator being excited to emit light.

With gamma radiation evidence is produced by secondary electrones being directly released across the detector walls or a scintillator being excited.

Neutron radiation, too, is only indirectly evidenced. Fast neutrons are retarded down to thermo energy by means of moderators (hydrogen cores such as prevailing in paraffin or plastic) before being measured by detectors which contain a strongly neutron-absorbing element such as boron or lithium. In personnel dosimetry measuring instruments are used which accumulate the radiation dose received and which are evaluated at more or less long periods of time.

In film dosimetry the blackening of photographic emulsions is utilized to determin the radiation dose received. Film dosemeters contain a film in a cartridge protected from the light. The cartridge has a number of metal filters. From the blackening generated behind the various filters the exposure dose and the"radiation grade"can be told.

Glass dosemeters contain a silver-activated phosphate glass contained in a capsule. Depending on the degree of radiation exposure more or less strong fluorescent centres are generated which, upon evaluation, are excited by UV light. The intensity of the fluorescent light is proportional to the dose received by the glass.

Pocket dosemeters provide direct reading of the dose received. They consist of a small electrometer whose cross-wire is made visible on a scale through a magnifying glass. Pocket dosemeters are charged by brief connection to a voltage supply and discharged in accordance with the radiation dose to which they are exposed.

3. Important Terms

3.1 Activity

Radio-active sources are substances which decompose as a result of nuclear processes, emitting radiation quantums. The number of emitted radiation quantums per time unit is referred to as activity. More recently, the unit of measurement is the reciprocal second ($1/s = S^{-1}$) indicated in Becquerel (Bq) (1 Bq = 1 disintegration/second). Another unit of measurement is Curie (Ci) which is equivalent to the activity of 1 g radium with 3.7×10^{10} disintegrations per second. From this the following conversions can be made:

$$1 \text{ Ci} = 3.7 \times 10^{10} \text{ Bq or}$$
$$1 \text{ mCi} = 37 \times 10^{6} \text{ Bq } (= 37 \text{ MBq})$$

3.2 Dose

3.2.1 Energy dose

The effectiveness of radiation depends on the energy dose, i.e. on the radiation energy imparted to the

radiated body related to the mass of the radiated volume. The unit of measurement nowadays used is the Gray (Gy), one Gy being equivalent to the energy dose corresponding to the energy of 1 Joule per Kg. Another unit of measurement is called Rad (rd) which is subject to the following conversion:

$$1 \text{ rd} = 10^{-2} \text{ J/kg} = 10^{-2} \text{ Gy}$$

3.2.2 Dose equivalent

Even with the energy dose being the same ionizing rays may have varying degrees of biological effectiveness in the body tissue. To assess this varying biological effectiveness for different kinds of radiation the quality factor (RBW factor = relative biological effectiveness factor) is used.

The energy dose multiplied by the quality factor gives the dose equivalent which is more recently indicated in Joule per Kg (must not be indicated in Gy since this term should exclusively apply to the energy dose). The dose equivalent 1 Joule/kg may also be expressed by 1 Sievert (Sv).

In addition to this, the term (rem) is used which expresses the following relationship:

$$1 \text{ rem} = 10^{-2} \text{ J/kg} = 10^{-2} \text{ Sv}$$

By assessing the energy dose on the basis of the quality factor it is possible to compare and add radiation quantities of different type and energy.

The following quality factors apply to different types of radiation:

Alpha rays	- quality factor = 20
Beta and gamma rays	- quality factor = 1
Neutrons, depending on energy	- quality factor = 3 to 10[x])

[x]) Note: If the energy is not known invariably use a quality factor of 10 to provide maximum safety.

3.3 Dose rate

The unit of measurement for the intensity of radiation is the radiation dose per time unit expressed in dose rate.

$$\text{Dose rate} = \frac{\text{dose}}{\text{time}}$$

The dose rate is normally given in hours expressed in mrem/h or (mJ/kg) per hour.

The dose rate (Dl) generated by an unsealed source at a given distance can readily be calculated from the activity (A) provided the dose rate constant (k) for the source is known.

$$Dl = A \cdot k$$

The following dose rate constants apply to the most frequently used isotopes:

for Co-60 $1.35 \frac{mrem \cdot m^2}{h \cdot mCi}$

for Cs-137 $0.35 \frac{mrem \cdot m^2}{h \cdot mCi}$

for Am-241 $0.0075 \frac{mrem \cdot m^2}{h \cdot mCi}$

4. Radiation Protection Measures

If the human body is exposed to radio-active radiation chemical and biological processes are set in motion in the body cells which may lead to cell changes, damage or destruction. In extreme cases, a poor blood count, skin burns, eye or gene damage may be the results.

To exclude detriments to the human body with a degree of probability bordering on absolute certainty, the annual maximum dose allowed for different groups of persons has been agreed internationally. One of the first and foremost demands is that every unnecessary exposure to radiation should be avoided and that measures must be taken to minimize exposure in the handling of radio-active substances.

The radiation protectures to be taken can r iily be derived from the formular for the calculation of the radiation dose.

The radiation dose (D) depends on the activity of the source (A), its dose rate constant (k) and the distance (a) from the source, the radiation time (T) and the weakening factor (s) of an existing shield.

$$D = \frac{A \cdot k \cdot T}{a^2 \cdot s}$$

Since "A" and "k" are given the above formular involves the following possible radiation protection measures:

a) Increasing the distance (a) to the radiation source, i.e. the distance between the source and the body. Since the dose rate (just as the light) follows the square law, doubling the distance means reduction in radiation intensity to one quarter.

b) Shortening the duration of exposure (T). The time as a linear effect, i.e. doubling the period of exposure means twice the radiation dose.

c) Use of shielding with a high weakening factor (s). This has an exponential dependence on the product from thickness and density of the shielding material.

With the help of these measures it is possible to prevent operating personnel, under normal operating conditions, from an exposure that exceeds the limits given by the legislator. A careful approach, reducing the exposure times to a minimum and keeping a maximum

possible distance from the source can all help to reduce, in practically all cases, the exposure to below the film dosemeter recording limit.

5. Functions of the Radiation Safety Officer (SV) and the Radiation Safety Steward (SB)

According to para 29 of the StrlSchV, the holder of the approval has to be the Radiation Safety Officer. Since he cannot normally perform the radiation protection functions himself he has to appoint in writing a Radiation Steward and authorize him accordingly. The position of the Radiation Safety Officer and the Radiation Steward are stipulated in para 30 of the Strahlenschutzverordnung and the obligations are given in para 31 of the Strahlenschutzverordnung.

In addition to the General Radiation Protection Principles (para 28) the following more important obligations apply:

5.1 No process involving exposure to radiation shall be carried out prior to the respective approval being given. The prerequisites for such an approval are stipulated in para 6 of the Strahlenschutzverordnung. As a rule, the factory inspection office and, in the Free State of Bavaria, the environmental control office of the land are the authorities concerned (see enclosure II). Insofar as the mining industry is concerned, the respective chief mine inspectorate is concerned.

5.2 The quantity and type of radio-active substances used must not exceed the scope of the approval.

5.3 The requirements specified in the approval must be strictly observed.

5.4 The installation or incorporation of the radiometric measuring instruments has to be monitored.

Important note: During the installation make sure that the work shielding remains closed to screen the active radiation bundle. The source must not be removed from its shield. Strictly observe the requirements specified in the approval !

5.5 Where control areas are to be observed these must be marked off and identified.

5.6 The persons working in the plants sections concerned have to be informed and instructed accordingly.

Main items of information:

- purpose, set up and function of the equipment
- dose rates
- radiation protection areas
- possible detriments and their external symptoms
- prevention of unnecessary radiation exposure

5.7 In special cases written instructions are to be issued. These instructions must consider the specialities of the plant concerned and may, at the same time, be used as a basis for informing and instructing the operating personnel.

5.8 Considerations must be given too and measures taken for situations arising from accidents or catastrophes (such as fire, explosion).

5.9 Radio-active substances must be protected from misappropriation and unauthorized persons. This applies in particular to radio-active sources temporarily not in use which must be stored in protected rooms or containers.

5.10 Radio-active substances no longer required are to be returned to a state disposal for radio-active waste or to the supplier (para 47 of the Strahlenschutzverordnung).

Enclosure I includes a list of all obligations incumbent on the radiation safety officer and radiation safety steward as specified in the Strahlenschutzverordnung).

6. Permissible Radiation Doses

6.1 Occupationally not exposed persons

Persons and, more particularly, members of the plant which are not occupationally exposed to radiation must not exceed an annual dose of 0.5 rem if they work in a monitoring area adjacent to the control area (para 51 as well as enclosures I and X of the Strahlenschutzverordnung).

6.2 Occupationally exposed persons in the category B

Personnel whose annual dose is higher than 0.5 rem but less than 1.5 rem rank amongst the occupationally exposed persons in category B. The body doses are to be recorded but no medical examination is generally required (para 49).

6.3 Occupationally exposed persons in the category A

Persons whose annual dose exceeds 1.5 rem must be classified category A. The maximum permissible radiation dose for these persons is 5 rem per annum. The personnel doses are to be determined by means of officially evaluated dosemeters. A medical examination once yearly is essential (paras 49 and 67).

7. Radiation Protection Areas

7.1 Barred areas

These are areas with a dose rate higher than 300 mrem/h. These areas must be secured so that no body can enter them unchecked, not even with parts of the body. Entry is only permitted under specific conditions and if there is an absolute need for it. The body doses must be recorded and the personnel doses measured (para 57).

Important note: These areas are restricted to the active radiation bundle. If it is possible to reach into the area, the area must be guarded accordingly.

7.2 Control areas

These are areas with dose rates of equivalent to or larger than 0.75 mrem/h. Control areas must be marked off and provided with a radiation warning symbol and the addition "Control Area" (also see DIN 25 430). Entry to the control areas is only allowed for carrying out specific operations. The body doses must be determined or the personnel doses measured. The authority concerned may grant exceptions if it can be proved that the whole body dosis will not exceed 1.5 mrem/year (para 58).

Important note: DIN 54 115, sheet 1 point 5. 3. 6 provides that in small areas in which whole body radiation is practically impossible, the regulations for control areas such as marking offand identification may be dispensed with.

7.3 Monitoring areas

The plant monitoring area starts at the control area with a dose limit of 1.5 rem per annum where an individual stayis in the area for 40 hours per weak (which is equivalent to a dose rate of 0.75 mrem/h) and reaches to a dose rate of 0.5 rem per annum for a theoretical stay of 8760 hours per annum. Measures must be taken to ensure that persons will not be exposed to a higher dose than 0.5 rem per annum considering the actual visits in this area.

The external plant monitoring area follows the plant monitoring area and ranges to a dose limit of 30 mrem

per annum. Measures must be taken to ensure that persons in the external plant monitoring area will not be exposed to a higher annual dose than 150 mrem/h.

8. Physical Radiation Protection Control

Depending on the prevailing working conditions the respective authority can specify the manner in which the body dose is to be determined, viz.:

a) by assessment or calculation.
b) by measuring the local dose or local dose rate.
c) by measuring the personnel dose.

If the authority has not specified the manner in which the body dose is to be determined, the personnel dose must be measured. For this, dosemeters are to be used and obtained from the land office concerned. The control office evaluates the personnel dose from the dosemeter and informs the indenting office concerned in writing.

All results of measurements and determinations are to be recorded and to be filed for 30 years. They are to be submitted to inspection by the authority concerned.as and when required.

Occupationally exposed persons in the category A have to be examined by a competent doctor. This examination is to be repeated after the expiry of one year. Further employment in the control area is only permissible after a certificate of non objection has been granted.

9. Further Regulations

9.1 Storage and custody

Radio-active substances must be stored in protective rooms or containers if not in use. Storage must be such that misappropriation or access by unauthorized persons is precluded (para 74).

9.2 Checking of sealed radio-active substances

Sealed radio-active substances are checked by the manufacturer for proper sealing prior to delivery. They are supplied with a relevant certificate which the user has to file and, upon request, submit to the respective authority. If it is found that the sealing of a source is damaged or corroded or, if so specified in the approval, a new sealing test has to be carried out by an office to be specified by the respective authority.

9.3 Transmission of radio-active substances

Radio-active substances must only be handed over or transmitted to persons which hold an appropriate approval. This also applies to the transmission to a carrier for the transport of the source on public roads. The carrier must be in possession of a carrying approval unless an exemption has been granted according to para 9 of the Strahlenschutzverordnung.

9.4 Recording and reporting

The acquisition of radio-active substances must be notified to the authority concerned within one month

indicating the type and activity involved and inclosing a copy of the sealing certificate. An inventory has to be submitted at the end of each calendar year (para 78, sections 1 and 3 of the Strahlenschutzverordnung). Moreover, records must be kept on the acquisition and transmission of radio-active substances. These records have to remain in the files for 30 years and must be submitted to the authority concerned upon request.

To ensure proper adherence to these instructions radio-active substances must only be purchased by the radiation safety steward.

9.5 Misappropriation of radio-active substances

The misappropriation of radio-active substances is to be reported at once to the supervisory authority or the authority concerned with public safety and order.

9.6 Penalties

Violations of the Strahlenschutzverordnung (regulations governing radiation protection) are offences subject to the payment of penalties. The radiation safety officer can be personally held responsible (para 81, section 2.3 of the Strahlenschutzverordnung).

10. Shielding

Alpha and beta rays have a low capacity of penetration and can readily be shielded. As has been said before alpha radiation can be shielded by thin paper and beta radiation by a few millimeters of metal.

The shielding effect in the case of gamma radiation depends, as a first approximation, on the specific wegt of the absorber. Calculations are based on so-called half-value layers. These indicate the respective thickness of the substance which reduces the original radiation dose to half its value. The following half-value layers apply for Co-60, Cs-137 and Am-241 for the more important shielding materials:

Material	Half-value Layer for Co-60	CS-137	Am-241
Water	157 mm	110 mm	40 mm
Concrete	68 mm	47 mm	15 mm
Steel	20 mm	14 mm	0.8 mm
Lead	14 mm	9 mm	0.13 mm
Heavy metal (T)	9 mm	6 mm	-

These figures are mean figures which may vary depending on the measuring field and source intensity.

Neutron radiation is shielded by means of hydrogen containing products such as water, paraffin or

polyethylene. The fast neutrons can be retarded by means of hydrogen down to thermo energies. The thermo neutrons are then shielded by thin cadmium sheeting which has a high absorption cross-section for thermo neutrons.

As an approximate value the half-value layer for paraffin is approx. 67 mm.

With the help of the formular given in section 4 (Radiation Protection Measures) a calculation of the expected radiation dose may now be carried out.

Example: A source with 10 mCi Co-60 is incorporated in a shielding of 67 mm lead thickness. Work has to be carried out at a distance of 50 cm for a period of 30 minutes.

Weakening factor

$$s = 2^{\frac{d}{HWS}} = 2^{\frac{67}{14}} = 27.6$$

Radiation dose

$$D = \frac{A \cdot k \cdot T}{a^2 \cdot s} = \frac{10 \cdot 1.35 \cdot 0.5}{0.5^2 \cdot 27.6} = \underline{0.98 \text{ rem}}$$

11. Rules of Approach

From the respective use, the set up of the measuring equipment, the type and enclosure of the source and the design of the shielding specific rules of approach can be derived which help to ensure safe operation and maintenance.

When drawing up instructions concerning the rules of approach, the following situations should be considered:

- Installation and removal of the plant (sources must never be removed from their work shielding).

- Measures to be taken where work has to be carried out in the immediate vicinity of the shielding.

- Measures to make sure that the lock of the shielding is closed if it should ever be necessary to walk on the container.

- Responsibility for the key to open and close the lock on the work shielding.

- Measures to be taken in the event of serious operational trouble, accidents or fire.

Positive measures must be taken to ensure that the radiation safety steward is informed at once if the function of the shielding or the capsular of the source could be affected in the event of trouble. He must check the situation on the spot and initiate all measures to prevent any unnecessary radiation exposure of the operating personnel.

TECHNICAL DOCUMENTS
SUPPORTING AN APPLICATION FOR PERMISSION TO HANDLE RADIOACTIVE SUBSTANCES

Commission number: (please quote)

Applicant:

1. Description of the radioactive substance:

1.1	Isotope designation:	$^{241}Am/Be$
1.2	Chemical composition:	Am_2O_3-Be
1.3	Physical state:	in powder form, pressed
1.4	Enclosed or open:	enclosed
1.5	Number off and individual activity:	off, each 100 mCi neutron yield 2.5×10^5 n/s
1.6	Manufacturer:	Amersham Buchler, Braunschweig
1.7	Supplier:	Labor Prof. Dr. Berthold, Wildbad/Schwarzwald, Germany

2. Description of the enclosure:

The radioactive substance is housed in a double special steel enclosure which is made leakage-proof by inert-gas welding. For details regarding the construction of the enclosure see drawing number P 2611-100. The enclosure of the radioactive source is tested for leaks prior to delivery by the manufacturer or supplier following the guidelines of the Physikalisch-Technische Bundesanstalt and a relevant certificate is issued.

3. Description of the shield:

The source is permanently fitted in the probe. The probe tube includes a Pb-shield which completely absorbes the 60 keV radiation (see drawing number 19166-002). When the probe is not in use (storage and transport) it is housed in the shield container LB 7407 Z (see drawing number 21121-002). The dose rates at the surface of the shield container are 2.5 mRem/h. The probe is fitted in such a way that the dose rates at generally accessible points are as low as 0.75 mRem/h under operating conditions.

4. Dose rates:

At a distance of 1 m from the unshielded source

by neutrons:	approx. 0.3 mRem/h
by gamma rays:	approx. 0.25 mRem/h

Limit of the control range from the unshielded source:	approx. 90 cm
Neutron dose rates at a distance of 1 m in the direction of the protective tube opening:	approx. 0.3 mRem/h
Limit of the control range from the neutron source fitted into the probe:	approx. 65 cm
Neutron dose rates at the face of the probe at a distance of 15 cm (30 cm polyethylene sphere fitted on direct):	approx. 12 mRem/h

5. Description of the intended handling process or use:

   The stationary moisture bunker probe is used for measuring the moisture or hydrogen content of container contents.

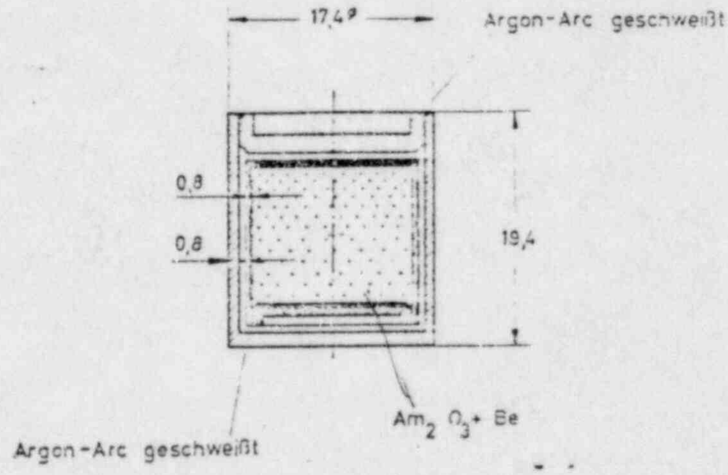
6. Protective equipment and protective measures:

7. Information regarding the whereabouts of radioactive sources which are no longer required:

   They will be returned to the relevant state collection point for radioactive waste or to the supplier.

Date:

Enclosures:
Drawing P 2611-100
Drawing 19166-002
Drawing 21121-002
PTB Opinion 6.3-27108/73



Neutronenausbeute: ~ $7{,}5 \cdot 10^5$ n/s (± 15 %) bei 300mCi ^{241}Am Be
~ $2{,}5 \cdot 10^5$ n/s (± 15 %) bei 100mCi ^{241}Am Be
~ $7{,}5 \cdot 10^4$ n/s (± 15 %) bei 30mCi ^{241}Am Be

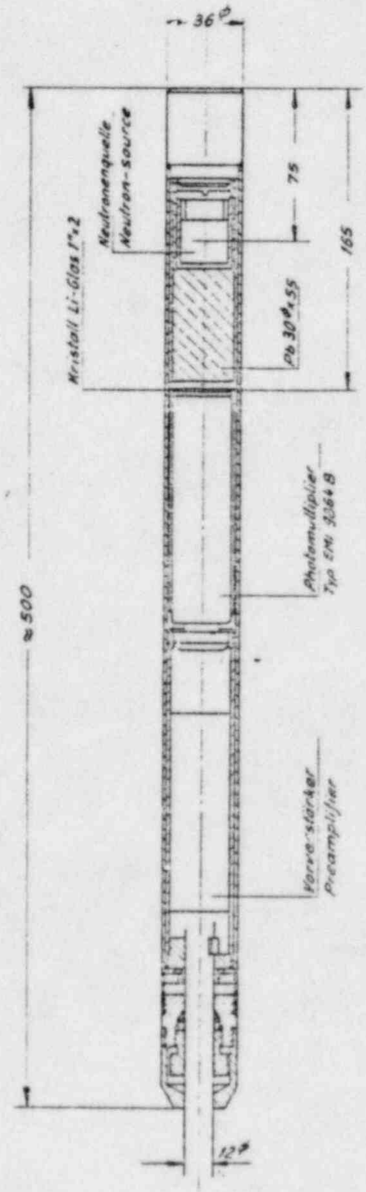
Dichtigkeitsprüfung:
Immersionstest (8 h in Wasser von 50° C)

Material der Umhüllung
Stainless Steel (18 Cr, 8Ni, 1Mn)

Kapseltyp: X . 2

Laboratorium Prof. Dr. Berthold
Wildbad im Schwarzwald

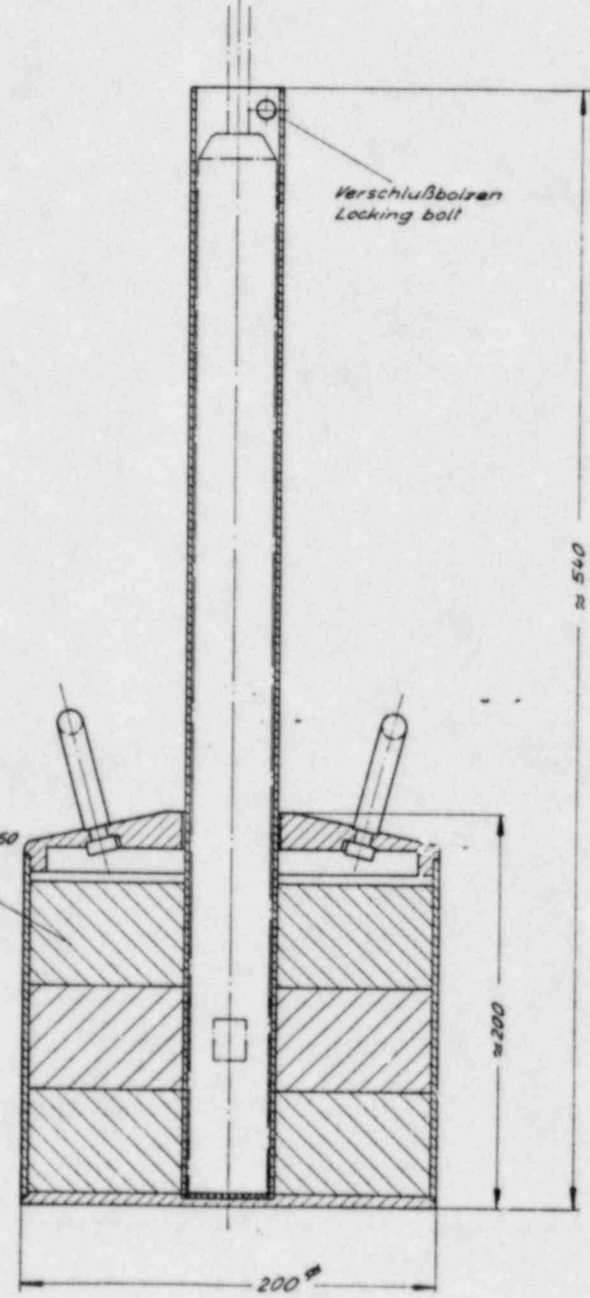
Bearbeitung	
Sonderbearbeitung	
Werkstoff	
Maße ohne Toleranzangabe	
Diese ... werden besonders geprüft	
Tag	Name
18.2.63	
Maßstab 2 : 1	Americium - Beryllium - Neutronenquelle 30, 100 u. 300 mCi Hersteller: Radiochemical Centre Amersham
Zeichnung Nr.	P 2611 - 100



7547 Wildbad Schwarzw.

Feuchte-Bunkersonde LB 6600 Z
Moisture-bunkerprobe LB 6600 Z

19 166-002



berthold
7547 Wildbad / Schwarzw

Abschirm- u. Transportbeh. LB 7407 Z f. Sonde LB 6600Z Shielding- a transp. container LB 7407 Z for Probe LB 6600Z	Zeichn. Nr. 21 121 - 002

Letter from: Physikalisch-Technische Bundesanstalt
33 Braunschweig
Bundesallee 100

Dated: 9.10.1973

To: Messrs. Amersham Buchler GmbH & Co KG
33 Braunschweig
Postfach 1120

Reference no.: 6.3 - 27108/73

Re: $^{241}Am/Be$ - Neutron sources; Statement with regard to section 44 of the First Radiation Protection Act

Regarding your application Sta/Gae of 12.9.1973

The statement given below refers to the following source types:

Code no.	maximum activity	capsule type	capsule dimensions diameter	height	wall thickness
AMN 11 to 18 AMN 116 and 117	300 mCi	X.2	17.4 mm	19.4 mm	2 x 0.8 mm
AMN 19 and 22 AMN 118 and 122	1 Ci	X.3	22.4 mm	31.0 mm	2 x 1.2 mm

1. Source construction: The sources produced by the Radiochemical Centre Amersham/England contain ^{241}Am in oxide form mixed with Be powder. In sources AMN 11 to 22 the mixture is pressed into tablet form while types AMN 116 to 122 are sintered at 1400° C. The latter form provides increased safety but reduced neutron emission.

   The radioactive substance is enclosed in a double-walled container; both enclosures consist of stainless steel sealed by argon arc welding.

   The used capsule types X.2 and X.3 are approved as "sources of specific form" under the international agreements for the safe transport of radioactive substances.

- 2 -

2. Conclusions: Prior to handing the sources over to the user the enclosure should be checked for leaks and adequate decontamination. If the activity of the removed radioactive substance is below 5 nCi, then the source is to be considered as an enclosed radioactive substance as laid down in section 2 (2) of the First Radiation Protection Act.

   Provided the sources are not subject to extraordinary mechanical, thermal or chemical stresses under operation or use, the sturdy construction of the enclosure justifies the period for repeat tests in accordance with section 44 of the First Radiation Protection Act being extended to three years. However, an immediate check by an official measuring authority is to be arranged should a leak be suspected due to damage or other exessive stresses having occurred.

   The invoice for this statement is enclosed.

per procura

(signed)

1 enclosure

(Prof.Dr.H.M.Weiss)

Technical documents supporting an application for
permission to handle radioactive substances

Commission number:

Applicant:

1. Description of the intended handling process or use of radioactive substances:

   Attachment for the sulphur analyser for compensating the C/H effect (manufacturer: Labor Prof. Dr. Berthold)

   For details regarding the operation and construction of the measuring system see the arrangement diagram 15 143.001.

2. Description of the radioactive substance:

2.1 Isotope designation:	$^{241}Am/Be$
2.2 Chemical composition:	Am_2O_3-Be
2.3 Physical state:	in powder form, pressed
2.4 Form of delivery:	enclosed
2.5 Number off:	
2.6 Activity:	100 mCi neutron yield $2.5 \cdot 10^5$ n/s
2.7 Manufacturer:	The Radiochemical Centre, Amersham/England

3. Description of the enclosure:

   3.1 $^{241}Am/Be$ source:
   The radioactive material is enclosed in a double-skinned enclosure of stainless steel (18% Cr, 8% Ni, 1% Mn) which is argon-arc welded (see enclosure: dimension sheet P 2611-100).

4. Radiation protection:

   4.1 Source location:
   The neutron source is permanently fitted in the special-steel through-flow container (pressure-proof up to 15 metric atmospheres gauge).

4.2 Dose rates:

4.2.1 At a distance of 1 m from the unshielded source
caused by neutrons: approx. 0.3 mRem/h
caused by gamma radiation: approx. 0.25 mRem/h

4.2.2 Limit of the control range with unshielded source: approx. 90 cm

4.2.3 Limit of the control range with fitted source (without the oil filling in the through-flow container): at a distance of approx. 65 cm.

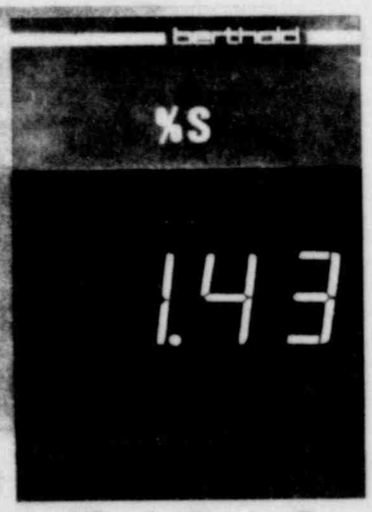
4.2.4 Neutron radiation dose rate at a distance of 1 m in operating condition (with oil filling in the through-flow container): approx. 0.1 m Rem/h.
In this case the control range limit is at a distance of only approx. 35 cm from the source.

Note:

The dose rate values quoted were measured using a wavelength-independent dose rate meter type TOL/E (for the gamma radiation) and a virtually energy-independent neutron Rem dose rate meter type LB 140.

Date:

Enclosures: 1 prospectus
1 drawing 15143.001
1 dimension sheet P 2611-100
1 drawing 1555.100-021
1 x CERTIFICATE OF APPROVAL OF DESIGN OF CAPSULE SFC 8
1 x CERTIFICATE OF RADIOACTIVE SOURCE INTEGRITY QCS 167



Berthold Continuous Sulphur Analyzer LB 375 for Mineral Oil

Accuracy 0.01 % weight

Continuous sulphur analyzer LB 375 . . .

Applications

The continuous Sulphur Analyzer LB 375 has been designed for continuously monitoring the sulphur content of mineral oils without physical contact with the oil.

The Analyzer LB 375 is used for

- checking crude oil supplies, separating oil grades in process plants, during processing for product mixing and for final product checking
- for monitoring SO_2 and SO_3 emission from oil-fired power stations by checking the sulphur content of the fuel oil

  The system LB 375 is capable of determining the concentration of elements with higher atomic numbers in a fluid consisting of constituents with lower atomic numbers (hydrocarbons etc.), for example the lead content of petrol.

Operation and mechanical layout

A bled-off sample flow of mineral oil flows upwards through a measuring arrangement consisting of several counting sections for measuring the sulphur content, density, hydrogen content and temperature. The sulphur content is established by measuring the absorption of the radiation emitted by a ^{244}Cm source (10 mCi, half-life = 17.8 y). The density is determined by an absorption measurement of the gamma radiation from an ^{137}Cs source (100 mCi, half-life = 30 y). This is carried out in a second counting section which is adapted to the measuring problem and mounted on the same equipment frame. Both radiation intensities are measured by a suitable NaI (Tl) scintillation detector. The oil must have the same density and temperature in both measuring paths. When monitoring hot oil, the tube connecting the two oil flow counting vessels must therefore be thermally insulated. It is important, however, that a vertical air gap should remain between the windows of the oil flow counting vessels and the source on the one side and the detector on the other, so that the resulting air circulation prevents temperatures in excess of 60° C at the detector.

Where it is necessary to determine the hydrogen content, the oil is passed through an additional measuring cell which houses a fast neutron source (100 mCi AmBe). The slow neutrons, which provide an indication of the hydrogen concentration, are counted by a lithium glass scintillation detector.

The measuring arrangement can also include a temperature sensor in a pressure-sealed enclosure.

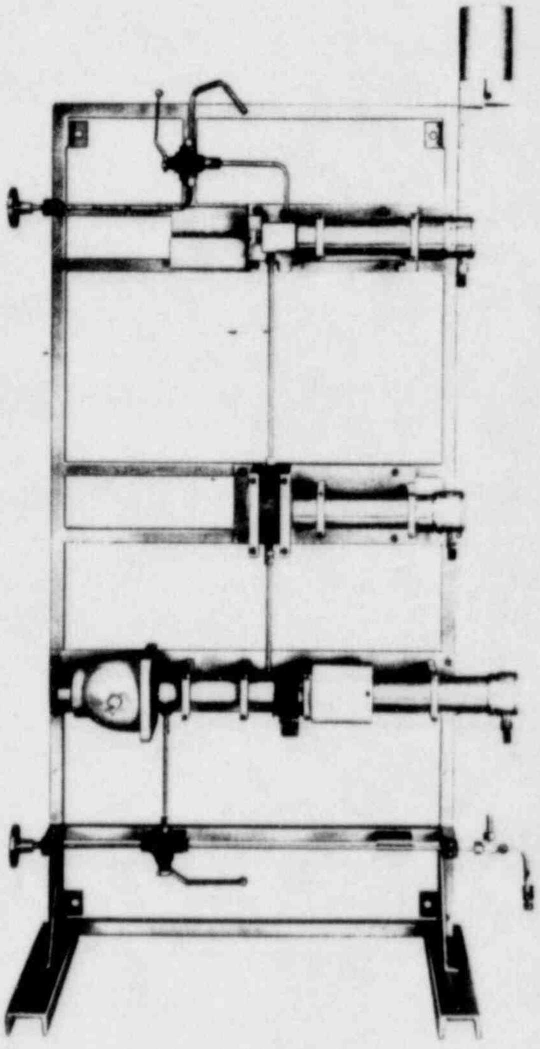
Advantages of continuous measurements without direct medium contact

No sample extraction and sample preparation, consequently reduced labour costs.

Count result unaffected by physical variables, e. g. pressure, temperature, viscosity and flow rate of product

high long-term stability

no wearing parts



Measuring arrangement for continuous sulphur analysis

LABORATORIUM PROF. DR BERTHOLD · D-7547 Wildbad 1 · Calmbacher Str. 22 · P. O. Box 160 · Phone (0 70 81) 39 81 · Telex 7 24019

.... measures the sulphur content of mineral oils without contact with the oil

The measuring amplifier and how it operates

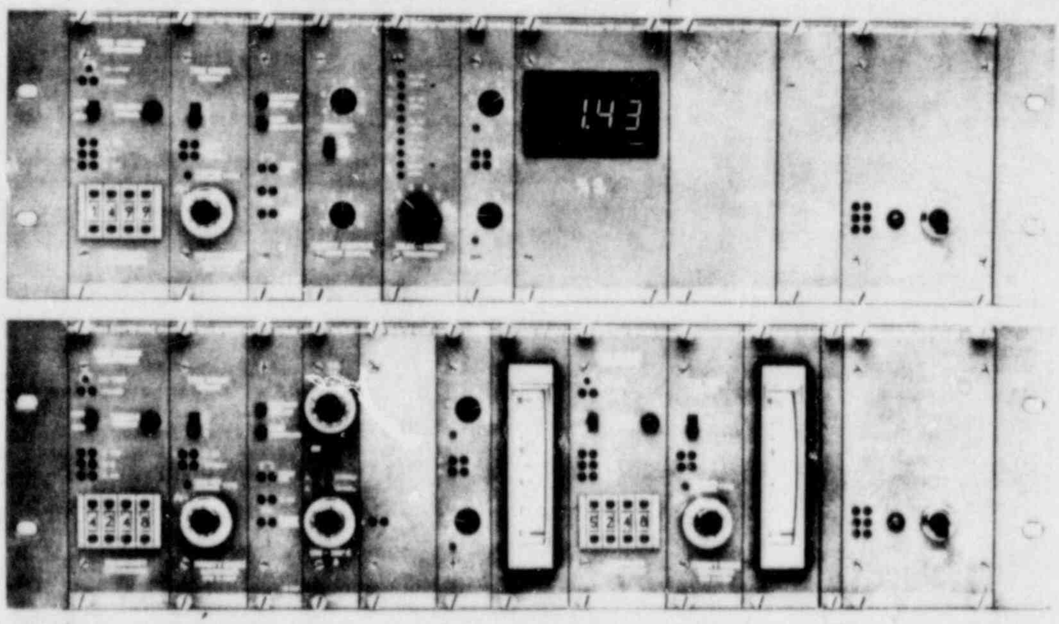
The individual scintillation detectors are connected to a ± 15 V power supply provided by the TOWER SUPPLY module. The HV supply for the photomultipliers and also control of drift stabilization (German patent) of the electronic measuring circuits is performed in the housing of the scintillation detector. The standard count pulses generated by the detectors are connected through optocouplers to their respective measuring devices. A special circuit layout ensures high interference rejection. The measuring amplifiers are assembled from individual function modules on European standard printed circuit cards which are plugged into two module chassis (chassis height 3 U). A special calculator card is included to provide compensation and linearisation of the count results. The sulphur content is indicated on a digital read-out, the hydrogen density on an analog edge-type instrument. Two HI/LO thresholds for sulphur content and density are also included.

The output consists of 0/4–20 mA current outputs for sulphur content (electrically isolated) and for density and hydrogen density (electrically isolated version optional).

A further option allows the selection of up to 5 extended sub-ranges of the sample content. This range extension only affects the current output. The range selection can also be controlled externally.

A product temperature compensated density output is also available as a separate option.

Sulphur content measurement LB 375 S



Density measurement LB 375 D

Hydrogen density measurement LB 375 H

LABORATORIUM PROF. DR. BERTHOLD · D-7547 Wildbad 1 · Calmbacher Str. 22 · P. O. Box 160 · Phone (0 70 81) 39 81 · Telex 7 24019

Continuous Sulphur Analyzer LB 375

Accuracy

Sulphur content:	max. 0.01 % weight. 1 % of measuring range
Density:	± 0.0004 g/cm³
Hydrogen content:	0.0002 g/cm³

Effects of Impurities on S measurement

Max. change of fraction	% S	Max. change of fraction	% S
100 ppm V	0.026	1000 ppm N	0.0038
100 ppm Fe	0.036	1000 ppm H_2O	0.0062
100 ppm Fe_2O_3	0.030	1000 ppm O_2	0.0074
100 ppm Na	0.003	1000 ppm SiO_2	0.033
100 ppm NaCl	0.008	1000 ppm Al_2O_3	0.030
100 ppm Cl	0.011		

Technical Data

Measuring Arrangement

Dimensions:	1925 x 1050 x 470 mm
Material:	Measuring sections: special steel, equipment frame: steel Permachron, stove enamelled
Product connections:	Flange sizes to user specification
Weight:	150 kg (incl. scintillation probes)
Max. product temperature:	473 K, for short periods 523 K (200° C, 250° C)
Max. pressure:	1.5 x 10^6 Pa, for short periods 2 x 10^6 Pa (15 bar, 20 bar)

Radiation Sources

Sulphur content:	3.7 x 10^8 Bq (10 mCi) ^{244}Cm half-life 17.8 y
Density:	3.7 x 10^9 Bq (100 mCi) ^{137}Cs half-life 30 y
Doserate at 1 m distance:	0.05 mR/h
Hydrogen density:	100 mCi ^{241}Am/Be half-life 433 y
Doserate at 1 m distance:	0.1 mR/h

Temperature Sensor

Resistance thermometer:	Pt 100, 4-wire network
Enclosure:	Flameproof Ex d 3n G5

Scintillation Probes

Sulphur content:	Sz 5 S 40/5 with NaI (Tl) crystal and radiation window made of 2.5 mm beryllium
Density:	Sz 5 D 1 40/35 with NaI (Tl) crystal, radiation window made of 3 mm steel
Hydrogen content:	Sz 5 H 44/2 with lithium glass scintillator
Housing:	Stainless steel
Weight:	6 kg (Sz 5 DI 15 kg)
Enclosure:	EEx dellC T6 to DIN EN 50014 En 50018, EN 50019, PTP No. Ex-80/1007 suitable for zone 1 applications
Ambient temperature:	253 K to 323 K (−20° C to +50° C)
Enclosure:	IP 65
Electrical connections:	Cable YMHCY – o. z. 7 x 1.5 max. length: 1000 m (Waflex CY – o. z. 7 x 1.5)
Supply voltage:	+15 V, 0V, −15 V

Measuring Amplifiers

Module chassis:	2 x 3 U high / 84 U wide
Power supply:	50/60 Hz, + 10 % to − 15 % 220 V, 110 V, 24 V
Power consumption:	approx. 60 VA
Ambient temperature:	273 K to 323 K (0 to +50° C)

Outputs

Sulphur content:	0/4–20 mA burden 500 Ω, isolated
Density:	0/4–20 mA, burden 500 Ω, and 0/10 V for compensation
Hydrogen density:	0/4–20 mA, burden 500 Ω, and 0–10 V for compensation
For sulphur content and density:	HI/LO relays, each with 1 change-over contact, max. 250 V/2 A, non-inductive open collector + 30 V, max. 0.1 A

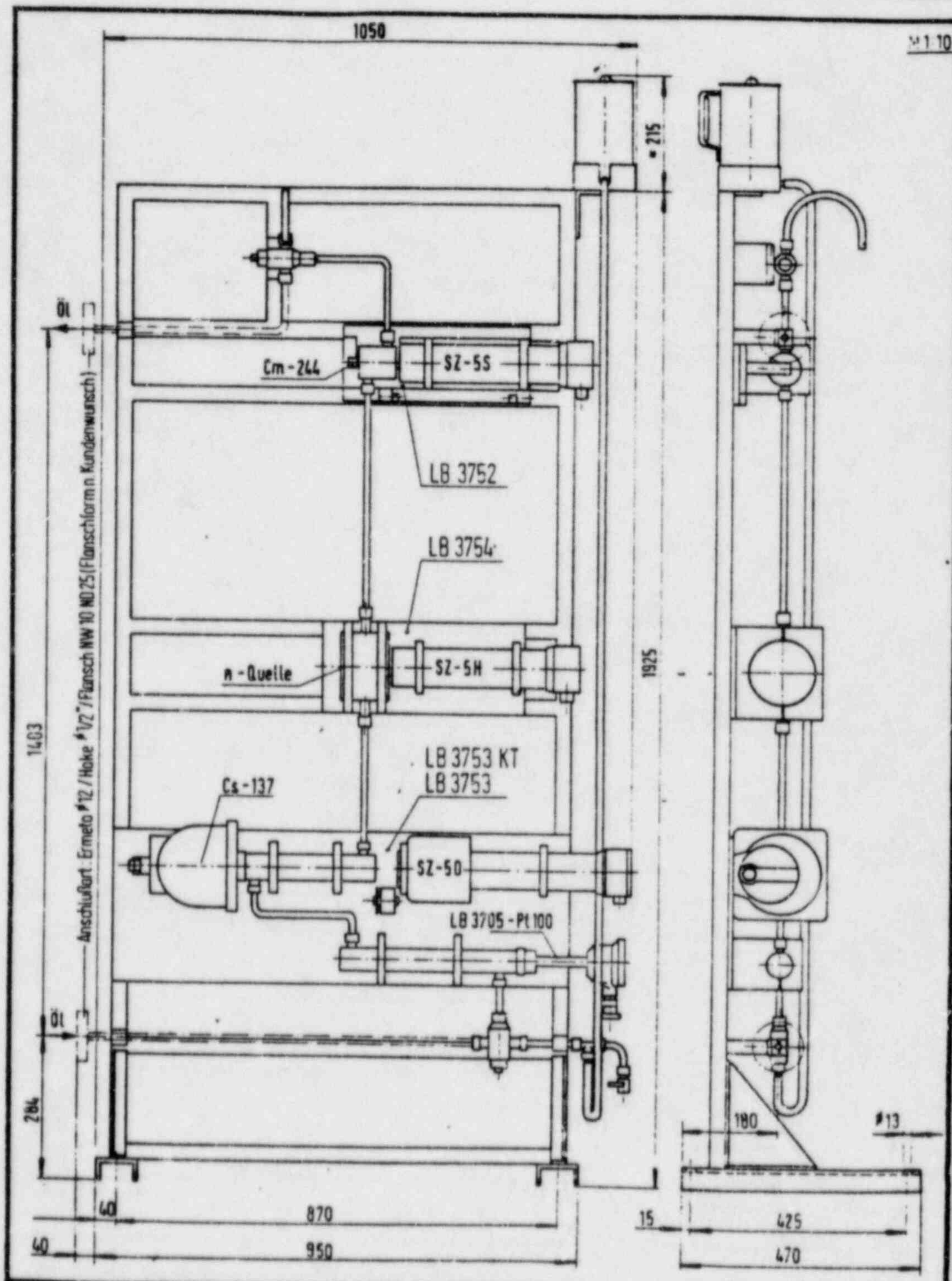
Display:

Sulphur content:	digital, 3.5 digits
Density and hydrogen content:	analog accuracy class 1.5

Details required for System Planning:

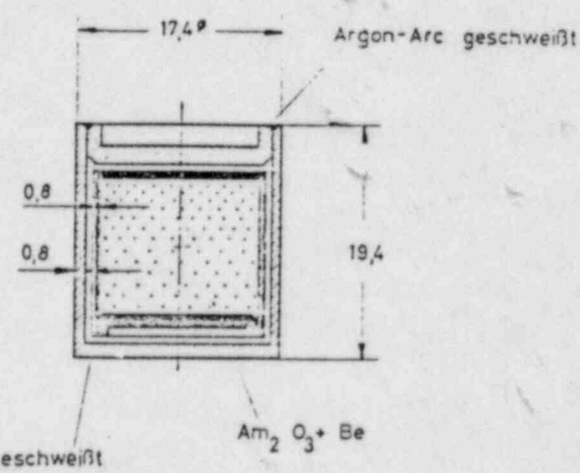
1. Anticipated min. and max. sulphur content ..... % S to ..... % S
2. Min. and max. product density at normal operating temperature ..... g/cm³, ... g/cm³
3. Typical and max. product temperature
4. Typical and max. product pressure
5. Frequent grade changes yes/no
6. Type of connecting flanges
7. Current output ☐ 0–20 mA ☐ 4–20 mA
8. Power supply ☐ 220 V ☐ 110 V ☐ 24 V 50/60 Hz

LABORATORIUM PROF. DR. BERTHOLD · D-7547 Wildbad 1 · Calmbacher Str. 22 · P. O. Box 160 · Phone (0 70 81) 39 81 · Telex 7 24019



					Tag	Name		
MW							Schwefelanalysator LB 3750-4	Liste
ZW				Bearb.	2.1.[illegible]	[illegible]	Sulphur analyzer	besteht aus
Ch B				Gepr.				___ Stck
EW				Norm.				
G				berthold			Nr.	Blatt-Nr.
P							15143.001	
M								
L	Aen. Urs.	Änderung	Tag	Name	7547 Wildbad / Schwarzwald			

MW	C-BI	G	M
ZW	EW	P	L



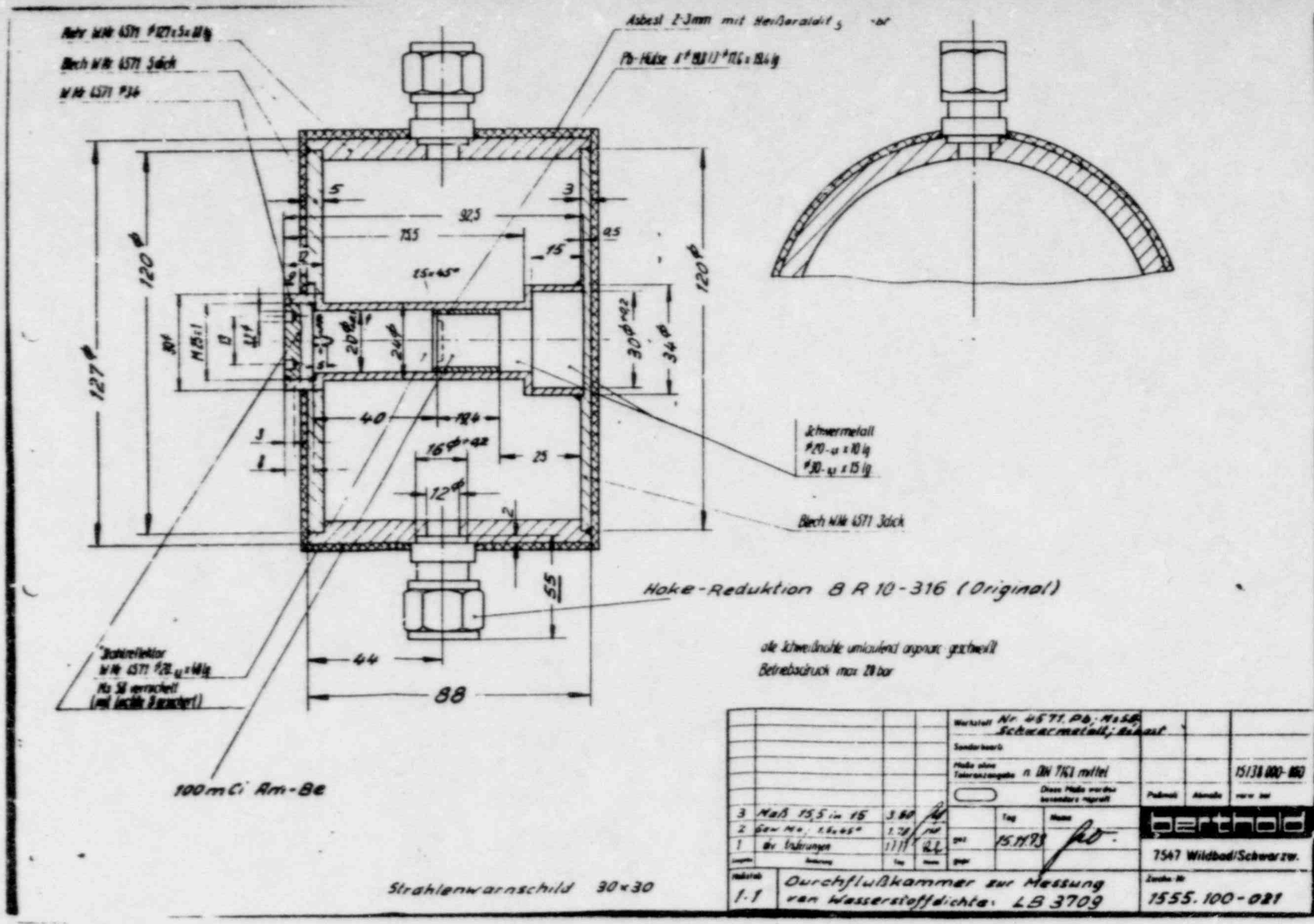
Neutronenausbeute:
~ $7{,}5 \cdot 10^5$ n/s (± 15 %) bei 300mCi ^{241}Am Be
~ $2{,}5 \cdot 10^5$ n/s (± 15 %) bei 100mCi ^{241}Am Be
~ $7{,}5 \cdot 10^4$ n/s (± 15 %) bei 30mCi ^{241}Am Be

Dichtigkeitsprüfung:
Immersionstest (8 h in Wasser von 50° C)

Material der Umhüllung
Stainless Steel (18 Cr, 8Ni, 1Mn)

Kapseltyp: X . 2

Ausgabe	Änderung	Tag	Name	Laboratorium Prof. Dr. Berthold, Wildbad im Schwarzwald	Bearbeitung / Sonderbearbeitung
Werkstoff	Maße ohne Toleranzangabe	Diese Maße werden besonders geprüft	gez.	18.2.63	
			gepr.		
Maßstab 2 : 1	Americium - Beryllium - Neutronenquelle 30,100u.300mCi; Hersteller: Radiochemical Centre Amersham		Zeichnung Nr.	P 2611 - 100	



Asbest 2-3mm mit Heißaraldit
Pb-Hülse
Blech W.Nr. 4571 5dick
W.Nr. 4571
Schwermetall
Blech W.Nr. 4571 3dick
Hoke-Reduktion 8 R 10-316 (Original)
die Schweißnähte umlaufend argonarc geschweißt
Betriebsdruck max 28 bar
100mCi Am-Be
Strahlenwarnschild 30×30
127
120
88
44
40
55
25
92,5
Werkstoff Nr. 4571, Pb; Ms58; Schwermetall; Asbest
n. DIN 7163 mittel
3 Maß 15,5 in 16
2 Gew. M..; 1,5×45°
1 div. Änderungen
15.11.73
berthold
7547 Wildbad/Schwarzw.
1:1
Durchflußkammer zur Messung von Wasserstoffdichte: LB 3709
1555.100-021

Design No. SFC 8

Issue 7

CERTIFICATE OF APPROVAL OF DESIGN OF CAPSULE FOR RADIOACTIVE MATERIAL

TITLE	Neutron Source Capsule X2
Drawing Nos. ~~and/or Specifications~~	BRC 10123/S Issue A BRC 10124/S Issue A
Radioactive Material	See over
Maximum Activity	See over

This is to certify that the Secretary of State for the Environment being, for the purposes of the Regulations of the International Atomic Energy Agency, the competent authority of Great Britain in respect of inland surface transport and the Secretary of State for Trade and Industry being the competent authority of the United Kingdom of Great Britain and Northern Ireland in respect of sea and air transport, have approved the above-mentioned Capsule Design. Radioactive material sealed in capsules manufactured to the above-mentioned design qualifies as special form radioactive material and as such will meet the requirements of the regulations overleaf.

This Certificate of Approval applies only to the design of the capsule as set out in the above named drawings and specifications ~~and/or specifications~~ HS 5002/2/SFC 38 - 41 dated 30 September 1969 ~~submitted by~~ and Mr. Fletcher's letter dated 19 February 1976 submitted by The Radiochemical Centre, Amersham.

THIS CERTIFICATE CANCELS ALL PREVIOUS ISSUES

COMPETENT AUTHORITY
IDENTIFICATION MARK :
GB: SFC 8

UNITED KINGDOM COMPETENT AUTHORITY FOR THE TRANSPORT
- 4 MAR 1976
OF RADIOACTIVE MATERIALS

for E. J. Wilson (Dr.)
Transport Radiological Adviser on behalf of the Secretary of State for the Environment and the Secretary of State for Trade ~~and Industry~~

Date of Approval

Note: Any questions relating to this Certificate should be made to the Radiological Adviser at the following address: –

Department of the Environment,
~~St. Christopher House,~~ 2, Marsham Street,
~~Southwark Street,~~ London SW1P 3EB.
~~London S.E.1.~~

Telegrams: – [illegible]

Telex: – 22801 Answer back DOE MARSHAM LONDON

Telephone: – [illegible]
01 - 212 - 7247

CRM 2

REGULATIONS GOVERNING THE TRANSPORT OF RADIOACTIVE MATERIALS

1. INTERNATIONAL.– **International Atomic Energy Agency (I.A.E.A.)** Safety Series No.6. Regulations for the Safe Transport of Radioactive Materials, 1967 Edition. and 1973 Revised Edition.

   Intergovernmental Maritime Consultative Organisation (I.M.C.O.) International Maritime Dangerous Goods Code–Class 7. Radioactive Substances.

   International Air Transport Association (I.A.T.A.) I.A.T.A. Regulations relating to the carriage of restricted articles by air.

2. ROAD.– **Great Britain only.** Radioactive Substances Act 1948 [Section 5(2)]–The Radioactive Substances (Carriage by Road) (Great Britain) Regulations ~~[illegible]~~ 1974 S.I. ~~[illegible]~~ 1735 Code of Practice for the Carriage of Radioactive Materials by Road.

   Europe only. European Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR). Class IVb

3. RAIL.– **Great Britain only.** British Rail List of Dangerous Goods and Conditions of Acceptance for carriage by Freight Train and by Passenger Train.[BR22426 (Revised) November 1966] Class 7.

   Europe only. International Convention concerning the carriage of Goods by Rail (CIM).

   Annex 1. Regulations concerning the substances and articles not to be accepted for carriage or to be accepted subject to certain conditions (RID). Class IVb.

4. SEA.– Merchant Shipping (Safety Convention) Act 1949 (Section 23) and Merchant Shipping (Dangerous Goods) Rules 1965 as amended by S.I. 1968 : No. 322. The Report of the Standing Advisory Committee on the Carriage of Dangerous Goods in Ships 1966 (the "Blue Book") Class 7.

Radioactive Material	Maximum Activity
Americium – 241	2 Ci
Radium – 226	50 mCi
Thorium – 228	10 Ci
Actinium – 227	50 mCi
Promethium – 147	500 Ci
Curium	50 Ci
Plutonium – 238	7.5 Ci

The Radiochemical Centre Amersham

CERTIFICATE OF RADIOACTIVE SOURCE INTEGRITY

QCS 167

SPECIFICATION :- Capsule Type X2 Neutron Source

DWNG NO. : BRC 10124/S

NUCLIDE, RADIO TOXICITY GP. :- Americium-241, Group A

MAXIMUM ACTIVITY :- 300mCi

CLASSIFICATION DESIGNATION :- C/6/4/5/4/4

TEST SOURCES :- 1 x 5µCi Caesium-137 + He 1 x 30µCi Caesium-137 + He assembled as shown on drawing number BRC 10123/S

TEST	TEMPERATURE	PRESSURE	IMPACT	VIBRATION	PUNCTURE
1					
2					
3					
4		PASS 0.07 0.02		PASS 0.06 0.03	PASS 0.03 0.03
5			PASS 0.09 0.02		
6	PASS 0.06 0.02				

TEST CARRIED OUT IN ACCORDANCE WITH RECOMMENDATION OF:- BRITISH STANDARD 5288 AND DRAFT INTERNATIONAL STANDARD I.S.O. 2919

LEAK TEST:- IMMERSION AND WIPE

ADDITIONAL INFORMATION:- FIGURES IN TABLE DENOTE ACTIVITY (nCi) MEASURED IN LIQUID AFTER IMMERSION TEST

A.T.C. Hash
Quality Control Dept.

Date 18 July 1977

K.I. Fletcher
Radiation Sources Department

Am-241 Area Source

Technical Data Sheet Relating to Application for Permission to Use Radioactive Substances

Order No.:

Applicant:

1.	Description of radioactive substance:	
1.1	Radioactive substance:	Am 241
1.2	Chemical state:	Am_2O_3
1.3	Physical consistency:	compacted powder
1.4	Type:	fully enclosed type
1.5	Quantity and individual activity:	units, ≤ 100 mCi each
1.6	Manufacturer:	The Radiochemical Centre, Amersham, GB
1.7	Supplier:	Berthold, Wildbad

2. **Description of Containment**

All details concerning the construction of the containment are indicated on the enclosed drawing P 2642-100. The containment has been tested by the manufacturer for surface contamination and leaks. A test certificate to this effect will be supplied to the user on delivery.

3. **Description of Shielding:**

The source is permanently installed in a measuring unit as shown on drawing no. 15113.002.

4. **Dose rate:**

The dose rate at the surface of the measuring unit is ≤ 0,1 mRem/h.

5. Description of intended use:

The measuring system is intended for continuous density meausrements.

6. Instructions for disposal of surplus or decayed radioactive sources:

To be returned to the nearest public radioactive waste disposal centre or to the manufacturer.

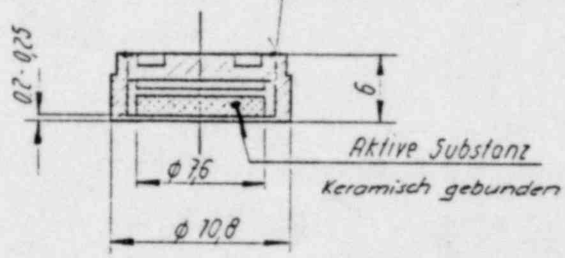
7. A PTB Test Certificate No. 6.32-R33 for the system which confirms compliance with the type approval requirements in the Federal Republic of Germany is enclosed.

Date:

Enclosures:

1 drawing - varies with individual order
1 drawing 15113.OC2
1 Test Certificate no. 6.32-R33 (with English translation)

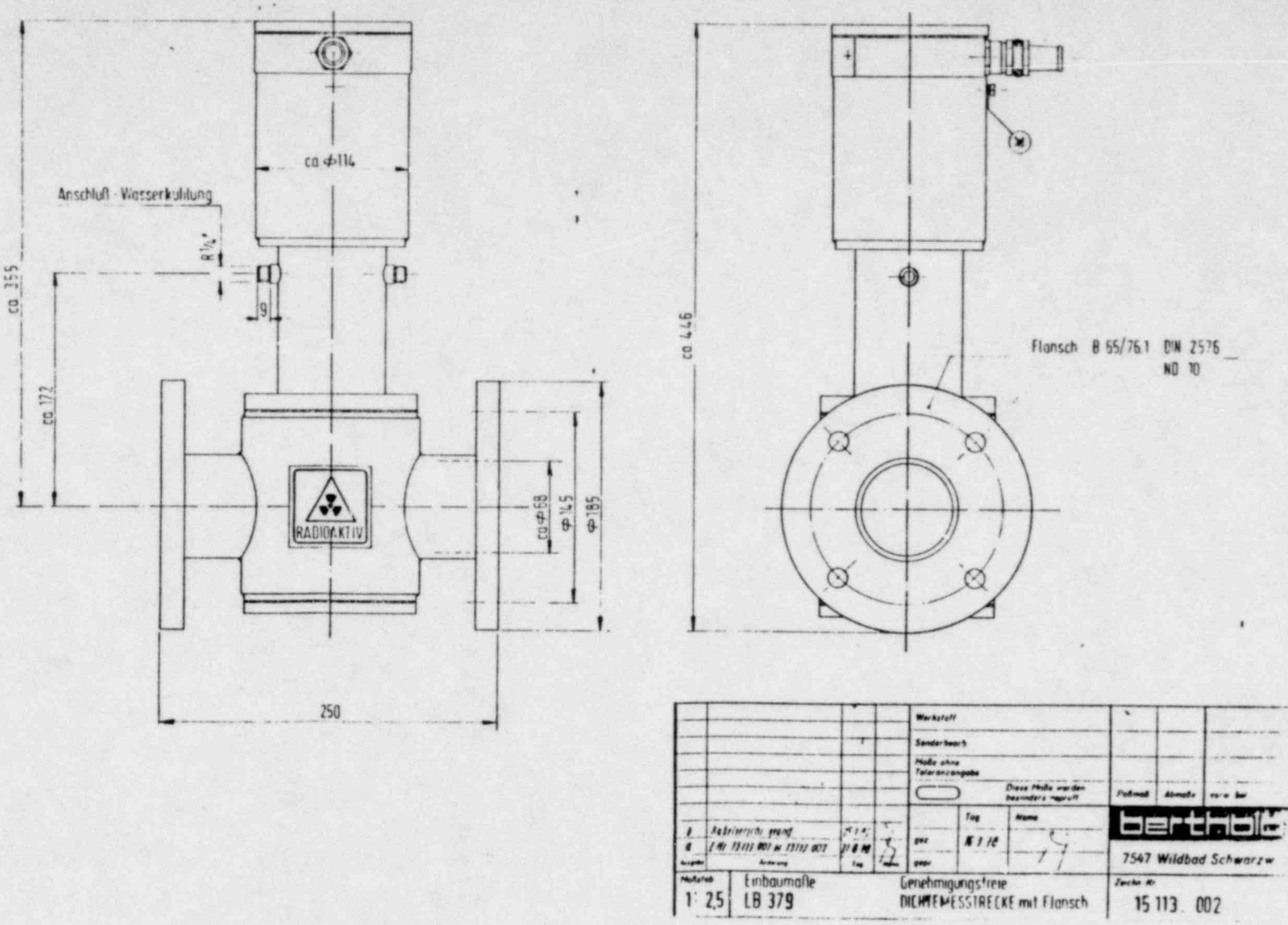
Mw	Cr	G	M
ZW	EW	P	L



Kapsel Typ X.91

Ausgabe	Änderung	Tag	Name				
				Werkstoff Edelstahl			
				Sonderbearb.			
				Maße ohne Toleranzangabe			
				Diese Maße werden besonders geprüft	Paßmaß	Abmaße	verw. bei
				Laboratorium Prof. Dr. Berthold Wildbad / Schwarzwald		Tag	Name
					gez.	16.6.71	
					gepr.		

Maßstab	Hersteller: The Radiochemical Centre Amersham Präparat AMC.16 100 mCi ^{241}Am	Zeichn.-Nr. P 2642 - 100



ca Φ114
Anschluß - Wasserkühlung
R1/4"
9
ca 355
ca 172
RADIOAKTIV
ca Φ68
Φ145
Φ185
250
ca 446
Flansch B 65/76.1 DIN 2576
ND 10
Werkstoff
Sonderbearb.
Maße ohne Toleranzangabe
Diese Maße werden besonders geprüft
Paßmaß
Abmaße
Tag
Name
gez
gepr
berthold
7547 Wildbad Schwarzw
Maßstab
1: 2,5
Einbaumaße
LB 379
Genehmigungsfreie
DICHTEMESSTRECKE mit Flansch
Zeichn Nr
15 113. 002

2nd Copy

Physikalisch Technische Bundesanstalt

Test Certificate
No. 6.32 - R 33

Object:	Density Measuring Unit Type: LB 379 Serial No. 1093.10.77
Manufacturer and Applicant:	Laboratorium Prof. Dr. Berthold P.O. Box 160, 7547 Wildbad 1, Germany
Construction drawing:	15113.100-000 dated 20/9/1977 and 15113.001 dated 4/7/1977
Intended purpose:	Density measurement of liquids
Radioactive substance:*	Americium - 241
Activity:*	100 mCi
Code No.:	AMC. 16
Type of containment:	X 91
Engraved marking:	TRC 0692 LA
Construction drawing:	P2642-100 dated 16/6/1971
Manufacturer:	Radiochemical Centre, Amersham Buckinghamshire, England

*) according to manufacturer's information

Characteristic Features of Device:*)

The density measuring unit consists of a flarged special steel tube (length 250 mm, outside diameter 74 mm, wall thickness 3 mm), the wall thickness in the centre section having been machined down to 1 mm over a length of approx. 30 mm. This area is irradiated at a right angle by the collimated effective radiation beam of an americium 241 source which is located outside the tube. The special steel tube is installed in a cylindrical special steel housing (diameter 133 mm, height 140 mm, wall thickness 3 mm) level with the centreline of the housing so that their respective axes intersect at right angles. One side of this housing holds the source complete with collimator, mount and shielding. The opposite side is provided with a flange-mounted scintillation detector which detects the radiation and also acts as a radiation trap.

Further details are indicated in the documents submitted to the Physikalisch-Technische Bundesanstalt.

The construction of the device described above has been examined in accordance with Section 22 of the Regulations concerning protection against damage by ionizing radiation (Radiation Protection Regulations - StrlSchV) of 13/10/1976 (Federal Gazette I, p.2905).

Test Results:

1. The radioactive substances installed in the device are fully contained and protected against inadvertent contact.
2. The activity of the installed radioactive substances is less than 10^6 times the exemption limit of Appendix IV, Table IV 1, Column 4.
3. The local dose rate at a distance of 0.1 m from the exposed surface of the device is less than 1 millirem per hour (10 microjoule per kilogram and hour).

* according to manufacturer's information

Conclusions:

The requirements for Type Approval in accordance with Appendix XIII Section 1 of the Radiation Protection Regulations have been complied with.

Braunschweig, 23rd April 1978

Physikalisch-Technische Bundesanstalt
Department 6
by Order

(seal) (signature)

(Dr. U. Lauterbach)
Oberregierungsrat

2nd Copy

Physikalisch-Technische Bundesanstalt

Supplement to Test Certificate
No. 6.32 - R 33

The housing of the density measuring unit is covered with a metal plate on the side where the source is installed. The round cord ring previously located between the housing and the metal plate has been replaced by a sealing gasket. The details are indicated on construction drawing No. 15113.001/1 of 4/7/77, revision A dated 29/8/78.

The modified density measuring unit also complies with the requirements for Type Approval in accordance with Appendix XIII Section 1 of the Radiation Protection Regulations.

Braunschweig, 12th October 1978

Physikalisch-Technische Bundesanstalt
Department 6
by Order
signature

(Dr. U. Lauterbach)
Oberregierungsrat

Seal

2nd Copy

Physikalisch Technische Bundesanstalt

Supplement to	TEST CERTIFICATE No. 6.32 - R 33
Object:	Density Measuring Unit Type: LB 379
Manufacturer and Applicant:	Laboratorium Prof. Dr. Berthold P.O. Box 160, 7447 Wildbad 1, Germany
Construction drawing:	15113.100-000 dated 20/9/1977 and 15113.001 dated 4/7/1977
Intended purpose:	Density measurement of liquids
Radioactive substance:	Americium - 241
Activity:	100 mCi
Code No.:	AMC. 16
Type of containment:	X 91
Construction drawing:	P2642-100 dated 16/6/1971
Manufacturer:	Radiochemical Centre, Amersham Buckinghamshire, England

The Density Measuring unit LB 379 can alternatively be supplied with one of the americium 241 sources listed below:

AMC 65 enclosed type X 11 (30 mCi) The Radiochemical Centre
Amersham, England

AME-2-B* (100 mCi) CEA, France

AME-1-B* (30 mCi) CEA, France

*) According to manufacturer's information

Details are indicated on the construction drawings No. 15113.001/1 revision b of 24/11/1978 and 15113.100-007 revision b of 24/11/1978 and in the documents submitted to the Physikalisch-Technische Bundesanstalt.

The requirements for Type Approval in accordance with Appendix XIII Section 1 of the Radiation Protection Regulations are also complied with when one of the above sources is installed into the density measuring unit.

It is recommended immediately to repeat the leakage test in the event of any damage, especially in the event of any cracks in that part of the tube wall which has been machined down to a wall thickness of 1 mm.

Note:

The original of this Test Certificate has been forwarded to the Approving Authority

Ministry of Labour, Health and Social Security
P.O. 1250, 7000 Stuttgart 1

where the application for approval should be submitted.

Braunschweig, 24th January 1979 Physikalisch-Technische Bundesanstalt

Department 6
by Order

(signature)
Dr. W. Kolb

seal