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

MS 12
K2

February 25, 1985

U.S.N.R.C.
Region I
631 Park Avenue
King of Prussia, PA. 19406-1498

ATTN: Mr. J Davis

Ref. Control # 02479

Dear Sir,

Regarding our phone ccnversation of February 22, 1985, wherein I stated that we would proceed with Berthold Systems, Inc. application for "G" license and give it priority over Berthold Instruments, Inc. application.

I have been instructed to proceed with both and I am attaching the added information you requested in support of Berthold Instruments, Inc. application.

Regards,

BERTHOLD INSTRUMENTS, INC.

James A. Welsh

JAW/dc

Enc.

02479
"OFFICIAL RECORD COPY"

C O N T E N T S

BERTHOLD INSTRUMENTS, INC.

Control # 02479

Statements:

(I) Devices designated for General Licenses will be labeled in accordance with 10cfr 3251 a (3), (i), (ii), and (iii).

a) Identification of manual of instructions and precautions

b) Maximum interval time for leak testing

c) Shutter operation test (every 6 months)

d) Isotope

e) Activity

f) Activity determination date

g) Labeling per 10 cfr 20.203(f)2

The example statement in 3 (iii) will be used and be the same.

II. Devices designated for Specific licenses will be labeled in accordance with 10 cfr 20.203 (f)2 and a thru f of item 1 above.

III. At installation, surveys using dose rate meter will be taken around the installation to determine if restricted barriers are required to insure that dose rates in excess of 10% of that specified in 10 cfr 20.101(a) are not incurred by General licensed users.

IV. Wipe tests frequency will be 6 months (unless otherwise granted by Materials Branch).

V. With regard to General license - The wipe test and shutter operation will be performed by either Berthold or by a person holding a Specific license pursuant to Parts 30 and 32 of 10 cfr or from an agreement state to perform such activities.

BERTHOLD INSTRUMENTS, INC.

Statement:

Quality Control Procedure used in Germany at Labor. Berthold was forwarded to Materials Branch in support of registration.

Berthold Instruments, Inc. will follow up by inspection and test of the received devices before shipping to a general as follows:

Inspect for:

a) Labels (in accordance with 10cfr 20.203 (f)2 and 32.51 a 3 (i), (ii), and (iii).

b) Noticeable damage

c) Manuals, procedures and instructions (attach notice)

d) Source certificates (wipe and bubble test)

e) Hardware

Test for:

a) Shutter operation (if applicable)

b) Shutter agreement of position with respect to "on" - "off" indication (where applicable)

c) Confirm radiation levels - at surface and 3 feet

Mechanical:

a) Apply epoxy paint to source access plate mounting screws (integrity purposes)

Note b) At the licensees facility apply epoxy paint to a set of screws/bolts on the mounting flange of the source housing

c) For the LB 386 density gauge prepare unit for integrity seal (install integrity seal at the licensee site after mounting)

NOTICE TO A GENERAL LICENSE

This device has been registered with the U. S. Nuclear Regulatory Commission.

The receipt of this device automatically identifies you as "General Licensee".

As a "General Licensee" you are subject to the regulations of the U. S. NRC (10cfr31.5) or of a State with which the NRC has entered into an agreement for the exercise of regulatory authority.

Berthold Instruments, Inc. will provide a copy of the regulations that pertain to the activity of a "General License" namely 10cfr31.5 and will go over these regulations with you as part of our installation/commissioning lecture.

Instructions to user: (Licensee requirements)

1) Do not install, remove or service this device at any time.

2) You are to assure that all labels and instruction affixed to this device are not removed and that there is a label providing this instruction.

3) You are to assure that the tests indicated on the labels are performed at the required time.

4) You are to assure that any service to the source and shield (including removing and relocation) are performed by the Manufacturer (Berthold) only.

5) You are to maintain records of tests and servicing.

6) Do not abandon the device containing radioactive material.

7) Removal and disposal of sources will be accomplished through Berthold Instruments, Inc.

8) Refer to 10cfr31.5 c8 and 9 regarding transfer.

9) Any questions regarding safety and compliance call Berthold Instruments, Inc. 412/922-2635.

Berthold Instruments, Inc.
136 Bradford Avenue
Pittsburgh, Pa. 15205
412/922-2635

NOTICE TO A SPECIFIC LICENSE

This device LB _____ manufactured in Germany, has been registered with the Nuclear Regulatory Commission and has been designated for specific license use only in the United States.

This operation manual in German/English provides a brief statement on Radiation protection which we encourage you to read.

We ask that you refer to 10cfr20, when statements in this manual referring to the regulation of the Federal Republic of Germany are made.

We ask also that you familiarize yourself with the labels and cautions on this device.

An installation lecture will be provide by Berthold prior to commissioning on Radiation Safety and operational aspects of this device.

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

Phone/ 412/922-2635

BERTHOLD MOLD LEVEL CONTROLS SURVEY DATA SHEET

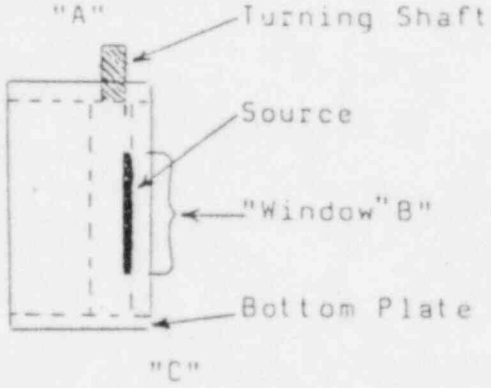
CUSTOMER: _____

LOCATION: _____

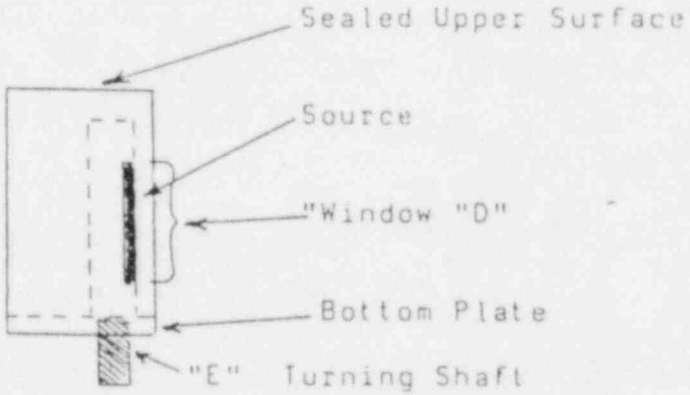
DATE: _____
Type of Source: _____
Source Strength: _____

IV. Source Holder ("Device") Wipe Tests

Top Operated



Bottom Operated



Wipe tests will normally be made on areas at or near point A,B,& C for top operated models, and points D & E for bottom operated models.

Type of unit: _____
Drawing No.: _____
Serial No.: _____

Test Location	Wipe test sample No.	Reported Results
A		
B		
C		
D		
E		

Physical condition of Source Holders _____

_____

_____

COMMENTS: _____

_____

Procedure for Replacing Source at the Customer's Facility

Note: The removal and replacement of Berthold device source will be by a Qualified Berthold Representatives named in our (Bertholds) license and not by the customer or their designate.

DRY RUN THIS PROCEDURE BEFORE ACTUAL RUN

Equipment Required:

A) Personnel monitoring - whole body badge, ring badge and pocket dosimeter (Victoreen 06-502)

B) Survey meter (Dose measuring) Berthold LB 1200/133 or Ludlum 14C

C) Contamination monitor - Berthold 1210 C (Optional)

D) Surgical gloves

E) Tongs

F) Shielding container (transport container)
(one required for routine source change due to decay or (2) for replacement of damaged source)

Procedure

Note: Initially the customer will be contacted and a new source will be shipped to the customer's facility in a shielded transport device. This device will be sealed and only opened by Berthold personnel (this will be clearly marked on the device)

A) Select a dose rate meter (item #B equipment required). Check calibration date and source check the instrument to insure it is operational

B) Locate the new source (in transport container) as close as possible to the device to be serviced.

C) Position your dose rate meter as close to the area you are working in a stationary position about 3/4 body height. If your survey meter has an audible, make sure it is on.

D) Proceed with the mechanics of dismanteling source device housing in preparation for removing source.

E) At the point where the source is ready to be removed, Stop, make sure film ring is on with the TLD on the palm side of the hand and then put on surgical rubber gloves.

F) At this point, make ready the transport shield to be able to transfer the new source and receive old source by removing the seal and loosen cap.

Note: The Cobalt source will vary in activity depending on the customer's use from as little as 1 mCi to 50 mCi. Cesium rod sources will have a range of 10 mCi to 300 mCi. You can see the degree of radiation exposure will change depending on isotope and activity.
A simple calculation can be performed to determine the dose rate at 1 foot as follows:

Cobalt 60
Dose rate a 1' in mr/hr = 14.66 x A
Where A is activity in millicuries after decay

Cesium 137
Dose rate at 1' in mr/hr = 3.66 x A
Where A is the activity mCi after decay

The above calculations are for approximation only and is based on a point source consideration. So in effect we are considering these rod source as point sources with decay compensation:

G) Before proceeding refer to * + **.
Remove the old source from the device housing and carefully lay it next to the transport shield. (In the case of a damaged or leaking source the source will be inserted into a second backup transport shield).

* H) Remove the new source from the transport shield and lay it down on the opposite side of transport shield. Pick up the old source and place it in the transport shield and replace cap.

* I) Pick up new source and install it in the instrument device housing.

J) Reassemble the instrument device housing.

K) Check the shutter orientation and operation. You can either use your dose measuring instrument or the systems electronics.

L) Secure and seal the transport shield containing the old source, and label it to identify isotope, activity, date, serial and model number of the instrument removed from and name of the cusomter.

M) With your dose measuring instrument - resurvey the surface of the instruments source shield and record. Do the same for the source transport shield.

O) Repack the transport container for shipment back to manufacturer or his agent.

P) Determine who is shipper and insure unit is shipped in accordance with regulations for "Special Form " A1 material.

Q) Dispose of surgical gloves in the proper manner (in the case of a broken source servicing, survey with a/210B contamination in monitor before disposing)

R) Record reading of personal pocket dosimeters

* Insure that personnel not required to be in the area are removed - use tongs when handling the source whenever possible.

\+ Use paper toweling to lay source on if leaking or damaged.

** If replacement of source is due to damage or leakage be sure that a second transport source shield is available to receive the damaged source, then clean the immediate source compartment and shutter before installing new source. All materials used for cleaning etc. are to be surveyed and disposed of in the proper manner. A wipe test using the Mark V kit should be performed after cleaning just prior to installing new source.

James Welsh
dc

Procedure for Receiving Shipments of Nuclear Devices from Germany or Returns from Customer

Note: All nuclear devices received shall be checked in accordance with the following procedure within three (3) hours if received during normal working hours or within eighteen (18) hours if received after working hours.

Responsibility

It is the responsibility of the Radiation Safety Officer to insure that all devices are received in a manner outlined in the following procedure. The Radiation Safety Officer may designate only those people named in the license to receive radioactive shipments. (refer to the list of authorized personnel)

Equipment Required

A) Survey meter (Dose measuring)
either Berthold LB 1200/LB 133 or Ludlum 14 C

B) Personnel monitoring - whole body radiation badge -pocket personal dosemeter,(optional) ring badge need not be worn unless service of the source and shutter is required.

Procedure

Note: When approaching any nuclear device for survey, use a survey meter to determine radiation levels. DO NOT rely on pocket dosemeters alone.

A) Select a survey instrument you determine to use, (refer to equipment required item A) check to insure the unit has been calibrated and has not gone beyond expiration date.

B) Source check the instrument to determine it is operating properly - if not, use another instrument. (Check out of the meter is to be done as far away from the package as practicable, at least 3 meters).

C) Examine the shipping documents to determine transport index information and isatope involved. Check for special handling instructions.

D) Approach the package, with the survey meter on, and held at a 45° angle, to within 1 meter, note reading (the reading should be less than 1 mr/hr. for our devices). If the meter reading is greater than 1 mr/hrs investigate with caution to determine cause. Notify Radiation Safety Officer of problems to insure that our responsibility for possible notification under 20.403 is considered.

E) If the meter reading at 1 meter is less than 1 mr/hr. proceed with checking radiation levels at the surface of the device. Four readings should be taken, spaced 90° apart around the device at 1 meter and surface and logged for record purposes. (Use radiation survey map (refer to figure 1)

F) A wipe test is not required due to classification "Special Form" material but will be performed if the device is damaged in shipment to the extent that it appears that the integrity of the source is questioned. (refer to wipe test procedure).

G) Record all survey results and other information in the shipment and receipt log and on the survey map, and file for records.

H) If survey results indicate the unit was shipped in accordance with regulations and in a safe manner, then processing the device for repair or service can be initiated following the appropriate procedure.

I) If survey results indicate that the device was not shipped in a safe manner, then check our responsibility under 10Cfr20.403. (If this be the case, documentation is most important)

James A Welsh
dc

Procedure for Shipping Devices

Note; All nuclear devices shall be surveyed in accordance with the following procedure to enhance the safe transport of these Devices.

Responsibility

It is the responsibility of the Radiation Safety Officer to insure that the following procedure is followed as well as the requirements of 10cfr71.

Equipment Required

A) Personnel monitoring - badge (whole body) audible pocket dosimeter - ring badge need not be worn unless handling of the source or servicing the shutter is required.

B) Survey equipment (Dose measuring)
Either Berthold LB 1200/Lb 133 or Ludlum 14 C

Procedure

A) Determine the dose measuring instrument to be used (item B Equipment required) and source check instrument to insure instrument is operational.

B) Check calibration sticker to insure you are not using an instrument that is out of calibration.

C) With the survey meter on, approach the device for inspection.

D) Visually inspect shutter (if a shuttered unit), insure that the shutter is in the closed position and secured from opening - if provisions are made for a lock or pin, make sure they are in place and secured.

E) Check the radiation levels at the surface of the device or package on all six surfaces (if in a box or outer container), or at 6 points 90° apart (4 on X axis and 2 on Y axis) if the device is to be shipped in its own shield. Record readings.

F) Repeat step E at 3 feet from the surface. Record readings. Step E and F provides information for transport index and labeling as well as defining the position of the shutter in devices that use its shield housing for transport purposes.

G) As dictated by the survey results select the proper warning labels ie. Radioactive white I, yellow/white II, or yellow III. Two labels are required (on opposite sides).

For Example:

a) If a surface reading on the exterior of the package or device is less than 0.5 mr/hr. white I labels are proper.

b) If the surface reading on the exterior of the package or device is greater than 0.5 mr/hr. but less than 50 mr/hr, yellow/white II labels are required.

This label requires a transport index - the transport index is the reading taken at 3 feet from the surface in mr/hr.

c) If the surface reading on the exterior of the package is 50 rem/hr - yellow III labels are required. The transport index again is the reading at 3' in mr/hr.

H) Refer to 49 cfr 173 for pertinent D.O.T. regulations prior to shipment. There are three considerations to establish in determining what D.O.T. regulations apply, and that is the type, quantity and form of the radioactive material. Our devices will be considered "Special Form" (A.)

James A. Welsh
dc

Procedure for Wipe Testing Rod Sources P2608-100/101 Located in a Shield for Mold Leveling

Note: Mold level devices used in the steel industry are equipped with a 3mm steel window in the shutter port. This is a permanent window and renders the source itself inaccessable so a wipe of the window and seal will be required.

Equipment Required:

A) Survey equipment (Dose measuring)
Either Berthold LB 1200/LB 133 or Ludlum 14C survey meter

B) Pocket dosimeter (Victoreen 06-502)

C) Mark V wipe test kit

D) Whole body badge and ring badge

Procedure

A) Select a survey meter (dose measuring item A equipment required)

B) Check to insure survey meter is within calibration time

C) Source check instrument to insure it is in operation

D) Approach the device with your survey meter on (includes audible)

Note: Mold level source housing are affixed to the mold, leaving a space of about 3" at the top and bottom between the device housing and the mold to insert a wipe swab. It is your option to either obtain the wipe from either end (naturally the most accessable point is recommended).

E) Position the source in the off position. This can be verified by your survey meter at the top or bottom 3" access point and the systems electronics.

F) With your wipe test swab wipe the window and seam area

G) After the wipe is accomplished insert the sample into its protective tube, and label the tube with the required information - isotope date, device serial number and customers name.

H) Follow up on sample for analysis.

I) Document for records.

Applied HEALTH PHYSICS inc.
2986 Industrial Blvd. • Box 197 • Bethel Park, Pa. 15102 • Phone 412 • 563-2242

INSTRUCTIONS FOR USE OF MARK V LEAK TEST KIT ON SEALED SOURCES

These procedures are to be followed by the individual trained and authorized by the licensee's RSO to employ the Mark V Leak Test Kit for leak testing sealed sources of radioisotopes. Should any question arise concerning proper use of the Kit, contact Applied Health Physics, Inc.

1. Pre-Test Procedures

In preparing the Mark V Leak Test Kit, follow these simple procedures:

a. Remove the plastic cap with its cotton swab insert from the plastic test tube. Add a few drops of water to dissolve the powdered wetting agent in the tube. Slightly dampen the swab's cotton tip with the wetting agent solution, and discard any unused solution that may remain in the tube.

Return the prepared swab to the test tube.

b. Complete the information required on the self-sticking, circular leak test label which is included in the Kit, and securely attach to the midsection of the test tube.

c. Obtain a remote handling device, such as an AHP Protecta-Holder, which will be used in manipulating the swab stick during the actual testing procedure.

d. Carry out final preparation for all radiation protection measures that must be employed.

2. General Testing Procedures

The following general testing procedures should be used on sealed sources:

a. Grasp the cap or the bare end of its swab stick with the AHP Protecta-Holder or other suitable remote handling device.

b. Carefully, but firmly, wipe the dampened tip of the cotton swab over surface areas of the sealed source. With certain sealed sources that are located or permanently used in special equipment, it is only necessary to wipe surfaces of the mounting or storage device on which radioisotope contamination might be expected to accumulate.

c. Immediately following the wiping procedure, dispense with the remote handling device and securely replace the cap and its swab insert in the labeled plastic test tube. Avoid touching the cotton tip to the body or other objects.

3. Post-Test Procedures

Pursuant to completion of the leak test, these steps must be taken:

a. Complete the Mark V Leak Test Data Form in a legible fashion. This form must be signed by the individual who performed the sealed source leak test.

b. Enclose the Data Form and the sealed plastic test tube in the mailing box, and seal the box. Fill in the proper return address on the Applied Health Physics, Inc.'s shipping label and securely attach to the box.

c. Monitor all external surfaces of the mailing box with a calibrated survey meter, such as a Geiger-Muller meter with an end-window probe detector. Post Office Department regulations require that radiation levels at any surface of the box must be less than 10 milliroentgens for 24 hours; i.e., an average of approximately 0.4 milliroentgens per hour.

If results of the survey meet these requirements, proceed with mailing the Mark V Leak Test Kit to Applied Health Physics, Inc. Should the survey indicate that any surface of the box has a dose-rate greater than 0.4 milliroentgens per hour, immediately notify Applied Health Physics, Inc. by telephone.

Applied HEALTH PHYSICS inc.
2986 Industrial Blvd. • Box 197 • Bethel Park, Pa. 15102 • Phone 412 • 563-2242

RADIATION PROTECTION MEASURES DURING USE OF MARK V LEAK TEST KIT

Precautionary measures must be observed by any individual authorized to leak test sealed sources with the Mark V Leak Test Kit for radioisotope users licensed by the U. S. Atomic Energy Commission or an Agreement-State. They may be summarized as follows:

1. Certain sealed sources of radioisotopes are NOT TO BE REMOVED from shielding devices within which they are permanently mounted or stored. Radiographic exposure devices, density gauges, teletherapy units, and other such devices shall be leak tested by conducting the test on accessible surfaces of the device upon which contamination might be expected to accumulate.

   NOTE: When testing such devices, the sealed source must be in the "OFF" position. This must be confirmed by conducting a radiation survey of the device prior to performing the leak test.

2. The individual conducting the test should wear a lapel film badge, a ring badge, and pocket dosimeters or pocket chambers as may be required by the AEC or Agreement-State license conditions. With this same consideration, personnel monitoring devices should also be worn by other individuals permitted to remain in the area where leak testing is being performed.

3. The leak tester must monitor the test area and any adjacent areas with calibrated survey meters, and any required signs must be posted in accordance with Title 10-CFR-20.203 or other applicable regulations.

4. Only remote handling rechniques shall be used during the manipulation of "free" sealed sources. Sources must not be allowed to come into contact with the hands or other portions of the body. Full advantage should be taken of the inverse square law and minimizing exposure time.

5. It is recommended that the leak tester wear protective clothing during the testing of certain sealed sources. Flexible protective gloves, such as AHP:446, offer significant shielding from beta radiation and also prevent the possible contamination of hands. When leak testing higher activity sealed sources of strontium-90 or other energetic beta-emitters, thick lens safety glasses can afford significant protection to the eyes.

   NOTE: Ordinary x-ray aprons and similar garments made of leaded rubber, plastic, or glass offer insignificant protection from high energy gamma-emitters such as cobalt-60 and radium-226.

6. When necessary, accessory shielding devices should be used in the leak testing are. Should the tester not have an AHP Periscopic Shield at his disposal, he may employ a barrier composed of appropriated thicknesses of lead, steel, or concrete when dealing with various gamma-emitters. A portable shield of one-half inch thick lucite or other transparent plastic not only absorbs most beta radiations encountered, but facilitates viewing during the leak testing process.

7. Since the surface of some sealed sources, especially those containing beta-emitters, may be made of a thin foil, special care must be taken to avoid puncturing, erroding, or otherwise damaging this surface during leak testing.

8. It is recommended that "dry runs" are conducted prior to the actual testing. If dummy sources are used during such a practice session, the test operator should dispense with them before beginning the "wet run". Confusing the real sealed sources with the simulated ones can be conducive to over-exposure incidents.

9. Although most licensees are required to leak test sources at intervals not exceeding six (6) months, sealed sources should be leak tested following any incidents wherein they may be damaged. Should a source be subjected to chemical or physical stresses beyond those for which it was designed, an immediate leak test is recommended.

10. Adherence must be given to the provisions of the AEC's Title 10-CFR-20.101, "Exposure of individuals to radiation in restricted areas, "and other applicable sections of AEC and Agreement-State regulations during all leak testing procedures.

2503 V

Radiation Surveys for the Berthold Controls

CUSTOMER: _____ User License No. _____

LOCATION: _____

Date Material Received: _____

Type of Berthold Equipment: _____

Berthold Drawing No. _____

Source Type: _____

Source Strength: _____

No. Source Holders (Devices) and Sources: _____

No. of Sources shipped separately from the Source Holders: _____

Source Holder Serial No's.: _____

As indicated below, the following tests will be made on the equipment listed above.

	Tests to be performed	
	Yes	No
I. Shipping Packaging Survey		
II. Localized Area Survey of Storage area		
III Radiation Measurements of each device		
IV Source Holder ("Device") Wipe Tests		
Shutter closed		
Shutter Open		
Other (specify)		

Date of work performed _____

Measurements made by _____

Customer Acknowledgement _____

Date _____

BERTHOLD CONTROLS SURVEY DATA SHEET

CUSTOMER: _____

LOCATION: _____

DATE: _____ SHIPPER _____

Type Berthold Equipment _____

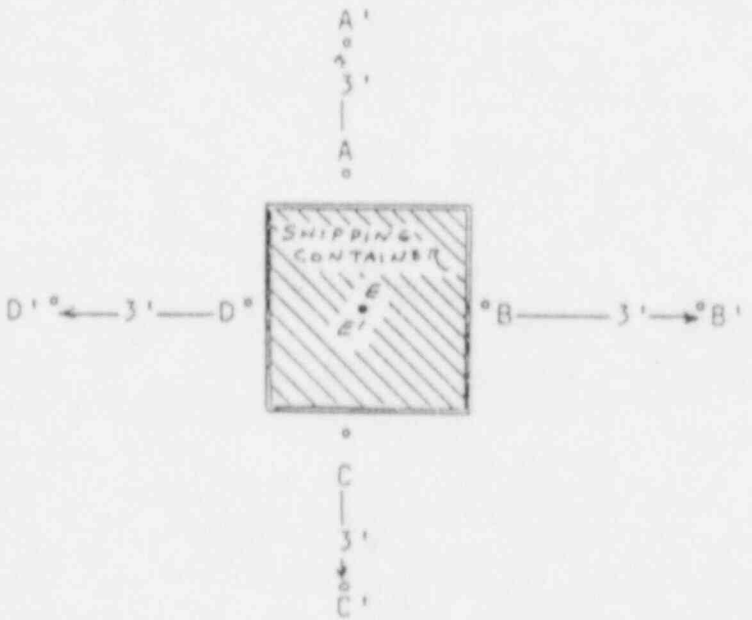
No. Unit in Package ____ of ____ shipped

Package Size _____

Type of Source _____

Source Strength _____

I. Shipping Packaging Survey



Radiation measurements will be made at the surface of all four sides plus the top (points A,B,C,D, and E), as well as at distances three (3') feet away from these locations (points A', B', C', D' and E'

LOCATION POINTS	SURFACE MEASUREMENTS	THREE' MEASUREMENTS
A		
B		
C		
D		
E		
A'		
B'		
C'		
D'		
E'		

BERTHOLD CONTROLS SURVEY DATA SHEET

CUSTOMER: _____

LOCATION: _____

DATE: _____ SHIPPER _____

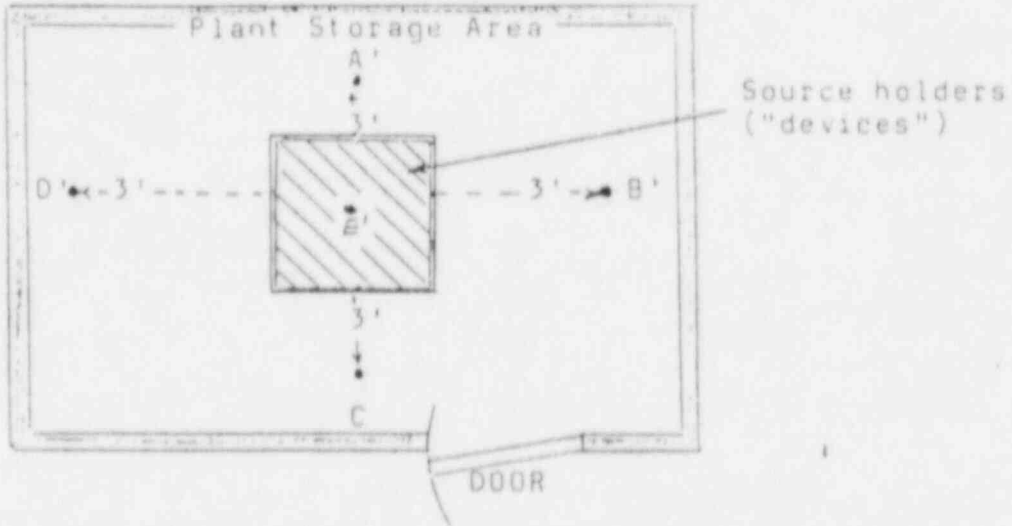
Type Berthold Equipment _____

Package Size _____

Type of Source _____

Source Strength _____

II. Localized Area Survey of Storage Area



Measurements to be made 3 feet (3') from all four sides and the top of the source holders (devices) in their stored location (points A',B',C',D' and E') before and after storage

LOCATION POINT	INITIAL SURVEY	AFTER STORAGE Survey
A'		
B'		
C'		
D'		
E'		

Type of construction of storage area _____

Size of storage area Width _____

Length _____

Height _____

No. of doors into storage area _____

Are doors(s) securely lockable _____

Have radiation warning signs been put in place? _____

Type of container used to hold the source Holders _____

Does container (if used) have radiation warning signs? _____

BERTH LD CONTROLS SURVEY DATA SHEET

CUSTOMER: _____

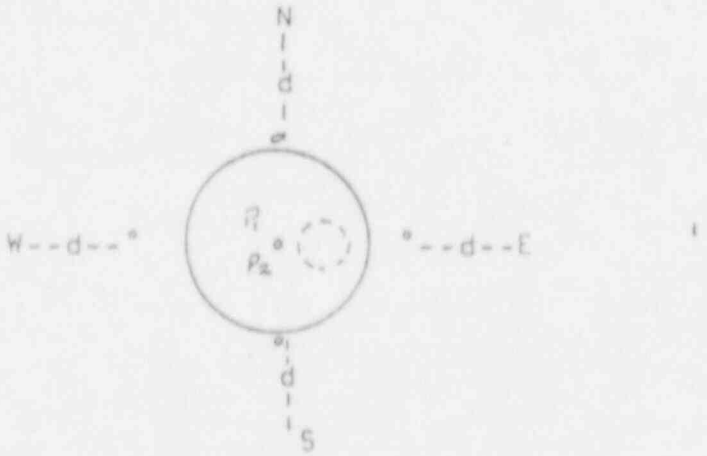
LOCATION: _____

DATE: _____ Shipper _____

Type Berthold Equipment _____

III. Radiation Measurements of Each Device

Type of Berthold equipment _____
Berthold Device Drawing No. _____
Date received _____
No. of Source Holders-Incl sources _____
Source Type _____
Source Strength _____
Device Serial No. _____



A radiation survey of each device will be made at each distance "d" of 0cm (surface), 5cm, 30cm and 100cm. Measurements can be made with shutter closed and shutter open.

A. Shutter Closed:

Test Location	0-cm (surface)	5cm	30cm	100cm
N				
S				
E				
W				
P_1 (top)				
P_2 (Bottom)				

III. Radiation Measurements of Each device

B. Shutter Open:

Test Location	0-cm (Surface)	5cm	30cm	100cm
N				
S				
E				
W				
P_1 (top)				
P_2 (bottom)				

Training of Berthold Personnel in U. S.

Operation and Service

Initial training will be provided by LAB. Berthold in Wildbad, West Germany and updated whenever new devices warrant. This training will be passed on in U. S. by the person trained in Germany

Radiation

A training program will be in effect for all employees handling radioactive sources and refresher training on a yearly basis (records will be maintained)
This training will be the responsibility of James Welsh.
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 PRACTICAL 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

James Welsh

dc

CUSTOMER TRAINING

Customer training will be the responsibility of Mr. James Welsh or his designate so named in our license.

I. Training for specific licensees (at installation)

Operational

A) Identification of component parts ie. Detector/electronics

B) Level calibration

C) Shutter operation and safety check

D) Problem determination

E) Dos and don'ts of operation

F) Who to call for servicing

G) Emphasis on source servicing by Berthold personnel only

Safety

A) Mechanics and physical properties of the isotope employed

B) Dose calculation

C) Activity calculations

D) Regulations regarding their responsibility as a specific license with emphasis on receiving sources

E) Occupational exposure limits

F) Personnel monitoring requirements

II. Training for General licensee (at installation)

Same as Item I A through G (operational)

Under Safety:

A) Do's and don'ts regarding safety - keeping it as simple as possible
B) Provide the customer with a copy of 10 cfr 31.5 (customers responsibility)
C) Question and answer period
D) Reviewing the labels on the device
E) Instructing the customer on Berthold's responsibility regarding the device.

Records of training will be kept.

James Welsh
dc

AUG 13 1985

Docket No. 030-20767
Control No. 02479

Berthold Instruments, Inc.
ATTN: Mr. A. McCabe
136 Bradford Avenue
Pittsburgh, Pennsylvania 15205

SUBJECT: APPLICATION FOR MATERIAL LICENSE DATED JUNE 4, 1984, AND OUR REQUEST FOR INFORMATION DURING A TELEPHONE DISCUSSION ON JUNE 5, 1985

Gentlemen:

This concerns the subject application for material license and our letter in which we notified you that the application was deficient and that certain additional information was required.

You are hereby notified that unless within thirty (30) days from the date of this notice we receive the additional information requested, we will consider that you have abandoned your application. This action is without prejudice to the resubmission of an application.

Sincerely,

for John E. Glenn, Ph.D., Chief
Nuclear Materials Safety Section B
Division of Radiation Safety
and Safeguards

RI:DRSS
Davis/rw
8/12/85

OFFICE RECORD COPY ML 017 DAVIS 8/7/85 - 0001.0.0
08/07/85

~~8511212550~~

ML1B

Department

berthold

Nuclear Instrumentation

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

January 11, 1985

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

ATTN: JACK DAVIS
CONTROL NUMBERS - 02478 AND 02479

Dear Jack,

With regards to our phone conversations of November 20, 1984, and January 8, 1985, wherein you requested clarification and additional information regarding Berthold Instruments, Inc., original application for possession and distribution of sealed source dated May 24, 1984. The points that we discussed I will address in the following manner.

Point #1) USE OF WHOLE BODY AND RING BADGES
I have checked our application and I cannot find any inconsistencies in the employment of these badges. I do admit that this point needs clarification and additional information as to their use as follows:

Whole body badges will be used by any employee who has access to the area where shield sources are stored.
Ring badges will only be employed when handling the source itself. (Naturally, whole body badges will always be employed).
We estimate that handling of the sources in storage awaiting distribution will be less than 1% of storage time if at all. In the field, we will handle the sources for replacement purposes due to damage (low probability) or decay (every 3 years (opp.) for Co and 15 years for Cs).

~~8512020354~~

02479

Most of our devices contain less than 50 mCi of activity but ring badges will be employed in all cases of source handling. Refer to attachment #6 original. Application for servicing operation item 1C i and ii for typical whole body exposures. We estimate at least 10 times the exposure indicated for hand exposures.

Point #2) INSTALLATION SURVEYS AND INSPECTION

Surveys and inspection will be performed on all installations to general licenses. In the case of specific license where the customer chooses to install on their own, we will make recommendations and give guide lines on external electromagnetic surveys and wipe testing.

Point #3) INSTALLATION SURVEY PROCEDURE

External electromagnetic radiation surveys will be performed at the surface, 30 cm and 1 meter from the source housing shield with the eccentric shutter open and closed. Again with the shutter open and closed, radioactive measurement will be performed at 30 cm and 1 meter on each side and detector end if accessable. This survey information will be provided to the customer and for our records.

EQUIPMENT USED

We will employ a Berthold LB 133 (refer to attachment #1 for specifications and technical data) for dose rate measurement. This instrument will be calibrated by Applied Health Physics Corporation in Bethel Park, Pittsburgh, Pennsylvania at a frequency dictated by regulation (10cfr).

Point #4) LEAK TESTING

Leak testing will be accomplished by wipe test at frequencies determined by regulations with regard to General licenses. Berthold Instruments, Inc., will either personally provide wipe test surveys and analysis or provide a Mark-V leak test kit manufactured by Applied Health Physics in Pittsburgh. Applied Health Physics Corporation does provide analysis for their kits.

Berthold Instruments, Inc., will elect to perform wipe surveys depending on circumstances. We will employ moist wattman paper or cotton swabs for the wipe tests. Analysis of these wipe test will employ P.M.T. sodium iodide detectors, (1" to 3" depending on the energy), with a Berthold LB 1026/27 electronics capable of responding to activities less than 0.005 uCi.

PROCEDURE:

The procedure for wipe testing will include 3 points for wiping as follows:

A) Face of shutter (shutter closed).

B) On beam port.

C) Any exterior housing surface.

*Each wipe will be approximately 4 square inches.

When supplying the customer with a leak test kit, instructions will be furnished on how to perform said test.

Point #5) INCOMING WIPE TEST

As an added precaution, a leak (wipe) test will be accomplished on all shipments received from Berthold - West Germany using the procedure described in Point #4 prior to distribution.

Results of these test will be part of our records.

Point #6) DISPOSAL OF DAMAGED/DECAYED SOURCES
The removal and replacement of all sources will be by Berthold personnel only. Decayed sources will be packed and shipped back to Germany by Berthold Instruments, Inc., personnel in accordance with regulations. We will utilize the services of Applied Health Physics Corporation for the disposal of damaged sources.

Point #7) FACILITY DIAGRAM (SKETCH)
Refer to attachment #2.

Point #8) CHANGE (DELETION AND ADDITION)
Berthold Instruments, Inc., would like to change Item #8, Attachment #1 of our original application. The following list will replace our original application Item #8, Attachment #1.

A	B	C	D
Co-60	Sealed Source	Berthold P2608-100	2 @ 50
Co-60	Sealed Source	Berthold P2608-101	2 @ 50
Co-60	Sealed Source	Berthold P2602-100	2 @ 200
Cs-137	Sealed Source	Berthold VA-287	2 @ 500
Cs-137	Sealed Source	Berthold P2623-100	2 @ 1000
Cs-137	Sealed Source	Berthold P2645.100-000	2 @ 1000
Am-241	Sealed Source	Berthold P-2642-100	3 @ 100
Am-241	Sealed Source	Berthold P-2611-100	3 @ 100
Cm244	Sealed Source	Berthold 2657.000-000	3 @ 10
Sr-90	Sealed Source	Berthold M1603A	10 @ 0.0001
Sr-90	Sealed Source	Berthold M1603B	10 @ 0.1
Sr-90	Sealed Source	Berthold 1210CS	20 @ 0.0001

NOTE: These activities are maximum amounts per source device. In most cases, activity levels will be less than that stated in Column D.

Point # 9) ADDITION
Please add to Item # 10 Radiation detection instruments (Attachment #2 original application) the following instrument.

A	B	C	D	E	F
Dose Ratemeter	Berthold	LB 140	1	Neutron	0.5 m rem/hr. to 15 rem/hr.

This instrument will be used for Surveys of the Am241 Be source 2611-100.

Point #10) ADDITION
Attachment #1, Item #9.
Storage of sealed sources (original application Item D).

1)	Rod source housing shield for sources 2608-100/101 and VZ287.	Berthold	21157.001
2)	Housing for Source P2611-100.	Berthold	19166-002
3)	Shield storage for housing 19166-002.	Berthold	21121-002
4)	Point Source shield housing for sources P-2602-100, P-2623-100, and 2645.100-000.	Berthold	PB2199.002
5)	Source housing for source 2642-100.	Berthold	2193-100-000 2193.200-000
6)	Source holder for source 2657.000-000.	Berthold	2648.000-000
7)	Housing for source holder 2648.000-000.	Berthold	15136.000-000
8)	Housing and holder for source 2642-100 in-line density guage.	Berthold	15113.002
9)	Housing and holder for source 2611-100. Moisture guage in Sulfur analyzer.	Berthold	1555.100-021
10)	Drawing of overall Sulfur analyzer shields including moisture and density detectors.	Berthold	15143.001

11)	Cs and Co point source shield housing.	Berthold	21135.100-00

I trust this added information and change is clear and precise. I appreciate your call informing us of these discrepencies and your prompt attention.

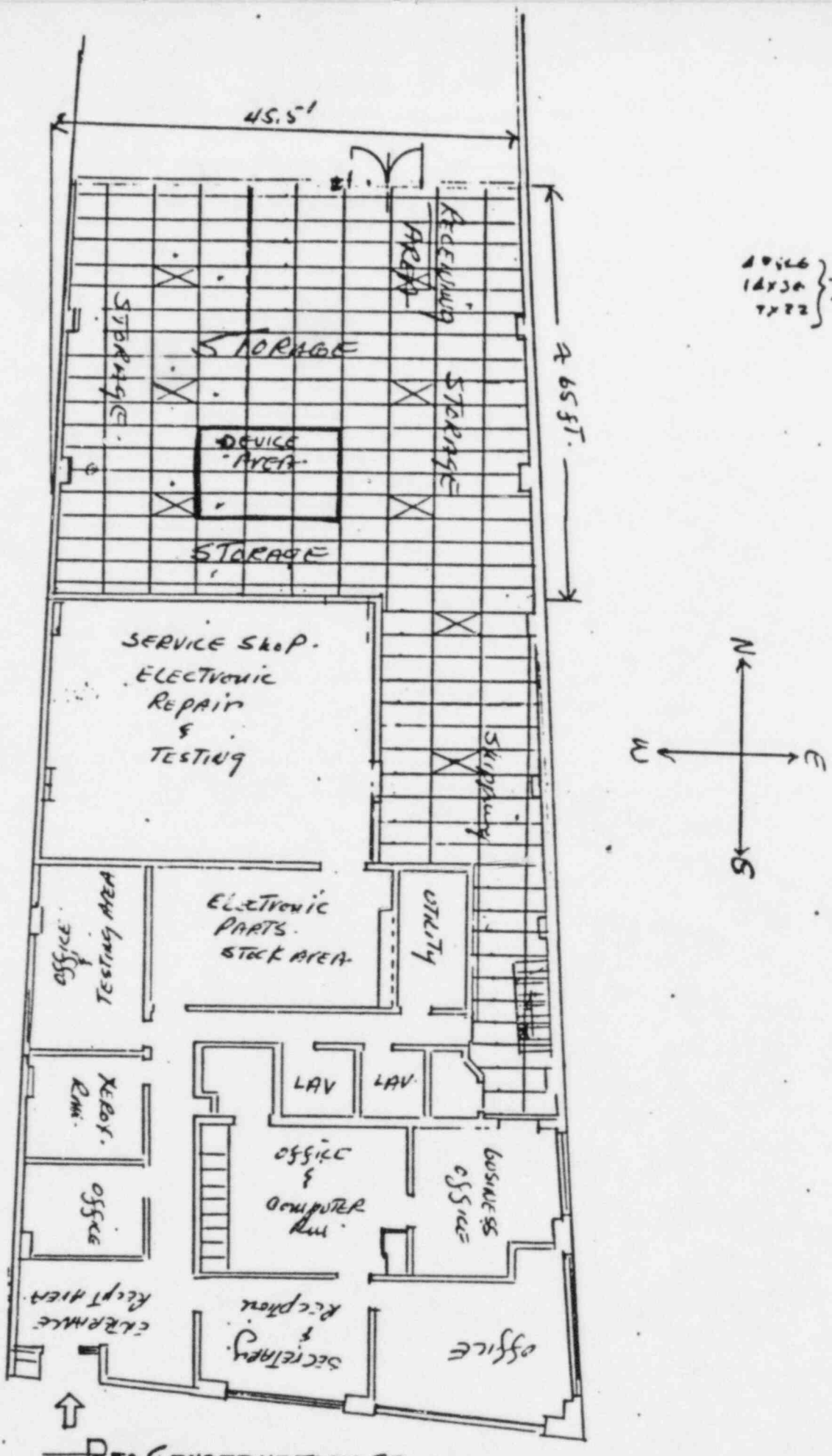
Regards,

Jim Welsh

Jim Welsh

JAW:mls

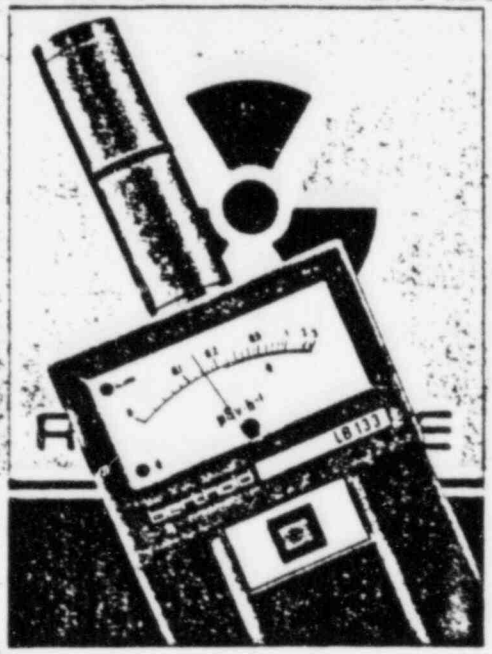
Enclosure



REA CONSTRUCTION CO.
136 BRADFORD AVE.
CRAFTON PA.

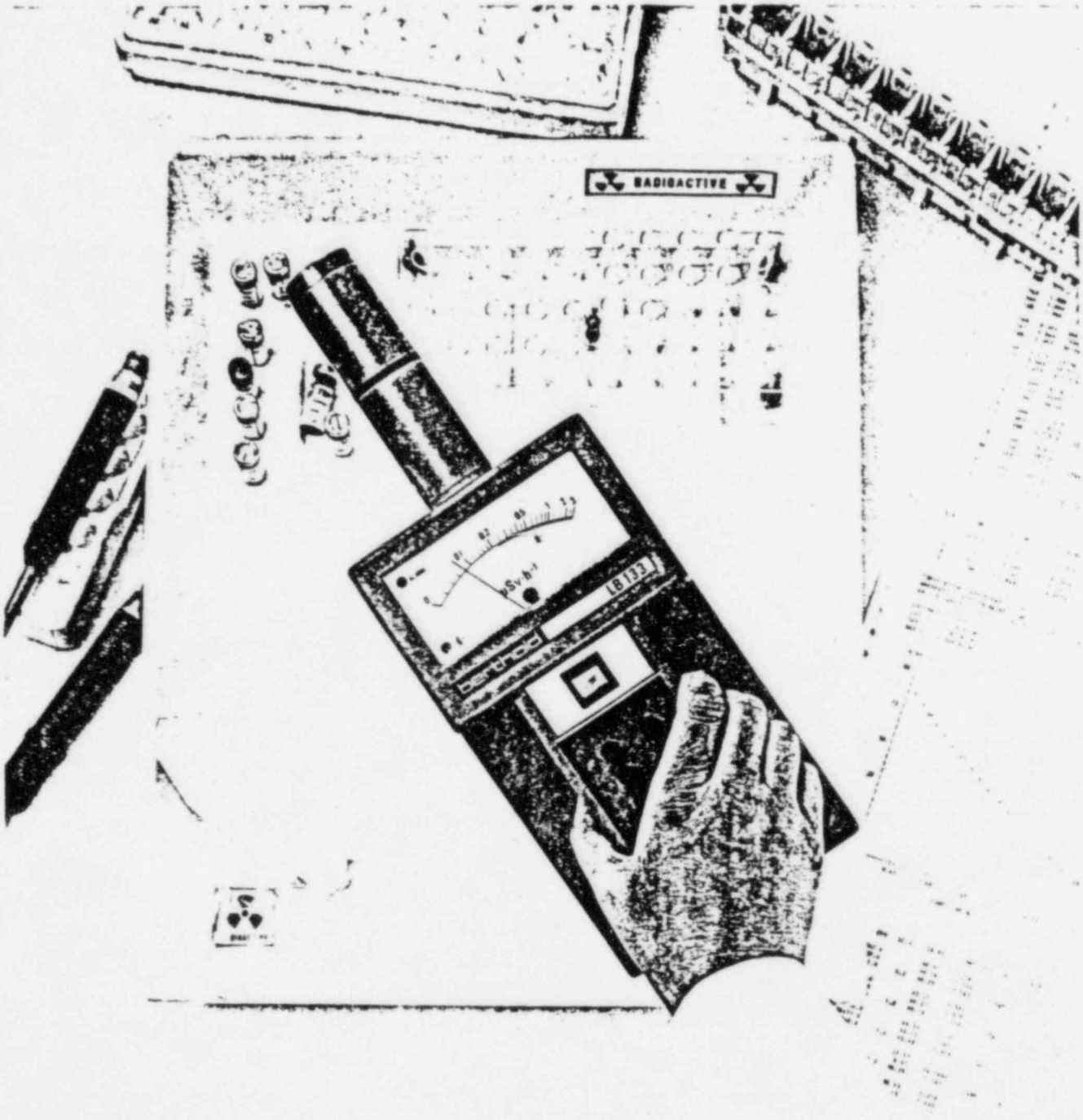
APPROX. OFFICE LAYOUT

Attachment #1



Berthold Portable Doserate Meter LB 133

The Portable Doserate Meter LB 133 ...



Application

The LB 133 has been designed as a handy doserate meter for universal application in nuclear engineering as well as nuclear medical installations.
Combining the low energy dependence of ionisation chamber instruments with the stability and high sensitivity of counter tube instruments, the LB 133 closes a real gap in doserate measurement. It is intended to be used primarily where the measuring range of conventional GM counter tube instruments does not provide sufficient sensitivity or where their energy dependence is inadequate.

The versatility of the instrument is increased further by the fact that the counter tube can be unscrewed and connected to the instrument by an up to 5 m long cable.

LABORATORIUM PROF. DR. BERTHOLD · D-7547 Wildbad 1 · Calmbacher Str. 22 · P. O. Box 160 · Phone (0 70 81) 39 81 · Telex 07 24019

... and its Outstanding Features

- **The doserate measuring system LB 133 has been approved for official calibration**

  under license no. $\frac{23.01}{80.42}$ according to the German calibration regulations*).
  It may therefore be calibrated and can – after the calibration has been carried out by the competent Bureau of Standards – be used for radiation protection measurements which are based on the legal regulations.

- **The LB 133 has already been scaled according to the new legal unit for the equivalent doserate "Sievert" (Sv).**

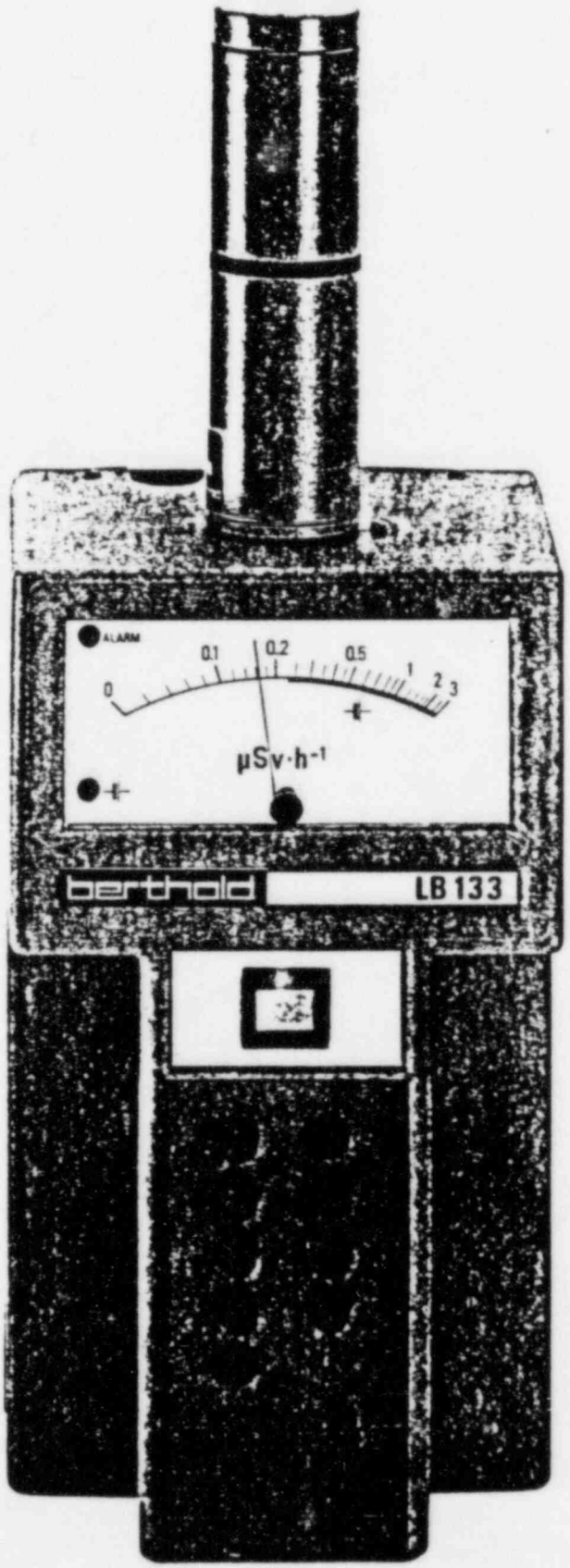
  To establish a simple numerical relation to the previously used units, the so-called "photon-equivalent-doserate", recommended by the PTB, will be displayed. Thus,

  $$1 \text{ Sievert (Sv)} = 1 \text{ J} \cdot \text{kg}^{-1} = 100 \text{ rem} = 100 \text{ R}$$

  resp.

  $$1\ \mu\text{Sv} \cdot \text{h}^{-1} = 0{,}1 \text{ mrem/h} = 0{,}1 \text{ mR/h}$$

- Smallest (quasi-linear) measuring range 0-3 μSv · h^{-1} (approx. 0-0.3 mr/h), therefore the **background count rate is easily detectable** (statistical standard deviation 16%).
- Using an energy compensated proportional counter tube in the pulse count mode as detector ensures a **large measuring range** combined with **low energy dependence**
- Suitable for **doserate measurements of** ^{125}I
- Visual and audible **alarm threshold** indication
- Flashing light **indicates** imminent **battery exhaustion**
- **Battery voltage check** incorporated in display
- **Threshold check** with display
- Simple **mains supply unit** for stationary use
- Radioactive **test equipment** for extension of the legal re-calibration period* from 2 to 6 years can be supplied as accessory
- **Extension cable** (5 m) between counter tube and electronics, can be supplied as accessory



*) Second Regulation on the obligation for calibrating measuring systems dated August 6, 1975 (BGBl I S. 2181) and the regulation on the period of validity of the calibration (Calibration Validity Regulation) of August 5, 1976 (BGBl I, S. 2083)

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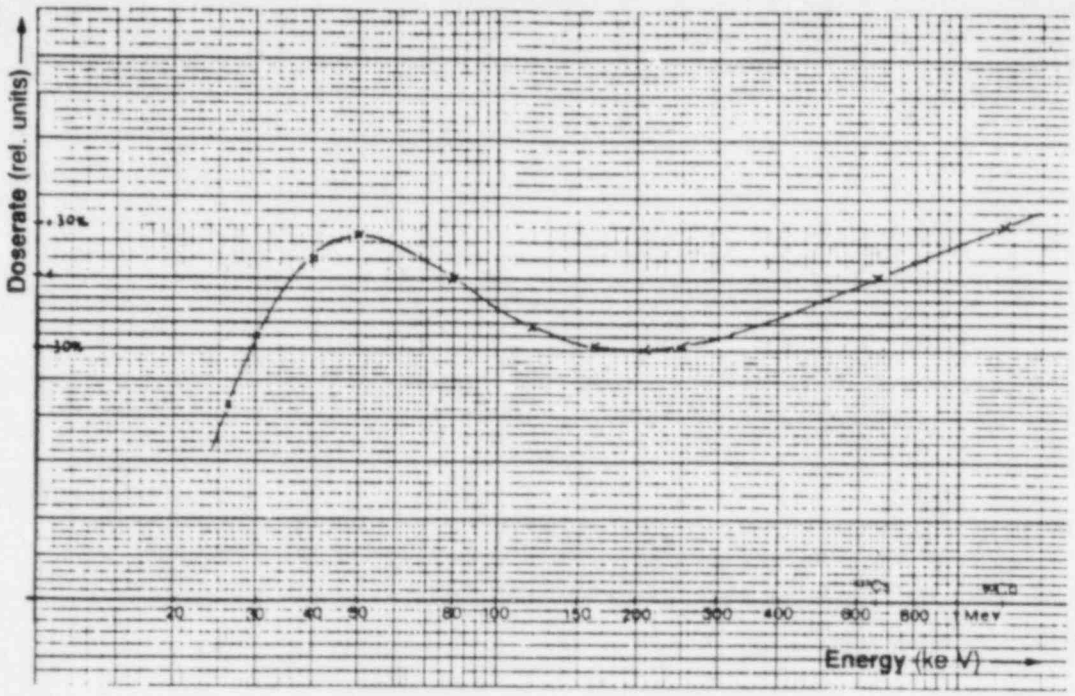
LB 133



Energy dependence

Technical Data

Detector
Proportional aluminium counter tube with special energy filter
Effective cross-section approx. 20 cm^2
Calibrating factor approx. 50 s^{-1} per 10 $\mu Sv \cdot h^{-1}$

Energy Dependence
See graph. Nominal range 30 keV - 1,3 MeV for photone energy

HV Supply
Preset to approx. 1900 V, internally adjustable ± 200 V

Measuring Ranges
0–3 $\mu Sv \cdot h^{-1}$ (approx. 0.3 mR/h) on quasi-linear scale
Factors × 1, × 10, × 100, × 1000, × 10000 selected by pushbutton, scale length 75 mm

Time Constants
2 s, × 10 by pushbutton selection

Single Pulse Indication
Audible, selected by ON/OFF pushbutton

Alarm Threshold
Adjustable over full scale length with slotted potentiometer in control panel
Threshold check on display by pushbutton selection
Audible and visual alarm when threshold is exceeded

Batteries
6 round miniature cells, 1.5 V, No. 7244 (IEC No. LR03)
Cell life 72 h continuous or 10 × 8 h intermittent
Battery check incorporated in display, pushbutton selected
Warning several hours before batteries exhausted by flashing LEDs on scale

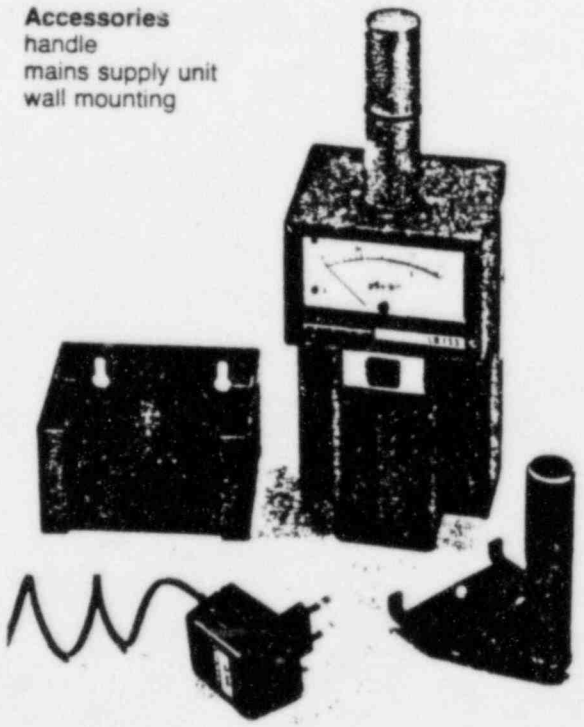
Mains Connection
Through external mains supply unit

Colour
orange

Weight
approx. 1500 g

Dimensions incl. Counter Tube
380 mm × 125 mm × 95 mm

Accessories
handle
mains supply unit
wall mounting



LABORATORIUM PROF. DR. BERTHOLD · D-7547 Wildbad 1 · Calmbacher Str. 22 · P. O. Box 160 · Phone (0 70 81) 39 81 · Telex 07 24019

Department

berthold

Nuclear Instrumentation

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

September 28, 1984

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

ATTN: JACK DAVIS

REF: CONTROL #5 - ~~02478~~ 02479 (POSSESSION)
02479 (DISTRIBUTION)

Attached is further information I forwarded to Steve Baggett on devices to be safety evaluated and certified. (Two copies for your file.)

By way of this letter, I request that the following information be added to attachments #1, Item #8 on both possession and distribution license applications with the control #02478 and #02479 respectively.

As follows:

Cm 244	Sealed Source	Berthold Inst.,Inc. 15136.000-000	4 @ 10 mCi
Am241/Be	Sealed Source	Berthold Inst.,Inc. 21121-002	2 @ 100 mCi
Am241/Be	Sealed Source	Berthold Inst.,Inc. 1555.000-021	2 @ 100mCi
Am241	Sealed Source	Berthold Inst.,Inc. 15113.002	2 @ 100 mCi
Am241	Sealed Source	Berthold Inst.,Inc. 2193.200-000	2 @ 100 mCi

If you should have any questions concerning this matter, please feel free to contact me at (412) 922-2635.

Sincerely,

James A. Welsh

"OFFICIAL RECORD COPY"

JAW:mls

Attachments - #2193.200-000 (2 Copies)
#15136.000-000 (2 Copies)
#21121-002 (2 Copies)
#1555.100-021 (2 Copies)
#15113.002 (2 Copies)

02479
MC10
01 OCT 1984

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
1.2	Chemical composition:	Am_2O_3
1.3	Physical state:	ceramic bond
1.4	Enclosed or open:	enclosed
1.5	Number off and individual activity:	off, 100 mCi each
1.6	Manufacturer:	The Radiochemical Centre, Amersham/England
1.7	Supplier:	Labor Prof. Dr. Berthold, Wildbad/Schwarzwald, Germany

2. Description of the enclosure:

For details regarding the construction of the enclosure see the enclosed drawing P 2642-100. The enclosure is tested by the manufacturer for surface contamination and leaks. A relevant test certificate is handed to the user on delivery.

3. Description of the shield:

The source is permanently fitted in a measuring head to drawing 2193. 100-000 M. The radiation outlet opening can be closed by a Pb shield.

4. Dose rates:

At the measuring head surface - excepting the radiation outlet opening:	0.20 mRem/h
At a distance of 1 m from the open radiation outlet opening:	max. 0.75 mRem/h

5. Description of the intended handling process or use:

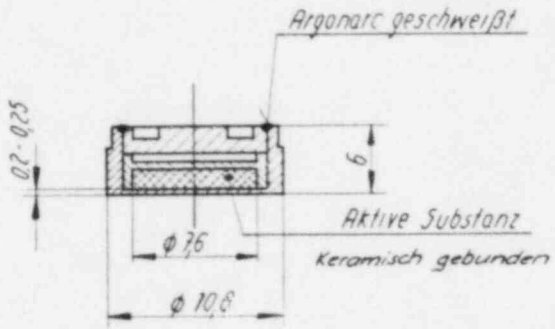
6. Information regarding the whereabouts of radioactive sources which are no longer required or decayed:

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

Date:

Enclosures:
Drawing P 2642-100
Drawing 2193.100-000 M

	MW	Chb	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
		Tag	Name
gez.		16.6.71	
gepr.			

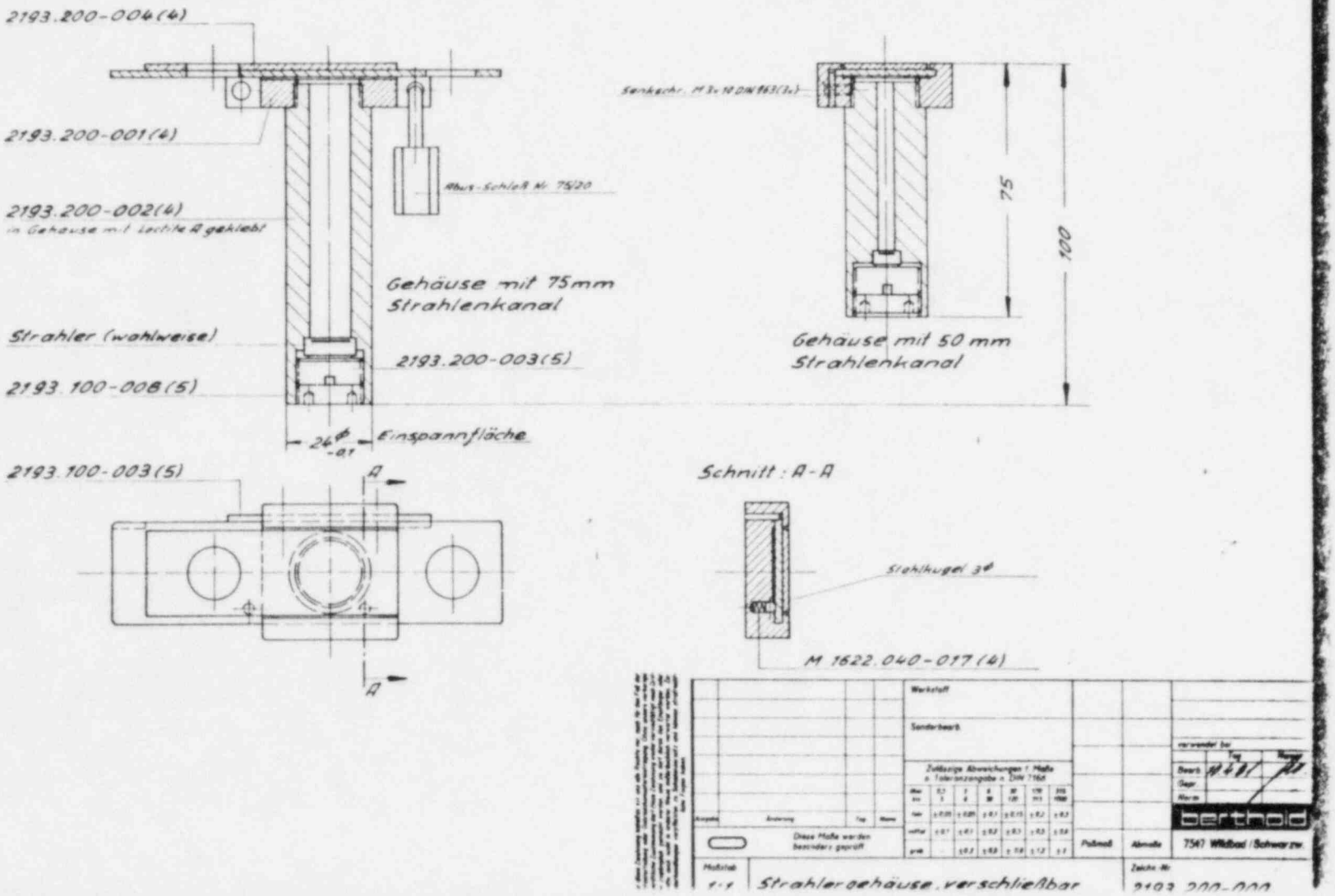
Laboratorium
Prof. Dr. Berthold
Wildbad | Schwarzwald

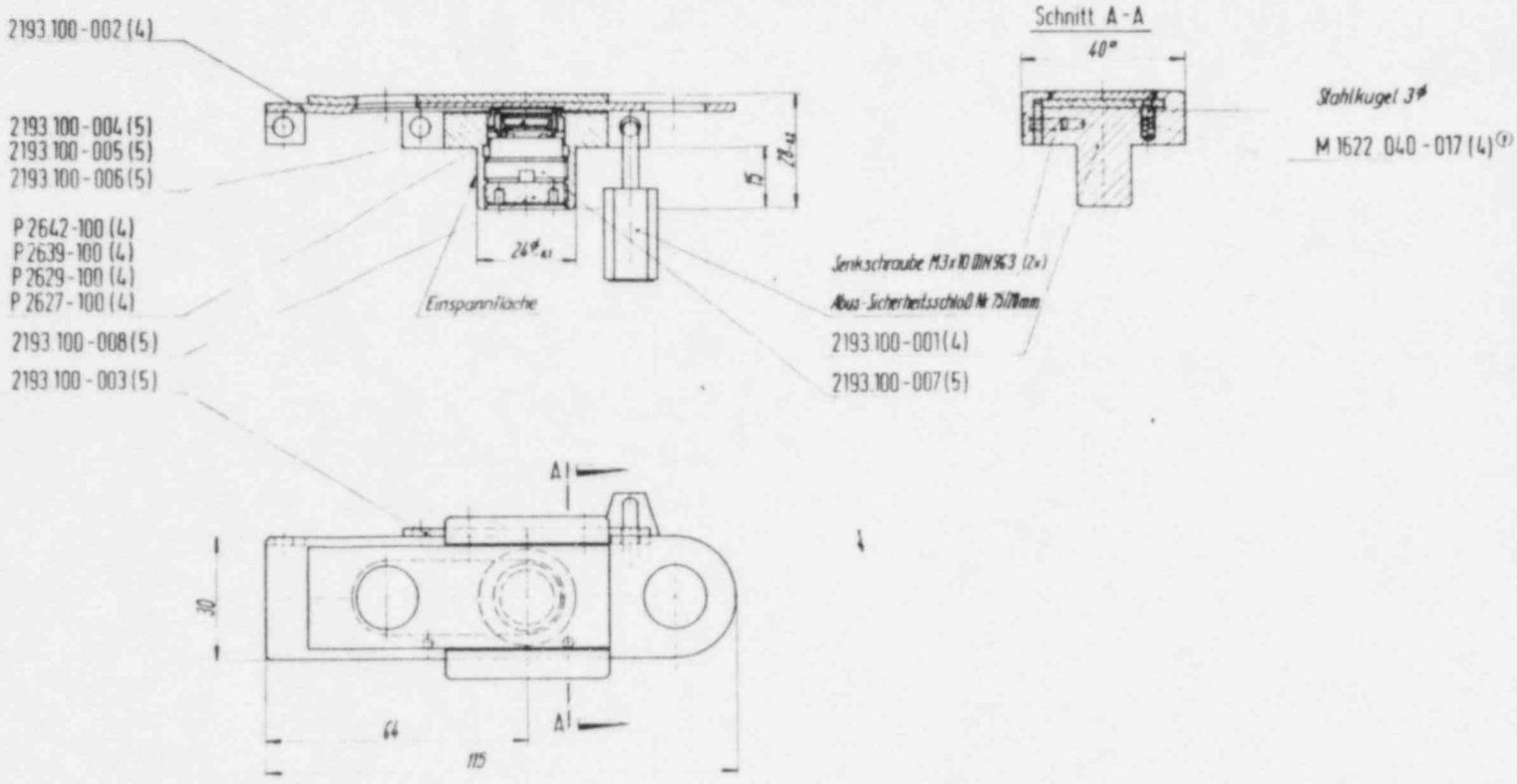
Maßstab

Hersteller: The Radiochemical Centre Amersham

Präparat AMC.16 100 mCi ^{241}Am

Zeichn.-Nr. P 2642 - 100


2193.200-004(4)
2193.200-001(4)
Abus-Schloß Nr. 7520
2193.200-002(4)
in Gehäuse mit Loctite A geklebt
Gehäuse mit 75mm
Strahlenkanal
Strahler (wahlweise)
2193.200-003(5)
2193.100-008(5)
24 -0,1
Einspannfläche
2193.100-003(5)
A
A
Senkschr. M3x10 DIN 963(4x)
75
100
Gehäuse mit 50 mm
Strahlenkanal
Schnitt: A-A
Stahlkugel 3Ø
M 1622.040-017(4)
Werkstoff
Sonderbeart.
Diese Maße werden besonders geprüft
Maßstab 1:1
Strahlergehäuse, verschließbar
berthold
7547 Wildbad / Schwarzw.



					Werkstoff				
					Sonderheit				
					Maße ohne Toleranzangabe				
						Diese Maße werden besonders geprüft		Paßmaß	Abmaße
						Tag	Name		berthold
1	Zeichng Nr geändert	19.8.	Bahr		gez	16.1.74	Bahr		7547 Wildbad/Schwarzw.
Ausgabe	Änderung	Tag	Name		gepr				
Maßstab 1:1	Präparatgehäuse verschließbar (neue Ausführung)							Zeichn. Nr 2193 100 - 000	

Lfd. Nr.	Stück-zahl	Benennung	Zeichnungs-Nr.	Teil-Nr.	Blatt-größe	Werkstoff	Normteil (Abmessung)	Bemerkung
1	1	Präparatgehäuse	2193.100 -	001	A4	□ Ms 58	DIN 1761	
2	1	Schieber	2193.100 -	002	A4	L Ms 58/Pb-Blech	DIN 1765	
3	1	Leiste	2193.100 -	003	A5	Ms 58	DIN 1759	
4								
5	1	Hülse (für Präparat P 2627-100)	2193.100 -	004	A5	Ms 58	DIN 1756	wird wahlweise verwendet je nach Auftrag
6	1	Präparat AMC.17 300 mCi ^{241}Am	P 2627 -	100	A4			
7								
8	1	Hülse (für Präparat P 2629-100, P 2642-100)	2193.100 -	005	A5	Ms 58	DIN 1756	
9	1	Präparat AMC.5 30 mCi ^{241}Am	P 2629 -	100	A4			
10	1	Präparat AMC.16 100 mCi ^{241}Am	P 2642 -	100	A4			
11								
12	1	Hülse (für Präparat 2639-100)	2193.100 -	006	A5	Ms 58	DIN 1756	
13	1	Präparat Typ X10 10 mCi ^{241}Am	P 2639 -	100	A4			
14								
15	1	Halteschraube	2193.100 -	007	A5	Ms 58	DIN 1756	
16	1	Kontermutter	2193.100 -	008	A5	Ms 58	DIN 1756	
17								
18 ①	1	Druckfeder	M 1622.040-	017	A4			
19								
20	1	Abus - Sicherheitsschloß					Typ : Nr. 75/20mm	
21	1	Stahlkugel					3 ø	
22								
23	2	Senkschraube					M 3 x 10 DIN 963	vernickelt
24								
25								
26								
27								

L	M	P	G	EW	Ch. B	ZW	MW	Name	Tag	Änderung	Ausgabe
								Kuhn	13.9.74	Pos. 18 ergänzt	1

Bearb. 15.1.74 Kuhn
Gepr.
Norm.

bertold
7547 Wildbad / Schwarzwald

Stückliste zu: Präparatgehäuse, verschließbar

Zeichnung-Nr. 2193.100-000 M besteht nur aus Baugruppe 100

Liste besteht aus 1 Blatt

Blatt-Nr. 1

Technical documents supporting an application for permission to handle radioactive substances

Commission number: (please quote in all correspondence)

Applicant:

1. Description of the radioactive substance:

1.1	Radioactive substance	244Cm
1.1.2	Chemical composition:	curium oxide
1.1.3	Physical state:	in ceramic form
1.2	Enclosed or open:	enclosed
1.3	Number off and individual activity:	1 off, 10 mCi each
1.4	Manufacturer: The Radiochemical Centre, ISO Classification: Capsule type:	Amersham/England C 64344 X131/4
1.5	Supplier: Labor. Prof. Dr. Berthold, 7547 Wildbad/Schwarzwald, Germany	

2. Description of the enclosure and shielding:

2.1 Description of the enclosure: For details of the construction of the enclosure see the enclosed drawing no. 2657.000-000. The enclosure is tested by the manufacturer for surface contamination and leaks. An appropriate test certificate is issued covering this.

2.2 Description of the shielding: The source is permanently fitted in a special steel capsule to drawing no. 2648.000-000. The dose rate at the capsule surface - excepting the radiation outlet opening - is 0.1 mR/h. On the measuring arrangement to drawing no. 15136.000-000 the radiation outlet opening is covered by the measuring cell opposite.

3. Description of the intended handling process or use:

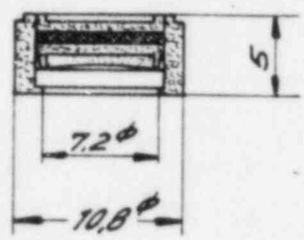
Continuous determination of sulphur in mineral oil

4. Information regarding the whereabouts of radioactive sources which are no longer required or decayed:

To be returned to the state collection point for radioactive waste.

Date:

Enclosures: 1 x drawing no. 2657.000 -000
1 x drawing no. 2648.000-000
1 x drawing no. 15136.000-000
1 x Certificate of Approval of design of capsule X131/4 SFC 144
1 x Certificate of Radioactive Source Integrity QCS 187



Kapsel Typ X 131/4

ISO Classification C 64344

Ref. RSD/CTR/59/1   1.12.1977

Werkstoff: Edelstahl

Sonderbearb.

Zulässige Abweichungen f. Maße o. Toleranzangabe n. DIN 7168

über / bis	0,5 / 3	3 / 6	6 / 30	30 / 120	120 / 315	315 / 1000
fein	±0,05	±0,05	±0,1	±0,15	±0,2	±0,3
mittel	±0,1	±0,1	±0,2	±0,3	±0,5	±0,8
grob	–	±0,2	±0,5	±0,8	±1,2	±2

Ausgabe	Änderung	Tag	Name

Diese Maße werden besonders geprüft

Paßmaß | Abmaße

verwendet bei:

	Tag	Name
Bearb.	15.11.79	[illegible]
Gepr.		
Norm.		

berthold

7547 Wildbad / Schwarzw.

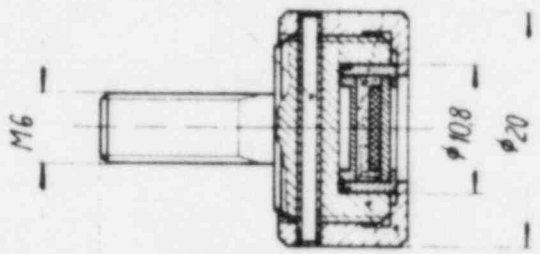
Maßstab

Hersteller: The Radiochemical Centre Amersham

Strahler C 64344 10-200 mCi ^{244}-Curium

Zeichn.-Nr. 2657.000-000

	MW	Cho	G	M
	ZW	EW	P	L



	Werkstoff		
	Sonderbearb.		15136.000-000
	Maße ohne Toleranzangabe		1572.000-000
	Diese Maße werden besonders geprüft	Paßmaß Abmaße	verw. bei
	Tag Name	berthold	
1 Strahler 2657.100.001 zusätzlich	gez. 12.2.75	7547 Wildbad Schwarzw.	
Ausgabe Änderung Tag Name	gepr.		
Maßstab 2:1	10 mCi ^{244}Cm-Strahler Präparatkapsel mit 10 mCi ^{238}Pu-Strahler	Zeichn.-Nr. 2648 000-000	

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.

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 1970. S.I. 1826. 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 [illegible]") Class 7.

Design No. SFC 144

Issue 1

CERTIFICATE OF APPROVAL OF DESIGN OF CAPSULE FOR RADIOACTIVE MATERIAL

TITLE	Low Energy Gamma Source Capsule Type XQ31/4
Drawing Nos. ~~and/or~~ Specification	BRC 10318/S Issue A
Radioactive Material	Americium 241 Plutonium 238 Curium 244
Maximum Activity	100mCi

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/or specification RSD/CTR/59 dated June 1974 submitted by The Radiochemical Centre, Amersham.

THIS CERTIFICATE CANCELS ALL PREVIOUS ISSUES

COMPETENT AUTHORITY IDENTIFICATION MARK :

GB: SFC 144

UNITED KINGDOM COMPETENT AUTHORITY FOR THE TRANSPORT OF RADIOACTIVE MATERIALS
4 JUL 1974

Date of Approval

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.

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

Department of the Environment,
~~Romney House,~~ 2 Marsham Street,
~~Tufton Street,~~ SW1 3EB
~~London SW1~~

~~Telex: 22601~~ MARSHAM
Telex: – 22601 Answer back DOE ~~HMTRY~~ LONDON

Telephone: – ~~01 212 3301~~
01 – 212 – 7247

The Radiochemical Centre Amersham

CERTIFICATE OF RADIOACTIVE SOURCE INTEGRITY

QCS 187
Issue 2

SPECIFICATION :- Capsule Type X121/4

DWNG NO. :- BRC10318/5

NUCLIDE, RADIO TOXICITY GP. :- Americium-241 Plutonium-238 Curium-244
Group A

MAXIMUM ACTIVITY :- 200mCi

CLASSIFICATION DESIGNATION :- C64344

TEST SOURCES :- 2 x 40 mCi Plutonium-238

TEST	TEMPERATURE	PRESSURE	IMPACT	VIBRATION	PUNCTURE
1					
2					
3			PASS < 0.01 0.01		
4		PASS <0.01 0.03		PASS 0.02 0.02	PASS 0.03 0.04
5					
6	PASS <0.01 <0.01				

TEST CARRIED OUT IN ACCORDANCE WITH RECOMMENDATION OF:- British Standard 528
and draft International Standard ISO 29

LEAK TEST.- Immersion and Wipe

ADDITIONAL INFORMATION:- Figures in Table denote activity (nCi) measured in liquid after immersion

P.T. Hartley
Quality Control Offr.

Date 28 February 1978

E.G. Hall
Radiation Sources Departme

OVERSIZE DOCUMENT PAGE PULLED

SEE APERTURE CARDS

NUMBER OF PAGES: 1

ACCESSION NUMBER(S):

8512020550-01

APERTURE CARD/HARD COPY AVAILABLE FROM RECORD SERVICES BRANCH, TIDC
FTS 492-8989

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 absorbs 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 B 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.

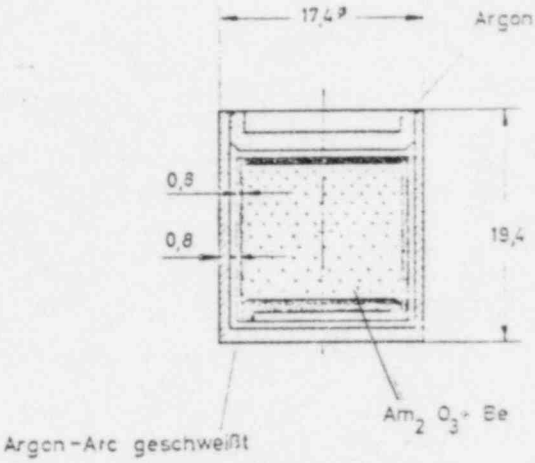
6. Protective equipment and protective measures:

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

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

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

Kapseltyp: X 2

Laboratorium Prof. Dr. Berthold
Wildbad im Schwarzwald

Bearbeitung

Sonderbearbeitung

Maße ohne Toleranzangabe

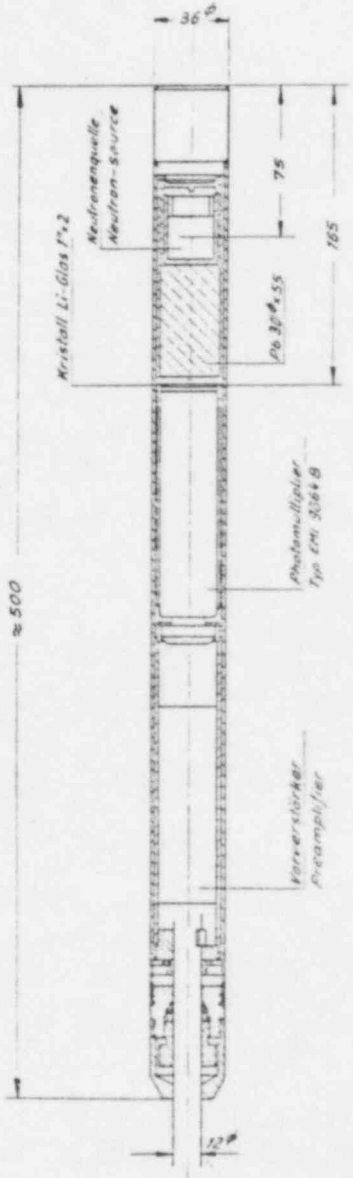
Diese Maße werden besonders geprüft

Tag 18.2.83

Maßstab 2 : 1

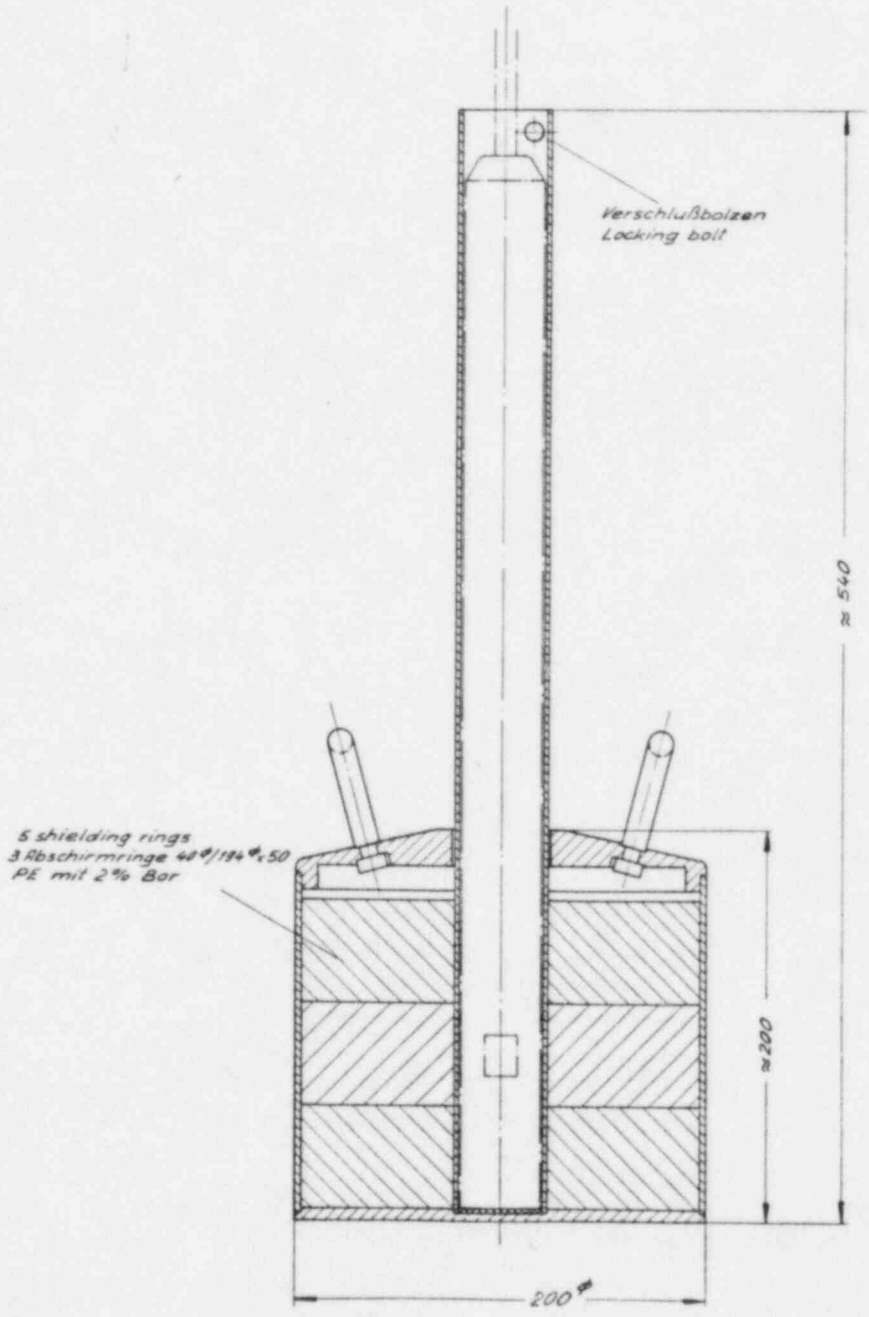
Americium - Beryllium - Neutronenquelle 30, 100 u. 300 mCi
Hersteller: Radiochemical Centre Amersham

Zeichnung Nr. P 2611 – 100



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. 27121-002

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. 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 · 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.

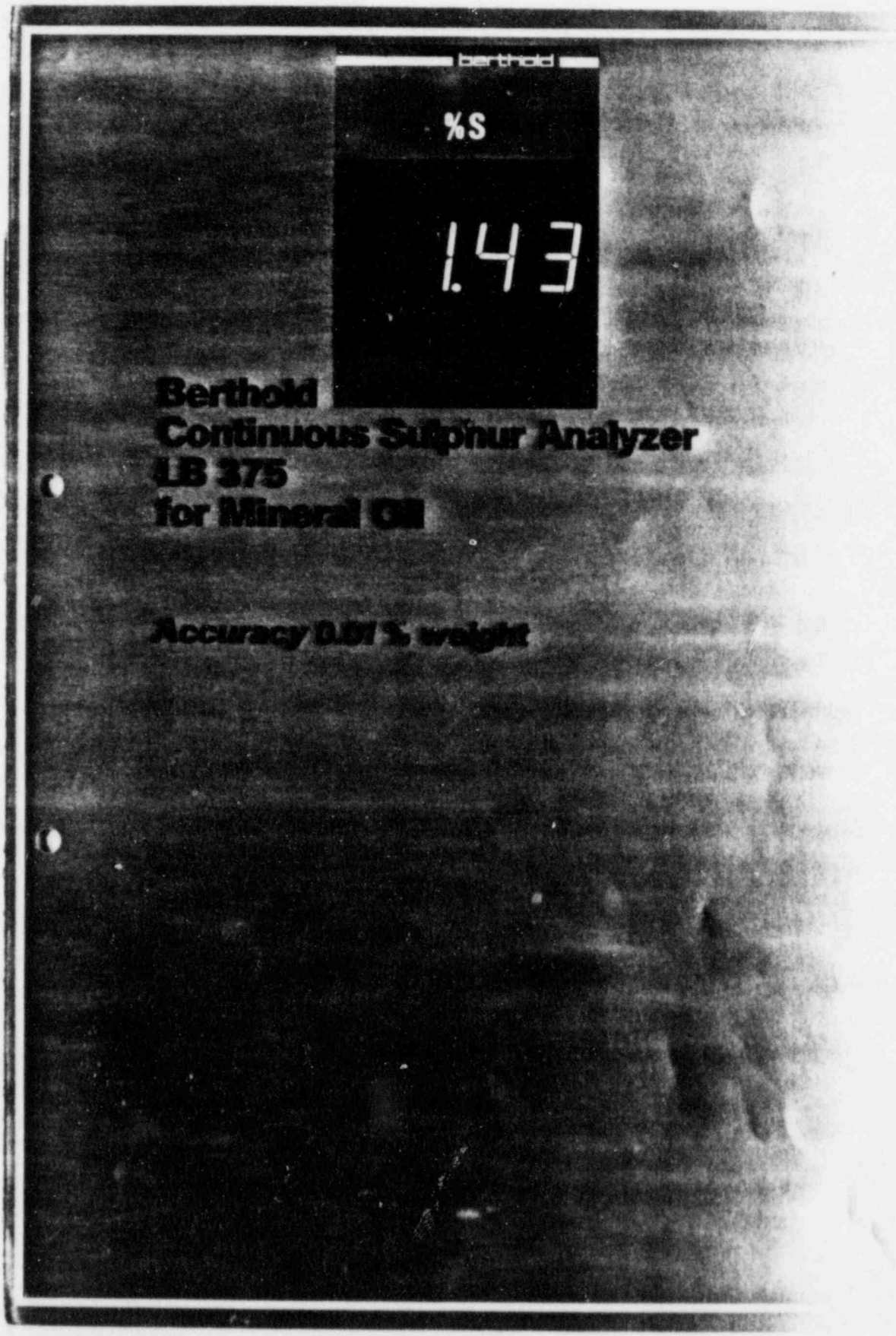
4.2.4 Neutron radiation dose rate at a distance of 1 m in operating condition (with oil filling in the through-flow container): approx. 0.1 m Rem/h.
In this case the control range limit is at a distance of only approx. 35 cm from the source.

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
%S
1.43
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.

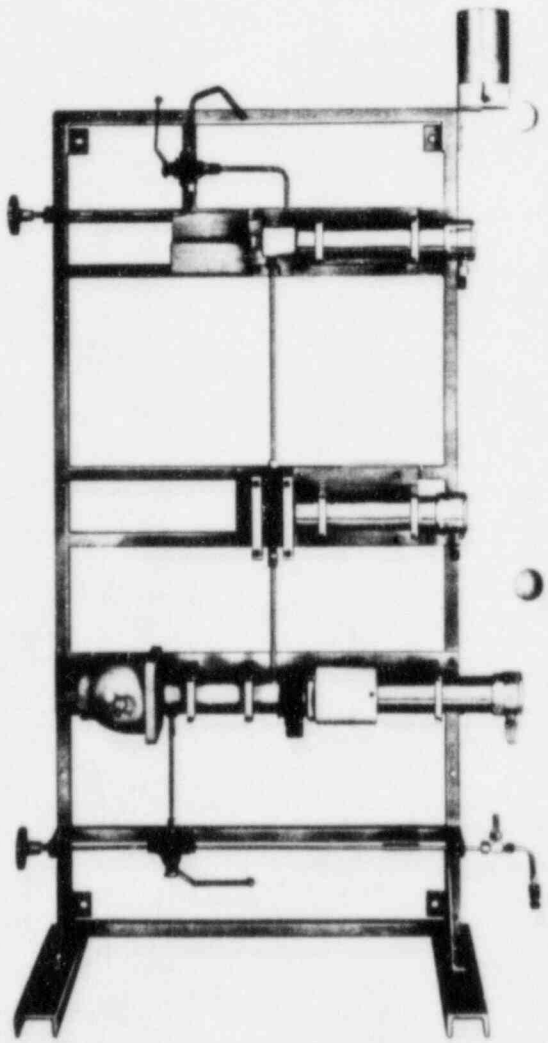
Advantages of continuous measurements without direct medium contact

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

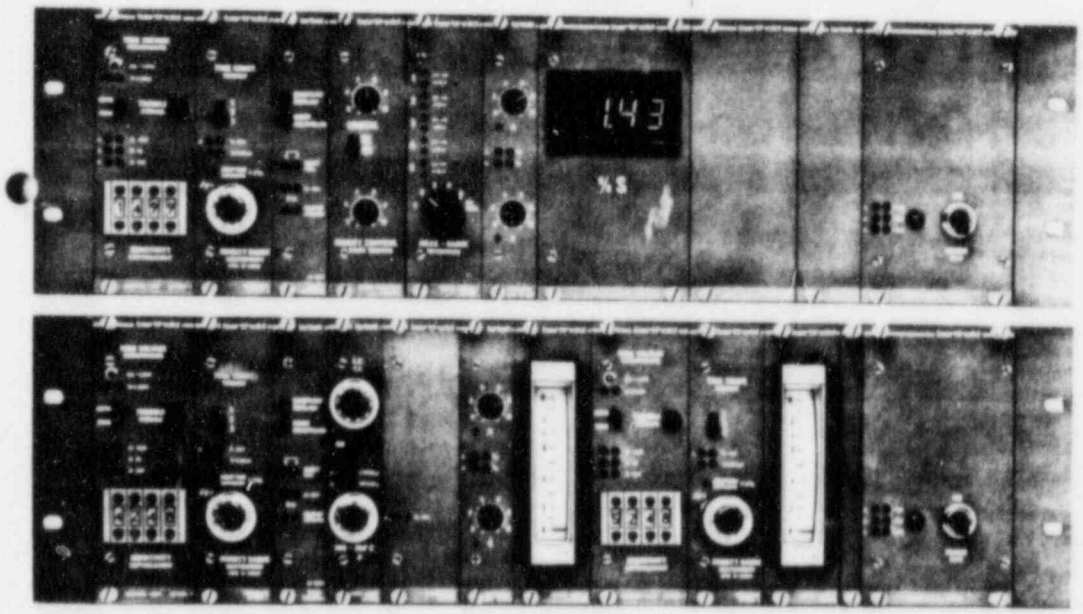
The individual scintillation detectors are connected to a ± 15 V power supply provided by the TOWER SUPPLY module. The HV supply for the photomultipliers and also control of drift stabilization (German patent) of the electronic measuring circuits is performed in the housing of the scintillation detector. 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 10^8 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 berylium
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 delIC 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

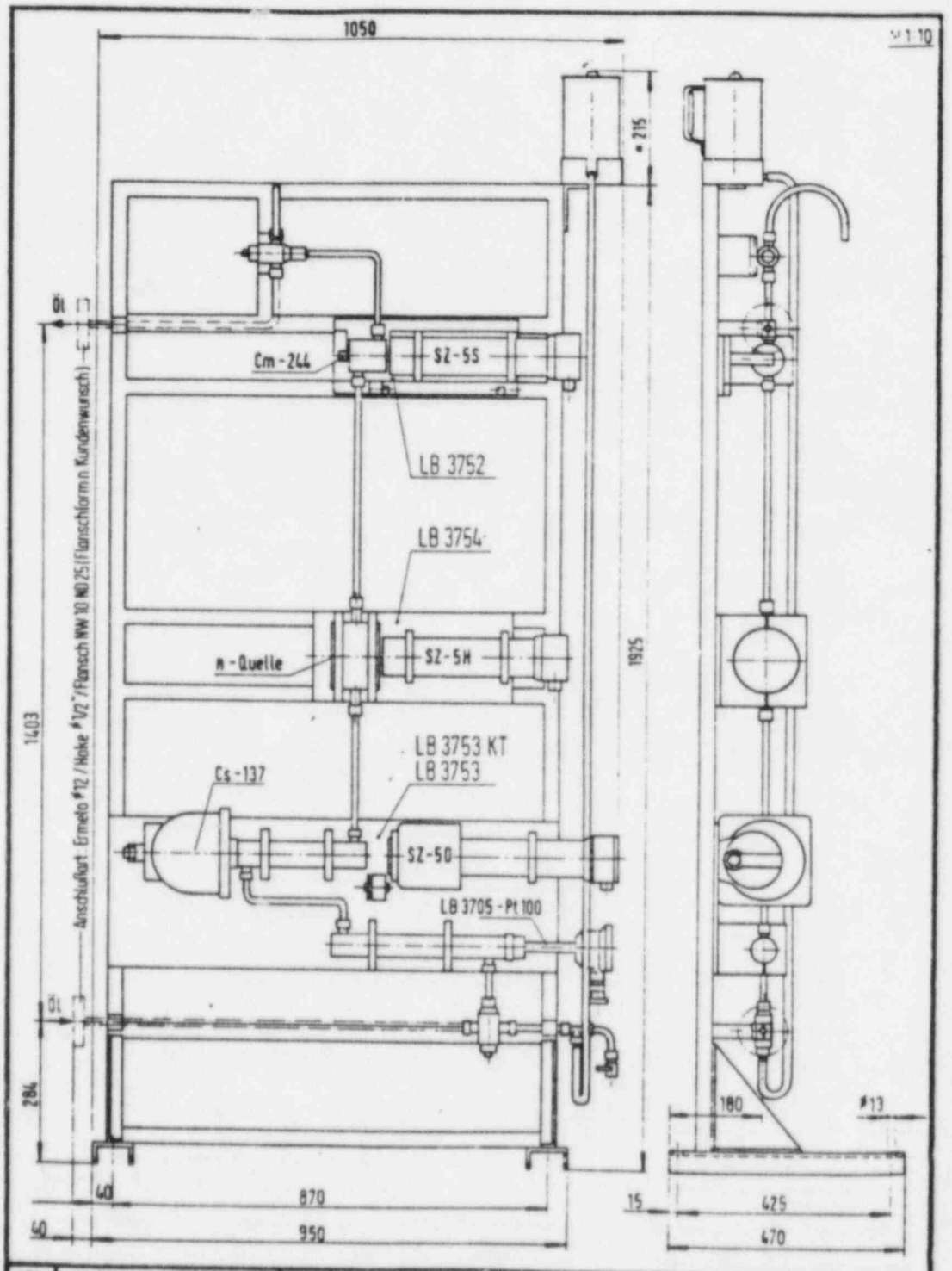
Display:

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

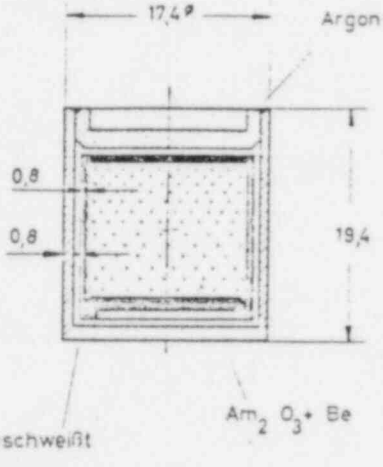
Details required for System Planning:

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 50/60 Hz ☐ 110 V ☐ 24 V

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



MW				Tag	Name	Schwefelanalysator LB 3750 - 4	Lose beiliegt aus
ZW			Bearb.	21.8	Lenk	Sulphur analyzer	
Ch B			Gepr.				Blatt
EW			Norm.				
G			berthold			Nr.	
P						15143.001	Blatt-Nr.
M							
L	Änderung	Tag	Name	7547 Wildbad / Schwarzwald			



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

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

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

Kapseltyp: X . 2

Laboratorium Prof. Dr. Berthold
Wildbad im Schwarzwald

Bearbeitung

Sonderbearbeitung

Name | Tag

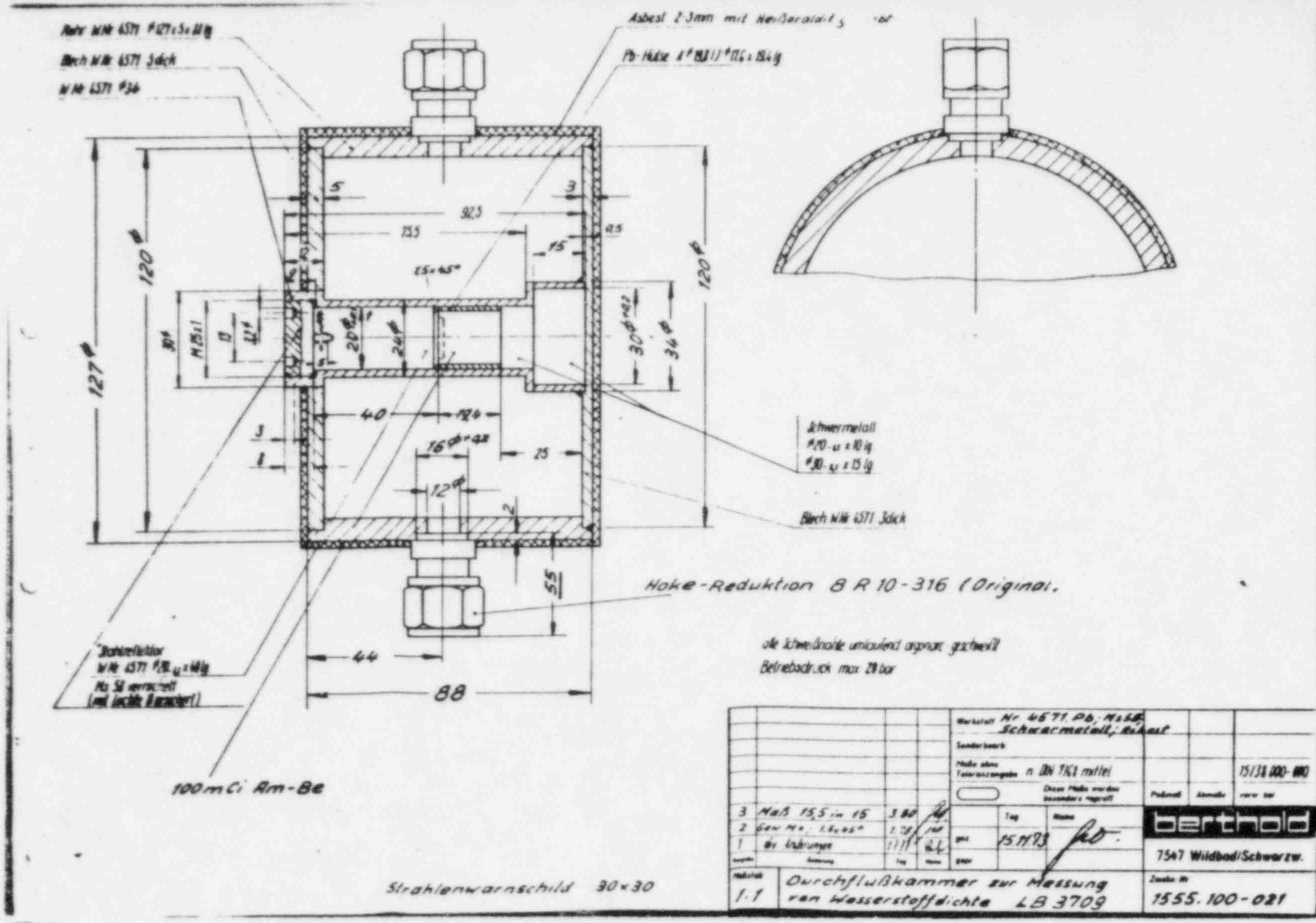
Maße ohne Toleranzangabe

Diese Maße werden besonders geprüft

Maßstab 2 : 1

Americium - Beryllium - Neutronenquelle 30, 100 u. 300 mCi
Hersteller: Radiochemical Centre Amersham

Zeichnung Nr. P 2611 – 100


Rohr W.Nr. 4571
Blech W.Nr. 4571 3dick
W.Nr. 4571
Asbest 2-3mm mit
Pb-Hülse
Schwermetall
Blech W.Nr. 4571 3dick
Hoke-Reduktion 8 R 10-316 (Original.
alle Schweißnähte umlaufend argonarc geschweißt
Betriebsdruck max 28 bar
Strahlenwarnschild 30×30
100mCi Am-Be
127
120
120
88
44
40
92,5
25
55
Nr. 4571, Pb; Ms58, Schwermetall; Asbest
n. DIN 7168 mittel
3 Maß 15,5 in 15
1:1
Durchflußkammer zur Messung von Wasserstoffdichte LB 3709
berthold
7547 Wildbad/Schwarzw.
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 Specification~~	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~~ HS 5002/2/SFC 38 - 41 dated 30 September 1969 ~~submitted~~ 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

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, Southwark Street, London SE1 0TE~~ 2, Marsham Street,
London SW1P 3EB.

Telegrams: ~~Environment London~~
Telex: 22801 Answer back DOE MARSHAM LONDON
Telephone: ~~01 212 7000~~
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] S.I. [illegible] Code of Practice for the Carriage of Radioactive Materials by Road. 19[illegible] 1735

   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. Hoath
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:

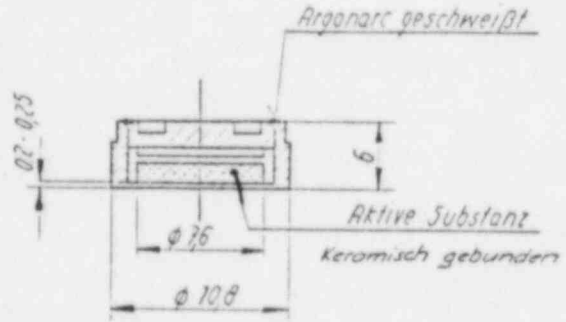
Enclosures:

1 drawing - varies with individual order

1 drawing 15113.002

1 Test Certificate no. 6.32-R33 (with English translation)

	MW	GS	G	M
	ZW	EW	P	L



Kapsel Typ X.91

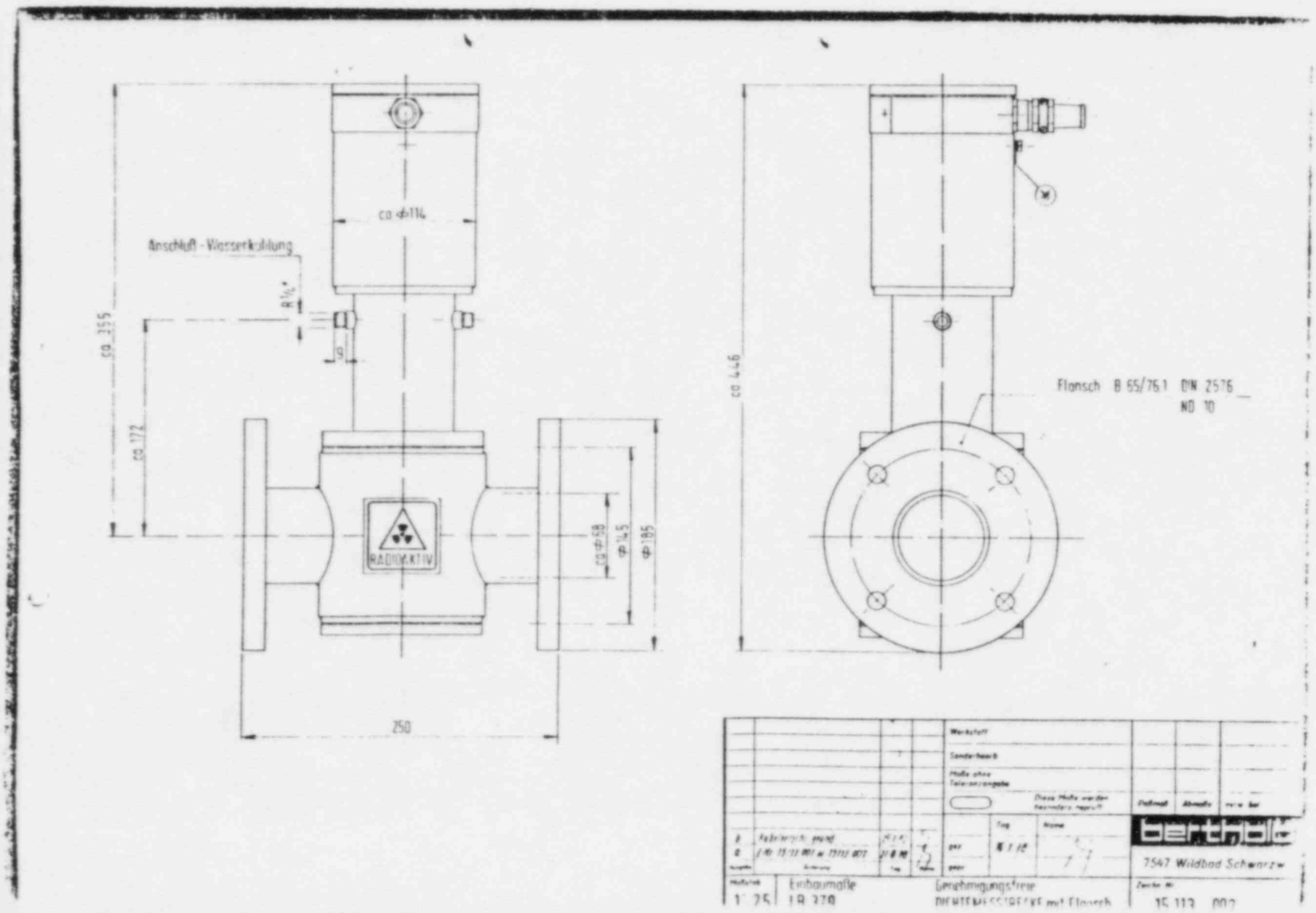
			Werkstoff: Edelstahl		
			Sonderbearb.		
			Maße ohne Toleranzangabe		
			Diese Maße werden besonders geprüft	Paßmaß	Abmaße / verw. bei
			Laboratorium Prof. Dr. Berthold Wildbad / Schwarzwald		Tag / Name
				gez.	16.6.71
				gepr.	
Ausgabe	Änderung	Tag	Name		

Maßstab

Hersteller: The Radiochemical Centre Amersham

Präparat AMC.16 100 mCi ^{241}Am

Zeichn.-Nr. P 2642 - 100



ca Φ114
Anschluß - Wasserkühlung
R 1/2"
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
Tag
Name
gez.
gepr.
berthold
7547 Wildbad Schwarzw.
Maßstab
1:25
Einbaumaße
LB 379
Genehmigungsfreie
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 flanged 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

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. - 02479 (DISTRIBUTION)

Dear Sir:

Our license application (Control # 02479) dated May 24, 1984, was submitted with discrepencies. Information that was not pertinent to this application was supplied and conversely information that was pertinent was not supplied.

Would you please remove and dispose of attachments:

#2 CONTAINING ITEMS #10, #11, #12.
#3 CONTAINING ITEMS #13, #14.
#4 CONTAINING ITEMS # 15.
#5 CONTAINING ITEMS #16, #17 FOR JIM WELSH AND ALFRED McCABE PLUS RESUME FOR WILLIAM KAUSEK.

Please use the bulk information title Application for Registration of Sealed Sources for Co-60, Cs137 and Source Housing sent to Steve Baggett as attachments #2, #3, and #4 respectfully as indicated in my cover leter dated May 24, 1984.

Please insert the enclosed attachments:

#5 PROCEDURE TO SERVICE SOURCES
#6 TRAINING FOR JAMES WELSH
#7 LABEL INFORMATION

I regret this inconvenience. If you have any questions concerning this matter, please contact me at (412) 922-2635.

Regards,

James A. Welsh

James A. Welsh
Industrial Product Manager

Enclosure: Attachments #5, #6, & #7. (2 copies)

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 measureme
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.

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 pre-requisite 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:

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

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*)

*) 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 (D1) 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.

$$D1 = A \cdot k$$

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

for Co-60	1.35	$\frac{\text{mrem} \cdot \text{m}^2}{\text{h} \cdot \text{mCi}}$
for Cs-137	0.35	$\frac{\text{mrem} \cdot \text{m}^2}{\text{h} \cdot \text{mCi}}$
for Am-241	0.0075	$\frac{\text{mrem} \cdot \text{m}^2}{\text{h} \cdot \text{mCi}}$

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 readily 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 b 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 officiall 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 off and 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 stay is 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 weight 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.

A label will be affixed to the shield housing with the following statement:

"The receipt, possession, use and transfer of this device Model # _____, Serial #_____ are subject to a general license or the equivalent and the regulations of the United State Nuclear Regulatory Commission or of a state with which the N. R. C. has entered into an agreement for the exercise of regulatory authority. This label shall be maintained on the device in legible condition. Removal of this label is prohibited."

CAUTION - RADIOACTIVE MATERIAL

BERTHOLD INSTRUMENTS, INC.