"OFFICIAL RECORD COPY"

030-20767

NRC Form 313 I (12-81) 10 CFR 30

U.S. NUCLEAR REGULATORY COMMISSION

APPLICATION FOR BYPRODUCT MATERIAL LICENSE
INDUSTRIAL

1. APPLICATION FOR: (Check and/or complete as appropriate)

L20723

X a. NEW LICENSE 03240

b. AMENDMENT TO LICENSE NUMBER

c. RENEWAL OF LICENSE NUMBER

See attached instructions for details.

Completed applications are filed in duplicate with the Division of Fuel Cycle and Material Safety, Office of Nuclear Material Safety, and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC 20555 or applications may be filed in person at the Commission's office at 1717 H Street, NW, Washington, D. C. or 7915 Eastern Avenue, Silver Spring, Maryland.

2. APPLICANT'S NAME (Institution, firm, person, etc.)

BERTHOLD INSTRUMENTS, INC.

TELEPHONE NUMBER: AREA CODE – NUMBER EXTENSION

(412) 922-2635

3. NAME AND TITLE OF PERSON TO BE CONTACTED REGARDING THIS APPLICATION

JAMES A. WELSH, PRODUCT MANAGER

TELEPHONE NUMBER: AREA CODE – NUMBER EXTENSION

(412) 922-2635

4. APPLICANT'S MAILING ADDRESS (Include Zip Code) (Address to which NRC correspondence, notices, bulletins, etc., should be sent.)

136 BRADFORD AVENUE
PITTSBURGH, PA 15205

5. STREET ADDRESS WHERE LICENSED MATERIAL WILL BE USED (Include Zip Code)

136 BRADFORD AVENUE
PITTSBURGH, PA 15205

(IF MORE SPACE IS NEEDED FOR ANY ITEM, USE ADDITIONAL PROPERLY KEYED PAGES.)

6. INDIVIDUAL(S) WHO WILL USE OR DIRECTLY SUPERVISE THE USE OF LICENSED MATERIAL
(See Items 16 and 17 for required training and experience of each individual named below)

	FULL NAME	TITLE
a.		
b.		
c.		

RECEIVED BY LFMB
Date 6/11/84
Log June 1 I
By Brown
Orig To
Action Compl. 6/12/84

2258 Application dated 5/30/84 Brown

7. RADIATION PROTECTION OFFICER

JAMES A. WELSH

Attach a resume of person's training and experience as required in Items 16 and 17 and describe his responsibilities under Item 10.

8. LICENSED MATERIAL

LINE NO.	A ELEMENT AND MASS NUMBER	B CHEMICAL AND/OR PHYSICAL FORM	C NAME OF MANUFACTURER AND MODEL NUMBER (If Sealed Source)	D MAXIMUM NUMBER OF MILLICURIES AND/OR SEALED SOURCES AND MAXIMUM ACTIVITY PER SOURCE WHICH WILL BE POSSESSED AT ANY ONE TIME
(1)	COBALT-60	SEALED ROD. SOURCE	BERTHOLD-GERMANY P-2608-100 & 101	50 mCi ea.
(2)	COBALT-60	SEALED POINT SOURCE	BERTHOLD-GERMANY P-2602-100	200 mCi ea.
(3)	CESIUM-137	SEALED ROD. SOURCE	AMERSHAM BUCHLER VZ-287 & SK-1208	500 mCi ea.
(4)	CESIUM-137	SEALED POINT SOURCE	AMERSHAM BUCHLER P-2623-100	1000 mCi ea.

	E DESCRIBE USE OF LICENSED MATERIAL
(1)	TO BE USED IN INDUSTRIAL DEVICES TO MONITOR AND MEASURE.
(2)	TANK LEVELS, DENSITY MEASUREMENT, BELT WEIGHING, MOISTURE MEASUREMENTS
(3)	AND ASH CONTENT DETERMINATION.
(4)	

04 JUN 1984

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REG1 LIC30
PDR

9. STORAGE OF SEALED SOURCES

LINE NO.	CONTAINER AND/OR DEVICE IN WHICH EACH SEALED SOURCE WILL BE STORED OR USED. A.	NAME OF MANUFACTURER B.	MODEL NUMBER C.
(1)			
(2)	N/A		
(3)			
(4)			

10. RADIATION DETECTION INSTRUMENTS

LINE NO.	TYPE OF INSTRUMENT A	MANUFACTURER'S NAME B	MODEL NUMBER C	NUMBER AVAILABLE D	RADIATION DETECTED *(alpha, beta, gamma, neutron)* E	SENSITIVITY RANGE *(milliroentgens/hour or counts/minute)* F
(1)						
(2)		N/A				
(3)						
(4)						

11. CALIBRATION OF INSTRUMENTS LISTED IN ITEM 10

☐ a. CALIBRATED BY SERVICE COMPANY

NAME, ADDRESS, AND FREQUENCY

☐ b. CALIBRATED BY APPLICANT

Attach a separate sheet describing method, frequency and standards used for calibrating instruments.

12. PERSONNEL MONITORING DEVICES

TYPE *(Check and/or complete as appropriate.)* A	SUPPLIER *(Service Company)* B	EXCHANGE FREQUENCY C
☐ (1) FILM BADGE ☐ (2) THERMOLUMINESCENCE DOSIMETER *(TLD)* ☐ (3) OTHER *(Specify)*: _____	N/A	☐ MONTHLY ☐ QUARTERLY ☐ OTHER *(Specify)*:

13. FACILITIES AND EQUIPMENT (Check were appropriate and attach annotated sketch(es) and description(s).

☐ a. LABORATORY FACILITIES, PLANT FACILITIES, FUME HOODS *(Include filtration, if any)*, ETC.

☐ b. STORAGE FACILITIES, CONTAINERS, SPECIAL SHIELDING *(fixed and/or temporary)*, ETC.

☐ c. REMOTE HANDLING TOOLS OR EQUIPMENT, ETC.

☐ d. RESPIRATORY PROTECTIVE EQUIPMENT, ETC. N/A

14. WASTE DISPOSAL

a. NAME OF COMMERCIAL WASTE DISPOSAL SERVICE EMPLOYED

b. IF COMMERCIAL WASTE DISPOSAL SERVICE IS NOT EMPLOYED, SUBMIT A DETAILED DESCRIPTION OF METHODS WHICH WILL BE USED FOR DISPOSING OF RADIOACTIVE WASTES AND ESTIMATES OF THE TYPE AND AMOUNT OF ACTIVITY INVOLVED. IF THE APPLICATION IS FOR SEALED SOURCES AND DEVICES AND THEY WILL BE RETURNED TO THE MANUFACTURER, SO STATE.

N/A

INFORMATION REQUIRED FOR ITEMS 15, 16 AND 17

Describe in detail the information required for Items 15, 16 and 17. Begin each item on a separate page and key to the application as follows:

15. RADIATION PROTECTION PROGRAM. Describe the radiation protection program as appropriate for the material to be used including the duties and responsibilities of the Radiation Protection Officer, control measures, bioassay procedures *(if needed)*, day-to-day general safety instruction to be followed, etc. If the application is for sealed source's also submit leak testing procedures, or if leak testing will be performed using a leak test kit, specify manufacturer and model number of the leak test kit.

16. FORMAL TRAINING IN RADIATION SAFETY. Attach a resume for each individual named in Items 6 and 7. Describe individual's formal training in the following areas where applicable. Include the name of person or institution providing the training, duration of training, when training was received, etc.

    a. Principles and practices of radiation protection.

    b. Radioactivity measurement standardization and monitoring techniques and instruments.

    c. Mathematics and calculations basic to the use and measurement of radioactivity.

    d. Biological effects of radiation.

17. EXPERIENCE. Attach a resume for each individual named in Items 6 and 7. Describe individual's work experience with radiation, including where experience was obtained. Work experience or on-the-job training should be commensurate with the proposed use. Include list of radioisotopes and maximum activity of each used.

18. CERTIFICATE

(This item must be completed by applicant)

The applicant and any official executing this certificate on behalf of the applicant named in Item 2, certify that this application is prepared in conformity with Title 10, Code of Federal Regulations, Part 30, and that all information contained herein, including any supplements attached hereto, is true and correct to the best of our knowledge and belief.

WARNING.–18 U.S.C., Section 1001; Act of June 25, 1948; 62 Stat. 749; makes it a criminal offense to make a willfully false statement or representation to any department or agency of the United States as to any matter within its jurisdiction.

a. LICENSE FEE REQUIRED *(See Section 170.31, 10 CFR 170)*	b. CERTIFYING OFFICIAL *(Signature)*
$ 950.00	c. NAME *(Type or print)* ALFRED J. McCABE
(1) LICENSE FEE CATEGORY: 3 G	d. TITLE EXEC. VICE-PRES.
(2) LICENSE FEE ENCLOSED: $ 950.00	e. DATE MAY 24, 1984

*ATTACHMENT # 1
*ITEM # 8 - LICENSED MATERIAL

A	B	C	D
H-3	Any		1
C-14	Any		0.1
I-125	Sealed Source	West Chemical WCA-501	20 @ 0.0001 mCi ea
I-129	Sealed Source	Packard Inst. 6018502	10 @ 0.0001 mCi ea
Cs-137	Sealed Source	Packard Inst. 6018501	10 @ 0.0003 mCi ea
Cs-137	Sealed Source	Berthold Inst., Inc. VZ287	2 @ 500 mCi ea
Cs-137	Sealed Source	Berthold Inst., Inc. P-2623-100	2 @ 1,000 mCi ea
Co-60	Sealed Source	Berthold Inst., Inc. P2608-100/101	2 @ 50 mCi ea
Co-60	Sealed Source	Berthold Inst., Inc. P-2602-100	2 @ 200 mCi ea
Co-60	Sealed Source	Nucleus, Inc. S-4	10 @ 0.001 mCi ea
Sr-90	Sealed Source	Nucleus, Inc. S-3	10 @ 0.0001 mCi ea
Sr-90	Sealed Source	Berthold Inst., Inc. M1603A	10 @ 0.0001 mCi ea
Sr-90	Sealed Source	Berthold Inst., Inc. M1603B	10 @ 0.001 mCi ea
Sr-90	Sealed Source	Berthold Inst., Inc. 1945-12-81	20 @ 0.0001 mCi ea
Po-210	Sealed Source	Nucleus, Inc. S-2	10 @ 0.0001 mCi ea
TL-204	Sealed Source	Amersham PB-75	1 @ 83.9 mCi ea

*ITEM # 9 - STORAGE OF SEALED SOURCES.

A. Returned Berthold sealed source.

Will be stored behind lead brick caves to await disposal.

B. Source awaiting distribution.

These sources will be stored in its own shielded housing approved for safety.

C. Sources used for instrument checking.

These sources will be of exempt quantity but aggregate quantities will be stored behind lead brick shields.

*ATTACHMENT # 2
*ITEM # 10 - RADIATION DETECTION INSTRUMENTS.

A	B	C	D	E	F	WINDOW THICKNESS
Dose Ratemeter	Berthold	LB 133	1	Gamma	0.3mr/hr.	
Dose Ratemeter	Berthold	LB 1200	2	Alpha Beta Gamma	0.01mr./h.	1.5mg/cm^2
Cont. Monitor	Berthold	LB 1210B	2	Beta Gamma	10cps-3000 cps	0.4mg/cm^2

*ITEM # 11 - CALIBRATION BY SERVICE COMPANY

NAME: APPLIED HEALTH PHYSICS, INC. - JOHN DOUGLASS

ADDRESS: 2986 INDUSTRIAL BLVD.
P.O. BOX 197
BETHEL PARK, PA 15102

PROCEDURE FILED WITH COMMISSION - YES

FREQ: ONE (1) YEAR

*ITEM # 12 - A. Film Badge.

B. Teledyne Isotopes, Westwood, New Jersey

C. Quarterly.

*ATTACHMENT # 3
*ITEM # 13

A) LABORATORY, PLANT FACILITIES, FUME HOODS

Our distribution, maintenance, repair and storage of nuclear detection instruments with associated by-product material are located at (refer to Form 313 - Item # 5). Since 70% of the activities at our facility is repair and check out of nuclear electronic instrumentation, (the remaining 30% being combined distribution and sales), using approved sealed sources. In light of this type of operation and it's Health Physics aspect, laboratory operation including fume hood are not required. We will comply with 10 cfr 20.203 regarding placarding.

B) STORAGE, CONTAINERS, SPECIAL SHIELDING

REFER TO ITEM # 9

C) Remote handling equipment such as forceps and tongs will be utilized in transfering high mCi amounts of Co and Cs from shield to sheild, 1% of operation, otherwise no remote handling equipment will be required for normal operation utilizing license exempt quantities.

D) RESPIRATORY PROTECTIVE EQUIPMENT WILL NOT BE NEEDED.

*ITEM # 14 - WASTE DISPOSAL

The only waste we feel will be generated are returns from customers of special devices which contain high mCi amounts of Cs or Co. The returns due to decay of isotope we estimate to be about every three years of Co-60 and 12 to 15 years for Cs137. The returns of damaged sources we estimate to be on an accidental basis and have contracted - Applied Health Physics Services located at 2986 Industrial Park, Bethel Park, Pittsburgh, Pennsylvania 15205, to handle this waste.

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

I. EMPLOYEE TRAINING PROGRAM

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

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

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

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

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

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

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

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

(a) A wipe test of sources indicates leakage.

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

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

Continuation

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

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

*ATTACHMENT # 5
*ITEM # 16 - FORMAL TRAINING IN RADIATION PROTECTION
BY JAMES A. WELSH

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

b - Packard Instruments, Inc.

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

*ITEM # 17 - EXPERIENCE

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

*ATTACHMENT # 5
*ITEM # 16 - TRAINING IN RADIATION PROTECTION BY ALFRED McCABE

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

*ITEM #17 - EXPERIENCE

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

Instrumentation: Liquid Scintillation Counters
Gamma Counters
Proportional Counters

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

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

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

EMPLOYMENT RESUME

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

MAY 1983 --- Present
Berthold Instruments, Inc.
136 Bradford Avenue
Pittsburgh, PA 15205

Technical Representative

1981 --- APRIL 1983

Pharmatopes, Inc.
3402 Butler Street
Pittsburgh, PA 15201

Sales Representative

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

1974 --- 1981

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

Cheif Nuclear Medicine Technologist

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

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

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

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

1979 --- 1980

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

Cheif N.M. Technologist

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

1978 --- 1979

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

Biomedical Repair Technician
Electronic construction of prototype devices

Area Service Rep. for:

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

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

Forma, Inc.
Incubation and environmental chambers

1969 --- 1973

United States Navy

Hospital Corps School
Great Lakes, Ill.

Great Lakes Naval Hospital
Great Lakes, Ill.

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

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

Honorably Discharged (HM2, E5)

1967 --- 1969

Washington Hospital School of X-Ray Technology
Washington, PA

Two year on the job training in X-ray technology

Received Registry

High School

Canon-McMillan Senior High School
Canonsburg, PA

Acedemic Course
Graduated: 1967

Others:

Cleveland Institute of Electronics
Radiotelephone License and Electronics

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

APPLICATION FOR REGISTRATION OF SEALED SOURCES

COBALT-60 POINT SOURCES

A SUMMARY DATA

1 Date of Original Submission - April 16, 1984

2 Sealed Source Type - "Point Source" - which is Co-60 in a sealed stainless steel capsule.

3 Model - According to drawing no P-2602-100, copy attached as Appendix 1.

4 Applicant

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

Berthold level control equipment will be furnished through us. We are not manufacturers of this equipment.

For additional information, please contact at the above address:

Mr A McCabe - Managing Director
Mr J Welch - Assistant Sales Manager

5 Other Companies Involved

The sources are manufactured by:

Labor Prof Dr Berthold
7547 Wildbad
West Germany

6 Isotope and Maximum Activity

Depending on requirements, the following activities would be used:

Cobalt-60 200 mCi - maximum

(normal requirements are usually less than 100 mCi)

7 Leak Test Frequency

Each individual source is given a leak test and wipe test at the manufacturer's plant within the six months prior to shipment. These tests are performed according to DIN specification 25426 part 4. Results of these tests leave a removable activity of less than 5 nCi. A test certificate for this accompanies each source. (A sample certificate is shown in Appendix 2). Further testing is only recommended if the ambient temperature directly on the source exceeds 400 °C (752,0 °F). For data on this factor, see Appendix 3 which gives an authenticated report of 16.01.74 on this subject by the Physikalisch-Technische Bundesanstalt (PTB), certificate no 6.3-38491/73. Please note that the tests done today are held to a 5 nCi level as described above.

Routine testing should not be required more frequently than once every five (5) years because the source is fixed mounted and well protected in its source holder (shielding). This period corresponds to the Cobalt-60 half-life, at which time the source will have to be replaced anyway.

8 Principal Use

Code "D": Gamma gauge to measure and control levels in all types of vessels.

9 Custom Source

No. The construction of these sources is essentially the same for all, with only the source activity as a variant.

10 Custom User

B DESCRIPTIVE DATA

1 Summary - Description

The properties of the source and capsule are shown below:

A Description of the radioactive substance:

a) Isotope (nuclide) - Co-60
b) Chemical condition - Co
c) Physical condition - solid wire
d) Activity - 1-200 mCi
(usual installations require less than 100 mCi)

B Description of the capsule:

a) Design - point source, capsulized per drawing no P-2602-100.

Manufacturer:

Labor Prof Dr Berthold
Wildbad
West Germany

Supplier:

Labor Prof Dr Berthold
Wildbad
West Germany

c) Dimensions - 10 mm external diameter, 23 mm overall length.

d) Material - stainless steel per DIN specification 1.7440, material no 1.4541 or 1.4571 (Chrome, Nickel, Titanium alloy).

e) Wall thickness - 1 mm

f) Sealing - argon arc welding

g) Classification - ISO/C6544 according to DIN 25426 (same as ANSI N-542-1977) and "Special Form" according to IAEA regulations. Reports on this are given by the Bundesanstalt für Materialprüfung of the West German Government. See Appendix 4 for this report.

2 Labelling

Because the source is so small, a name plate is attached to the source holder (shielding). This name plate contains the following information:

a) The nuclide used (source type)

b) The source activity

c) The Berthold serial number which is a series of three (3) sets of numbers as follows:

1st number - sequential number of source made that year
2nd number - month of manufacture
3rd number - year of manufacture

Serial numbers , as in 2 (c), are also engraved on each source.

3 Diagram

Please refer to drawing no P-2602-100 marked "Strahlerkapsel für Co-60" (point source). This drawing is shown in Appendix 5 (as Appendix 1 but smaller).

4 Conditions of Normal Use

The shielding consists of a lead filled casting housing.

The source capsule is fastened in the middle of the casted housing with an adaptor so that even in the extremely remote case that the lead melts and runs out, the source is fastened to the casted housing and will not be lost. In front of the source is a lead filled cylinder with an off-centre drilled hole. This is attached to a spindle which is in turn connected to a locking handle. By turning the handle, thus the cylinder, through 180° the radiation beam can be closed.

In the normal case the shielding container and detector are diametrically positioned on opposite sides of the vessel. With an open shielding, the well collimated radiation beam irradiates the vessel via the slit in the shielding and the radiation is detected by the scintillation counter on the other side. The change of level in the vessel initiates an increase or decrease in the radiation intensity at the detector. Such measuring systems are installed in and are designed for environmental conditions in the following industrial areas:

- chemical industry
- refineries
- mines
- food industry
- steel industry
- wood and paper industry

The shieldings and sources are constructed in such a way that they can withstand such environmental conditions, for example humidity, dust, aggressive atmospheres etc. The typical assembly is schematically shown in Appendix 6.

The useful life of the source units, would be at least the Co-60 half-life, or approximately five (5) years.

In the event that the container temperature would exceed 300 °C (572 °F), and the lead shielding would melt, the lead cannot leak out, so that even under these circumstances, the protection remains. The construction of the steel container is sufficiently strong enough to withstand the slight expansion of the lead at the 400-500 °C range. It is also impossible for the source to come loose and float at higher temperatures because the source is securely held in place.

An additional certificate from the Staatliches Materialprüfungsamt, Nordrhein-Westfalen (State Material Testing Institute) gives the result of a fire test according to DIN Spec. 4102. The testing temperature went up over 1000 °C (1832 °F) with the following results:

- No evidence of cracking was evident in the dye test.

(see Appendix 7 for this certificate)

5 Supporting Detail

The detailed listing of the physical properties of the source along with the details of its construction are given in Items B.1.A and B.1.B.

C HEALTH & SAFETY DATA

1 Safety Analysis Summary

The Berthold source units are carefully constructed as indicated in Section B.1.B above. Sources are tested for:

a) Seal (weld) tightness by bubble testing in diethylene glycol at a reduced pressure of less than 100 mm Hg. Testing is commonly done at a pressure of only 3-5 mm Hg.

b) Wipe testing to a limiting value of 5 nano Curies (nCi).

c) Source jacketing is tested on the following points:

temperature range, pressure, impact, oscillation, puncture resistance.

These tests were as per ISO/DIN Spec. 25416-part 1. The tests correspond to the ANSI specification N-542-1977. The results are shown in Appendix 8.

2 Manufacturing and Distribution Controls

a) Quality assurance and control:

During every step in the manufacture, the tests specified in the Berthold Sealed Radioactive Source Test Report (Appendix 2), are individually carried out for each and every source. Testing for the source strength is done in two ways, namely:

i) Based on the specific activity per unit length (mCi/meters) of the source material, this is done by a Nuclear Research Institute who activate this wire. The wire is cut and fitted into the capsule.

ii) Additionally, after fabrication, the total activity is checked again by two dose rate meters, operating in parallel, and whose calibration is regularly checked.

iii) Leak testing procedure is given above in Section A.7. See also Appendix 2.

International standards indicate a removal activity of less than 5 nCi.

b) Description of Lab Berthold's recommended maintenance, service and testing requirement for use:

i) Lab Berthold's procedure for leak testing has been fully described in Section A.7, includes Appendix 2.

ii) Unpacking:

I) In the normal case, the source is shipped in its use-container with the shutter in the closed position.

II) In certain cases, the source may be shipped separately, utilizing a specially designed lead shipping container. In this case, as would also be true for replacements, the replacement is carried out as follows:

- 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 either 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, or less. Whole body exposure: based on a time exposure of 1 minute and an average distance between body and source of approximately 1/2 meter (18"-20"), and a maximum source strength of 200 mCi the whole body exposure can be calculated to a value of 18 mrem.

iii) Leak testing:

The construction of the sources is such, that under normal circumstances, replacement is not required more often than the normal half-life of the source (for Co-60 this is approx 5 years).

In the event that the ambient temperature of the source exceeds 400 ^{o}C (752 ^{o}F) then it is recommended that the source be replaced.

c) Manufacturer's instructions to user:

Copies of the pertinent radiological safety and operating instructions for the source will be provided by the manufacture.

3 Manufacturer's Safety Analysis of Sealed Source Review

a) Safety Analysis:

Details of this are given above in sections B.1.B, C.1.a, b, and c, and B.4.d.

b) Prototype testing and evaluation:

- Maximum radiation levels based on the maximum source strength of 200 mCi and using the Specific Dose Rate constant for Co-60 which is given as:

$$1.35 \frac{\text{mrem} \times a^2}{h \times \text{mCi}}$$

where a = distance in meters from the source to the point being measured.
h = time in hours

eg: where a = 5 cm
the maximum radiation level would be 108,000 mrem/h

where a = 30 cm
the maximum radiation level would be 3,000 mrem/

- Results of tests performed on prototype source capsule.

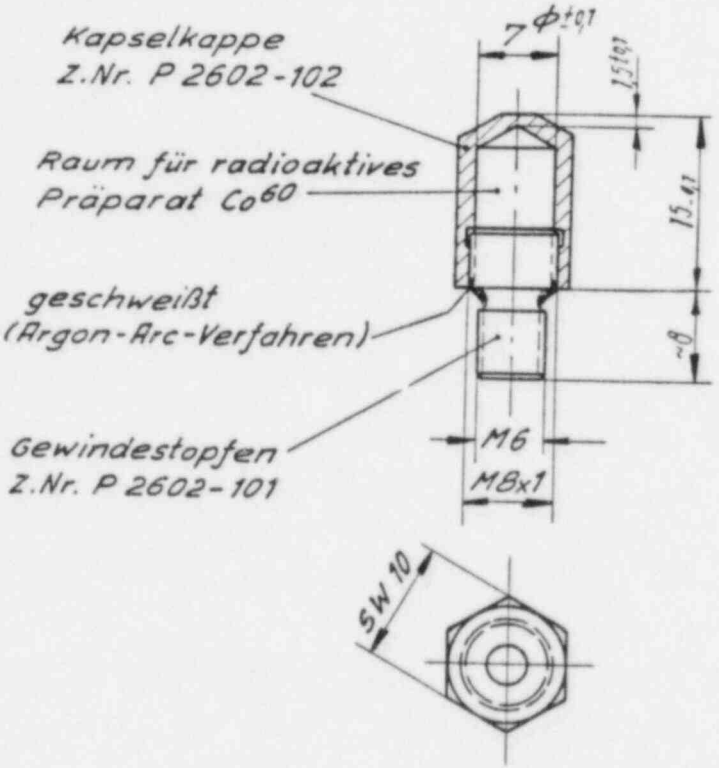
These test results are given above in item B.1.B. This classification is given by specification in ISO/C-65444 and this corresponds to ANSI spec. N-542-1977. See also Appendix 3.

c) Additional information:

As given in Section B.4.a.§4 above, additional information was presented on fire testing. See also Appendix 7.

	MW	Chb	G	M
	ZW	EW	P	L

APPENDIX 1



entspricht Z.Nr. A 61208-1

		Werkstoff Nr. 1.4541 oder 1.4571 Rd. Toleranzen n. DIN 671 6kt Toleranzen n. DIN 176			
		Sonderbearb.			
		Maße ohne Toleranzangabe DIN 7168 m			
		Diese Maße werden besonders geprüft	Paßmaß	Abmaße	verw. bei
0	div. Änderungen	28.11.61		Tag	Name
Ausgabe	Änderung	Tag	Name	gez.	1.3.61
		Laboratorium Prof. Dr. Berthold Wildbad / Schwarzwald		gepr.	
Maßstab 2:1	Strahlerkapsel für ^{60}Co			Zeichn.-Nr. P 2602 – 100	

APPENDIX 2

berthold

LABORATORIUM PROF. DR. BERTHOLD
D-7547 WILDBAD 1 · Fernsprecher (07081) 3981 · Telex 0724019

KERNSTRAHLUNGSMESSGERÄTE FÜR INDUSTRIE, WISSENSCHAFT UND MEDIZIN

Empfänger:
RECEIVER:

Bestell-Nr.:
ORDER-NO.:

Komm.-Nr.:
OUR COMM.-NO.:

Zertifikat Nr.
CERTIFICATE NO.

über Dichtheit und Beanspruchbarkeit umschlossener radioaktiver Stoffe
SEALED RADIOACTIVE SOURCE TEST REPORT

Nuklid: Co-60
NUCLIDE:

Typ: Punktstrahler
TYPE: point source

Beanspruchbarkeit: ISO/C 65444
CLASSIFICATION: SPECIAL FORM

Zeichnung: P 2602
DRAWING:

Prüfungen: **I. Dichtheitsprüfung:** **Blasentest**
TESTS: LEAKAGE TEST: BUBBLE TEST

II. Kontaminations-Prüfung: **Wischtest**
CONTAMINATION TEST: WIPE TEST

Ergebnis: < 0.18 kBq
RESULT:

Strahler-Nr. SOURCE NO.	**Aktivität** ACTIVITY m Ci	M Bq	**Prüfdatum** DATE OF TESTS	**Ursprungs-Nr.** ORIGIN NO.

Hinweis: Die Strahlerausführung entspricht PTB-Gutachten Nr. 6.3-38491/73

Die oben aufgeführten Strahler wurden individuell geprüft und gelten als dicht und kontaminationsfrei.
THE ABOVE LISTED SOURCES PASSED AN INDIVIDUAL TEST AND THEY ARE FREE OF LEAKAGE AND CONTAMINATION.

LABORATORIUM PROF. DR. BERTHOLD

Prüfmethoden

I Blasenprüfung
Der Strahler wird in eine geeignete Flüssigkeit (Diäthylenglykol) eingetaucht und der Druck in dem Gefäß auf 100 mm Hg reduziert. Es dürfen keine Blasen entstehen.

II Wischprüfung
Die Hülle, die Oberfläche oder wesentliche Teile des zu prüfenden Strahlers werden mit saugfähigem Material abgewischt. Anschließend wird die Aktivität des abgelösten radioaktiven Stoffes bestimmt.

In Anlehnung an DIN 25426, Teil 4, gilt ein Strahler in der Regel als dicht und kontaminationsfrei, wenn bei den entsprechenden Prüfungen der Grenzwert von 5 nCi nicht überschritten wird.

Besondere Form (special form)

Ein radioaktiver Stoff in besonderer Form ist ein Strahler, der besonderen, über den üblichen Beanspruchungen liegenden thermischen und mechanischen Anforderungen und Prüfverfahren genügt, wie sie in den IAEA transport regulations beschrieben werden.

Die Prüfungen werden von der zuständigen Behörde durchgeführt, die dann ein entsprechendes Zeugnis ausstellt, wenn der Strahler die Anforderungen erfüllt.

Die besondere Form eines Strahlers kann bei der Auswahl eines Transportbehälters wichtig sein, wird aber auch häufig zur Beurteilung der Qualität eines Strahlers herangezogen.

ISO/DIN-Klassifikation

Die internationale Organisation for Standardisation (ISO) hat ein System zur Klassifikation von umschlossenen radioaktiven Stoffen vorgeschlagen, das inzwischen weltweit angewendet wird.

Auf die ISO-Norm aufbauend wurde die DIN-Norm 25426, Teil 1, „Umschlossene radioaktive Stoffe, Anforderungen und Klassifikation", erarbeitet. Die beiden Normen sind nahezu identisch.

Zweck dieser Normen ist es, Herstellern, Lieferanten, Anwendern und zuständigen Behörden einheitliche Kriterien zur Beurteilung der Sicherheit beim Umgang mit umschlossenen radioaktiven Stoffen zu geben.

Klassifikation der Strahler nach ihrer Beanspruchbarkeit (nach DIN 25426, Teil 1).

Klasse / Prüfung	1	2	3	4	5	6	x
Temperatur	ungeprüft	– 40 °C (20 min) und + 80 °C (1 h)	– 40 °C (20 min) und + 180 °C (1 h)	– 40 °C (20 min) und + 400 °C (1 h) und thermisches Abschrecken von 400 °C auf 20 °C	– 40 °C (20 min) und + 800 °C (1 h) und thermisches Abschrecken von 800 °C auf 20 °C	– 40 °C (20 min) und + 800 °C (1 h) und thermisches Abschrecken von 800 °C auf 20 °C	Sonderanforderung
Druck	ungeprüft	250 mbar	250 mbar und 20 bar	250 mbar und 70 bar	250 mbar und 700 bar	250 mbar und 1,7 kbar	Sonderanforderung
Schlag	ungeprüft	50 g aus 1 m Höhe	200 g aus 1 m Höhe	2 kg aus 1 m Höhe	5 kg aus 1 m Höhe	20 kg aus 1 m Höhe	Sonderanforderung
Schwingung	ungeprüft	3 mal 3 Zyklen je 10 min 25 bis 500 Hz bei 5 g Beschleunigungsamplitude	3 mal 3 Zyklen je 10 min 25 bis 50 Hz bei 5 g Beschleunigungsamplitude und 50 bis 90 Hz bei 0,32 mm Auslenkungsamplitude und 90 bis 500 Hz bei 10 g Beschleunigungsamplitude	3 mal 3 Zyklen je 30 min 25 bis 80 Hz bei 0,75 mm Auslenkungsamplitude und 80 bis 2000 Hz bei 20 g Beschleunigungsamplitude	entfällt	entfällt	Sonderanforderung
		zusätzlich 30 min bei jeder Resonanzfrequenz					
Durchstoß	ungeprüft	1 g aus 1 m Höhe	10 g aus 1 m Höhe	50 g aus 1 m Höhe	300 g aus 1 m Höhe	1 kg aus 1 m Höhe	Sonderanforderung

Die Forderung einer Klasse gilt als erfüllt, wenn die Prüflinge nach der Beanspruchung dicht geblieben sind.

Mindestanforderungen an Strahler der Aktivitätsklasse C bei normaler Verwendung (nach DIN 25426, Teil 1).

Strahlerverwendung	Prüfung und Klasse der Strahler				
	Temperatur	Druck	Schlag	Schwingung	Durchstoß
Radiographie im industriellen Bereich					
ungeschützter Strahler	4	3	5	1	5
geschützter Strahler	4	3	3	1	3
Medizinischer Bereich					
Radiographie	3	2	3	1	2
Gamma-Teletherapie	5	3	5	2	4
interstitielle und intrakavitäre Therapie	5	3	2	1	1
Kontakttherapie	4	3	3	1	2
Gamma-Meßanlagen (mittlere und hohe Energie)					
ungeschützter Strahler	4	3	3	3	3
geschützter Strahler	4	3	2	3	2
Beta-Meßanlagen, Gamma-Meßanlagen niedriger Energie und Röntgenfluoreszenzanalyse (ausgenommen radioaktive Gase enthaltende Strahler)	3	3	2	2	2
Sonden für Tiefbohrungen	5	6	5	2	2
Tragbare Feuchte- und Dichtemesser (auch Handgeräte und fahrbare Geräte)	4	3	3	3	3
Neutronenquellen (ausgenommen Strahler zum Anfahren von Reaktoren)	4	3	3	2	3
Kalibrier- und Prüfstrahler mit geringer Aktivität (1,1 · 10^6 bis 3,7 · 10^7 s^{-1} (30 µCi bis 1 mCi))	2	2	2	1	2
Technische Gamma-Bestrahlung					
ungeschützter Strahler	4	3	4	2	4
geschützter Strahler	4	3	3	2	3
Ionengeneratoren (ungeschützte und geschützte Strahler)	3	2	2	1	1
Gaschromatographie	2	2	2	2	2
Elektrostatische Eliminatoren	3	3	2	2	2
Rauchdetektoren					

Prüfmethoden = Test Methods

Test Methods

I. Bubble testing (LEAK TEST)
The radiator is immersed in a suitable fluid (diethylene glycol) and the pressure in the vessel is reduced to 100 mm Hg. No bubbles must be produced.

II. Wipe testing
The casing, surface, or substantial portions of the radiator to be tested are wiped off with an absorbent material. Subsequently, the activity of the radioactive material removed is determined.

In accordance with DIN 25 426, Part 1, a radiator is considered as a rule to be tight and contamination-free when the limiting value of 5 nCi is not exceeded in the corresponding tests.

Special Form

A radioactive material in special form is a radiator which meets thermal and mechanical requirements and test methods above the usual requirements as described in the IAEA Transport Regulations.

The tests are performed by the competent authority, which then issues a corresponding certificate when the radiator meets the requirements.

The special form of a radiator can be important in the selection of a transport container; however, it is also frequently considered for evaluation of the quality of a radiator.

ISO/DIN Classification

The International Organization for Standardization (ISO) has recommended a system for t classification of sealed radioactive materials which meanwhile is employed worldwide.

Building up on the ISO Standard, the DIN Standard 25 426, Part 1, "Sealed Radioactive M terials, Requirements, and Classification", was prepared. Both standards are nearly id tical.

It is the purpose of this Standard to provide uniform criteria to manufacturers, suppli users, and responsible authorities for the evaluation of safety in handling radioactive terials.

Classification of Radiators According to their Load Capacity (per DIN 25 426, Part 1).

Class / Test	1	2	3	4	5	6	x
Temperature	not tested	- 40°C (20 min) and + 80°C (1 h)	- 40°C (20 min) and + 180°C (1 h)	- 40°C (20 min) and + 400°C (1 h) and thermal quench from 400 to 20°C	- 40°C (20 min) and + 600°C (1 h) and thermal quench from 600 to 20°C	- 40°C (20 min) and + 800°C (1 h) and thermal quench from 800 to 20°C	Special requirement
Pressure	not tested	250 mbars	250 mbars and 20 bars	250 mbars and 70 bars	250 mbars and 700 bars	250 mbars and 1.7 kbars	Special requirement
Impact	not tested	50 g from 1 m ht.	200 g fr. 1 m ht.	2 kg from 1 m ht.	5 kg from 1 m ht.	20 kg fr. 1 m ht.	Special requirement
Oscillation	not tested	3 x 3 cycles every 10 min: 25-500 Hz at 5 g acceleration amplitude	3 x 3 cycles every 10 min: 25-50 Hz at 5 g acceleration amplitude and 50 to 90 Hz at 0.32 mm deflection amplitude and 90 to 500 Hz at 10 g acceleration amplitude	3 x 3 cycles every 30 min: 25-80 Hz at 0.75 mm deflection amplitude and 80 to 2000 Hz at 20 g acceleration amplitude	omitted	omitted	
		In addition: 30 min at each resonance frequency					
Puncture	not tested	1 g from 1 m ht.	10 g from 1 m ht.	50 g from 1 m ht.	300 g fr. 1 m ht.	1 kg from 1 m ht.	Special requirement

Translations from Technical and Commercial Afrikaans, Bulgarian, Czech, Danish, Dutch, French, German, Italian, Norwegian, Polish, Portuguese, Romanian, Russian, Serbo-Croatian, Slovenian, Spanish, Swedish, and Ukrainian

The requirement for a class is considered as met when the specimens have remained tight after stressing.

Minimum Requirements for Radiators of Activity Class C in Normal Use (per DIN 25 426, Part 1).

Radiator Application	Test and Class of Radiator				
	Temperature	Pressure	Impact	Oscillation	Puncture
Radiography in industrial field					
unprotected radiator	4	3	5	1	5
protected radiator	4	3	3	1	3
Medical field					
Radiography	3	2	3	1	2
Gamma-teletherapy	5	3	5	2	4
Interstitial and intra-cavity therapy	5	3	2	1	1
Contact therapy	4	3	3	1	2
Gamma measuring devices (medium- and high-energy)					
unprotected radiator	4	3	3	3	3
protected radiator	4	3	2	3	2
Beta measuring devices, low-energy gamma measuring devices, and roentgen fluorescence analysis (except radiators containing radioactive gases)	3	3	2	2	2
Probes for deep well drilling	5	6	5	2	2
Portable moisture and density meters (also manual devices and mobile devices)	4	3	3	3	3
Neutron sources (except radiators for the startup of reactors)	4	3	3	2	3
Calibration and test gauges with little activity ($1.11 \cdot 10^6$ to $3.7 \cdot 10^7 s^{-1}$) (30 µCi to 1 mCi)	2	2	2	1	2
Technical gamma radiation					
unprotected radiator	4	3	4	2	4
protected radiator	4	3	3	2	3
Ion generators (unprotected and protected radiators)	3	2	2	1	1
Gas chromatography	2	2	2	2	2
Electrostatic eliminators	3	2	2	2	2
Smoke detectors					

Translation of letter of

PHYSIKALISCH-TECHNISCHE BUNDESANSTALT
Department 6, Braunschweig

Messrs.
Laboratorium Prof. Dr. Berthold

7547 Wildbad
Postfach 160

D-33 Braunschweig,
16th January, 1974

No. 6.3 -38491/73

Re.: ^{60}Co-sources for level measuring equipments; reference in respect to § 2(2) and § 44 of the "Erste Strahlenschutzverordnung" of the Federal Republic of Germany

Ref.: Your letter : Lohr/J of 18/12/73 with construction drawing no. P 2602-100

The source capsules manufactured by Laboratorium Prof. Dr. Berthold for the utilization at level gaging equipments contain ^{60}Co in a massive metallic form, according to the statement of the manufacturer, and that as a piece of wire made out of a Cobalt-Nickel-alloy (~50 % Co, ~49 % Ni). For each of the sources an acitivity with max. 200 mCi is stated.

According to the construction drawing no. P 2602-100, the radioactive material is encapsuled into a stainless steel (V_2A) container with a min. wall thickness of 1.5 mm. The container is screwed by means of a worm plug and additionally welded by way of the Argon-Arc-method.

Each source capsule must be examined on seal and sufficient decontamination of its coat before dispatch to the applicant. If the activity of the wipe sample is less than 10 nCi, the source is to be considered as encapsuled radioactive material according to § 2(2) of the "Erste Strahlenschutzverordnung" of the Federal Republic of Germany (first decree of radiation protection).

In the opinion of the Physikalisch-Technische Bundesanstalt, seal tests according to § 44 of the "Erste Strahlenschutzverordnung" are unnecessary if the sources are applied up to temperatures of 400°C. This statement is a replacement for the certificate of the Physikalisch-Technische Bundesanstalt of the 29th September, 1961, no. 24320 VI B/Ra.

Enclosure
bill of costs

By order

(Prof. Dr. H. M. Weiß)

TRANSLATION

Sealed Radioactive Sources

Requirements and Classification

DIN 25 426 Part 1

Basis of this standard is the USA Standard "Classification of sealed radioactive sources"[1]), the ISO Standard "Sealed radioactive sources - Classification"[2]) deriving therefrom, as well as the ISO Standard "Sealed radioactive sources - General"[3]).

Classification as "special form radioactive material" per IAEA[4])- "Safety Standard Regulations for the safe transport of radioactive materials"[5]) or as similarly defined "highly safe radiator" per DIN 54 115 Part 2[6]) calls for slightly differing test methods.

Contents

1 Scope

The rules of this standard apply to the manufacture and use of sealed radioactive sources.

Excepted are sealed radioactive sources used in nuclear reactors (e.g., fuel elements, neutron sources for startup) and other sealed radioactive sources for which special regulations apply (e.g., radionuclide batteries, tritium gas light sources).

2 Purpose

It is the purpose of this standard to provide manufacturers, suppliers, users, and responsible authorities with uniform criteria for the evaluation of safety in dealing with sealed radioactive sources. For this purpose, sealed radioactive sources are classified in accordance with their radioactive content, physico-chemical condition, and thermal and mechanical load capacity.

3 Definitions

3.1 Sealed radioactive source

A sealed radioactive source (hereinafter designated as "radiator") in the sense of this standard is a component in which the radioactive material is continuously enclosed by an all-around tight, rigid, inactive casing or is so embedded in rigid, inactive material that an escape of radioactive material is safely prevented under ordinary operating load. A dimension must amount to at least 0.5 cm.

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1) ANSI N5.10-1968
2) Currently ISO/DIS 2919.2 as of February, 1975
3) Currently ISO/DIS 1677.3 as of October, 1975
4) International Atomic Energy Agency
5) Safety Series No. 6, 1967 Edition or 1973 Revised Edition
6) Currently being revised

Continued on pages 2-6

Standards Committee - Nuclear Engineering (NKe) in DIN
Standards Committee - Radiology (NAR) in DIN
Specialty Standards Committee - Material Testing (FNM) in DIN

3.2 Casing

A casing is the tight enclosure of the radioactive material which cannot be opened without its destruction.

3.3 Shielded Radiator

A shielded radiator is a radiator which even during use remains constantly in a device protecting it against external effects.

3.4 Unshielded radiator

An unshielded radiator is a radiator which is not constantly surrounded by a device protecting it against external effects or in which essential parts of the protective device are removed during use.

3.5 Type sample

A type sample is an example of a type which serves as a sample for the manufacture of all radiators of the same type.

3.6 Substitute sample

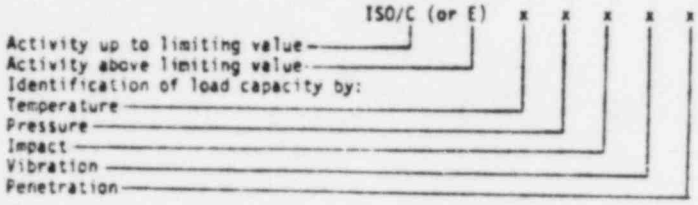
A substitute sample is an example similar in design and manufacture of a type which, however, instead of the proposed radioactive material, contains an inactive or considerably less active material which corresponds to it in other physical and chemical properties to the extent practicable.

3.7 Type testing

Type testing is the testing of type samples or substitute samples before radiators of this type have been placed in use.

4 Classification

The class in which a radiator is to be classified is identified by the symbol ISO with a subsequent letter and five figures. The letter denotes Activity Class per Table 2. The figures denote load capacity per Table 3, in which larger numbers correspond to higher requirements.



According to Appendix A, ISO/C 43515, for example, would denote a radiator which is suitable in unshielded condition for industrial radiography.

If the radiator also meets the requirements for "special form radioactive material" per IAEA "Regulations for the safe transport of radioactive materials[5]) or for similarly defined "highly safe radiators" per DIN 54115 Part 2[6]), this can be so identified by the appended letter S.

5 Arrangement by activity and load capacity (classifying)

5.1 Classification methods

5.1.1 The manufacturer first determines the Activity Class (C or E) with regard to toxicity of the radionuclide in accordance with Table 1, as well as the extractability or reaction possibility of the radioactive content in the physical and chemical form to be employed with its proposed dimensions in accordance with Table 2. Radionuclides not listed in Table 1 are to be classified in accordance with their free limits according to the Radiation Protection Regulation. Activity at the time of manufacture is governing.

Table 1. Classification of radionuclides frequently used in radiators according to their toxicity (excerpted from ICRP[7]) Publication No. 5 and IAEA Technical Report No. 15)

Group 1 Very high toxicity; free limits: $3.7 \cdot 10^3 s^{-1}$ (10^{-7} Ci) ^{241}Am, ^{252}Cf, ^{210}Pb, ^{210}Po, ^{238}Pu, ^{239}Pu, ^{226}Ra, ^{228}Th
Group 2 High toxicity; free limits: $3.7 \cdot 10^4 s^{-1}$ (10^{-6} Ci) ^{110m}Ag, ^{210}Bi, ^{144}Ce, ^{36}Cl, ^{60}Co, ^{134}Cs, ^{137}Cs, ^{152}Eu, ^{192}Ir, ^{54}Mn, ^{22}Na, ^{106}Ru, ^{124}Sb, ^{125}Sb, ^{46}Sc, ^{89}Sr, ^{182}Ta, ^{204}Tl, ^{170}Tm
Group 3 Medium toxicity; free limits: $3.7 \cdot 10^5 s^{-1}$ (10^{-5} Ci) ^{198}Au, ^{14}C, ^{109}Cd, ^{57}Co, ^{58}Co, ^{55}Fe, ^{95}Nb, ^{63}Ni, ^{147}Pm, ^{113}Sn, ^{65}Zn
Group 4 Low toxicity; free limits: $3.7 \cdot 10^6 s^{-1}$ (10^{-4} Ci) ^{3}H, ^{85}Kr

Table 2. Upper limiting values for Activity Class C[8])

Toxicity group per Table 1	Limiting value of activity	
	Extractable (1) or reactive (3)	Slightly extractable (2) or slightly reactive (4)
1	$1.11 \cdot 10^{10} s^{-1}$ (0.3 Ci)	$1.11 \cdot 10^{11} s^{-1}$ (3 Ci)
2	$1.11 \cdot 10^{12} s^{-1}$ (30 Ci)	$1.11 \cdot 10^{13} s^{-1}$ (300 Ci)
3	$1.11 \cdot 10^{13} s^{-1}$ (300 Ci)	$1.11 \cdot 10^{14} s^{-1}$ (3000 Ci)
4	$1.85 \cdot 10^{13} s^{-1}$ (500 Ci)	$1.85 \cdot 10^{14} s^{-1}$ (5000 Ci)

(1) Extractable means elimination of more than 10^{-4} of the total activity in at least 100 ml of still water at 20°C in 48 h. Powdery materials are equated to the extractable.

(2) Slightly extractable means elimination of less than 10^{-4} of the total activity in at least 100 ml of still water at 20°C in 48 h.

(3) Reactive means reactive in air or water (e.g., the metals Na, K, U, Cs).

(4) Slightly reactive means not reactive in air or water (e.g., noble metals).

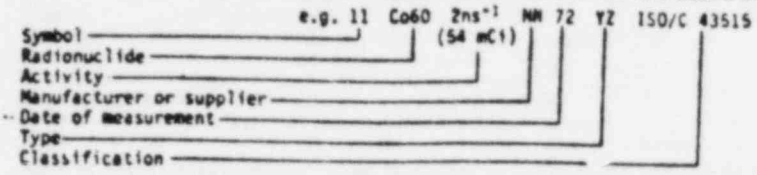
[5]) and [6]) See Page 1.
[7]) International Commission on Radiological Protection.

5.1.2 Then, the manufacturer determines the load capacity of the radiator by temperature, pressure, impact, vibration, and penetration in accordance with Table 3.

5.2 Identification and cover letter (certificate)

5.2.1 The radiator must be clearly identifiable by identification (e.g., engraved serial number) durably attached by the manufacturer if its dimensions and load capacity in accordance with its classification permit this.

Insofar as possible, the radiator identification should include additional information, arranged by importance:



Note on units of measurement. The following is valid by Resolution of the 15th General Conference for Measurement and Weight of June 2, 1975: 1 Becquerel (Bq) = 1 s^{-1}; for the stated example: 2 ns^{-1} = 2 · $10^9 s^{-1}$ = 2 GBq = 54 mCi.

5.2.2 A cover document (certificate) on which, in addition, the information deemed necessary per Section 5.2.1 must be restated.

a) Description of radioactive content

Activity in neutron emission source strength (identified in each case as nominal value or measured value) and target material, chemical and physical form, radioactive impurities if applicable, mass or volume, dimensions if applicable

b) Description of casing

Dimensions, materials, type of sealing, if applicable area, material, and thickness of outlet window

c) Dose rate in a defined interval (e.g., 0.1 m)

d) Date, method, and results of acceptance test on contamination freedom and tightness[9])

e) Information on maximum allowable temperature in continuous operation and on special corrosion sensitivity, if applicable, instructions for cleaning and sterilization

f) In case tests with special requirements (Class X) or special tests take place: basis, method, and results

g) Instructions for transport, e.g., license as "special form radioactive material"

5.3 Selection of requirements

According to the intended purpose, the requirements on load capacity of the radiator may be taken from Table 3.

6 General data for type tests

6.1 Prerequisites for tests

Each individual test for classification of a radiator per Table 3 must be performed on at least two specimens (type samples or substitute samples). For each test, new specimens may be used. In case identification is provided for mass production, corresponding marking of the specimens must take place before loading, in which figures that cannot be determined before classification may be replaced by general symbols. Shielded radiators must be tested without their protective devices. All tests, other than temperature tests, must be conducted at normal ambient temperature.

Other test methods may be employed when their equivalence has been demonstrated. The classification may also be inferred from corresponding test results on comparable specimens.

6.2 Evaluation of tests

The requirement of a class is considered to be met when the specimens have remained tight under load. With multiple enclosure of a radiator, it is sufficient when at least one casing has remained tight under load.

7 Test methods

7.1 Temperature test

7.1.1 Slow temperature changes

7.1.1.1 Test method

The specimens are to be brought to the test temperature within the time intervals indicated in Table 4 and maintained at this temperature for at least the time intervals prescribed in Table 3; then, they must gradually reassume the ambient temperature in air.

Table 4. Maximum allowable time interval up to attainment of test temperature

Test temperature, °C	-40	80	180	400	600	800
Time interval, min	45	5	10	25	40	70

7.1.1.2 Requirements on test device

The chamber for cooling or heating the specimens must be at least five times as large as the volume of the specimens.

Heating tests must be performed in air; low-temperature test may be performed in a CO_2 atmosphere. In ovens fired with oil or gas, an oxidizing atmosphere must be maintained constantly.

7.1.2 Thermal quenching

7.1.2.1 Test method

The specimens are to be heated to the test temperature according to Section 7.1.1.1 and maintained at this temperature for at least 15 minutes. Then they must be immersed within 15 seconds in water with a maximum temperature of 20°C.

Either new specimens or those used in the temperature test per Section 7.1.1 may be used.

7.1.2.2 Requirements on test device

The water in the immersion bath must either flow with a velocity of at least ten times the radiator volume per minute or, if it is still, must have at least twenty times the radiator volume.

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[9]) An additional part of DIN 25 426 on suitable test methods with the data of tightness criteria, coordinated with ISO Technical Report 4826, "Sealed radioactive sources - leak test methods", is being prepared.

Table 3. Classification of radiators according to their load capacity

Class / Test	1	2	3	4	5	6	X
Temperature	not tested	-40°C(20 min) and +80°C(1 h)	-40°C(20 min) and +180°C(1 h)	-40°C(20 min) and +400°C(1 h) and thermal quench from 400 to 20°C	-40°C(20 min) and +600°C(1 h) and thermal quench from 600 to 20°C	-40°C(20 min) and +800°C(1 h) and thermal quench from 800 to 20°C	special requirement
Pressure	not tested	250 mbars	250 mbars and 20 bars	250 mbars and 70 bars	250 mbars and 700 bars	250 mbars and 1.7 kbars	special requirement
Impact	not tested	50 g from 1 m height	200 g from 1 m height	2 kg from 1 m height	5 kg from 1 m height	20 kg from 1 m height	special requirement
Vibration	not tested	3 x 3 cycles every 10 min: 25-500 Hz at 5 g acceleration amplitude	3 x 3 cycles every 10 min: 25-50 Hz at 5 g acceleration amplitude and 50-90 Hz at 0.32 mm deflection amplitude and 90-500 Hz at 10 g acceleration amplitude	3 x 3 cycles every 30 min: 25-80 Hz at 0.75 mm deflection amplitude and 80-2000 Hz at 20 g acceleration amplitude	omitted	omitted	special requirement
		in addition:	30 min at each resonant frequency				
Penetration	not tested	1 g from 1 m height	10 g from 1 m height	50 g from 1 m height	300 g from 1 m height	1 kg from 1 m height	special requirement

7.2 Pressure test

7.2.1 Test method

The specimens are to be subjected twice successively to the prescribed test pressure for a duration of 5 minutes at a time in a test chamber. Between the two pressure loadings, the test chamber is to be brought to atmospheric pressure.

7.2.2 Requirements on test device

The vacuum test must take place in air. The pressure test for Classes 3 to 6 must take place hydraulically; in these cases, the specimen must be surrounded by water.

7.3 Impact test

7.3.1 Test method

The specimen is to be laid on an impact plate so that it sustains the maximum damage in the impact of the hammer (e.g., a cylindrical falling body) falling from 1 m height. The height of fall is the distance between the upper side of the specimen lying on the impact plate and the underside of the hammer in the tripping position.

The weight of the hammer is to be selected in accordance with Table 3.

7.3.2 Requirements on test device

The hammer must have a suspension device above and a flat impact surface of steel of 25 mm diameter with a rounded edge of 3 mm radius of curvature beneath. Suspension point, center of gravity of the hammer, and center of the impact surface must lie on one axis.

The impact plate of steel must have at least ten times the weight of the hammer and be rigidly anchored so that it is not moved appreciably by the impact of the hammer. Its flat, horizontal surface must be large enough to encompass the entire radiator.

7.4 Vibration test

Each specimen is to be stimulated to forced vibrations by a vibration transmitter with which it - with respect to any mountings - is to be rigidly connected by means of a suitable clamping device successively along three axes standing perpendicular to each other.

For the test for Classes 2 and 3, the frequency cycle must be passed through three times after each clamping from the minimum to the maximum and back with uniform time frequency change within at least 10 minutes. For the test for

Class 4, the duration has to amount to a frequency cycle of at least 30 minutes. In addition, for all classes, it must be maintained for 30 minutes at each established resonant frequency.

7.5 Penetration test

7.5.1 Test method

Each specimen is to be laid on an impact plate so that it sustains the maximum possible damage in the impact of the hammer (which ends below with a pin) falling from 1 m height. With several equally sensitive points, the test is to be performed on each.

The height of fall is the distance between the upper side of the specimen lying on the impact plate and the lower end of the pin in the tripping position of the hammer.

The weight of the hammer is to be selected in accordance with Table 3.

7.5.2 Requirements on test device

The hammer must have a suspension device above and a rigidly mounted pin beneath. This pin must have a free length of 6 mm, a diameter of 3 mm, and a hemispherical underside and consist of a material with a Rockwell hardness between C50 and C60. Its axis must pass through the center of gravity and the suspension point of the hammer.

The impact plate of hardened steel must have at least ten times the weight of the hammer and be rigidly mounted. The contact area between specimen and impact plate must be so large that it is not deformed by the impact. If necessary, a mounting of suitable form may be attached between specimen and impact plate.

Should the dimensions of the radiator to be tested not permit the desired free fall of the corresponding hammer, the hammer can be linked to the impact point by a suitable guide, which must not appreciably hinder its fall.

7.6 Quality control in mass production

The manufacturer must assure, by suitable quality control during manufacture, that all examples of a type correspond to the classified type sample. In particular, the manufacturer must test each finished radiator as to contamination freedom and tightness[9]).

---

[9]) See Page 3.

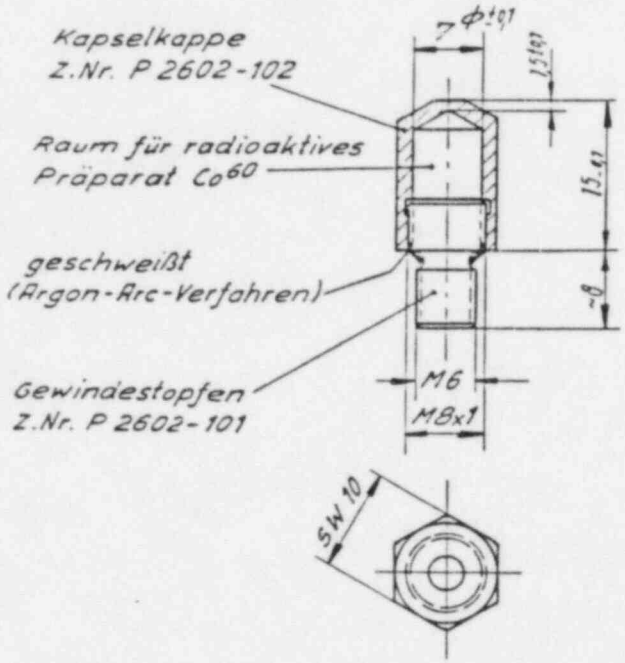
Appendix A

the following tables, taken over essentially unchanged from ISO/DIS 2919.2, examples are listed for minimum requirements on radiators of Activity Class C for some typical applications. For shielded radiators, the additional protective device is thereby taken into account.

The test conditions corresponding to these minimum requirements cover normal radiator application, including possible minor incidents in handling and use. For application at constant high temperatures, under the influence of aggressive substances, and increased probability of fire and explosion, as well as in each use of radiators of Activity Class E, supplier, user, and responsible authorities must critically evaluate these special risks. This can lead to increased requirements and possibly to special tests or additional safety measures. Also for the case of anticipated special mechanical loadings, e.g., in bending with needle-shaped radiators, additional suitable special tests may be called for.

Radiator Application	Test and Class of Radiator				
	Temperature	Pressure	Impact	Vibration	Penetration
Radiography in industrial applications unshielded radiator shielded radiator	 4 4	 3 3	 5 3	 1 1	 5 3
Medical applications Radiography Gamma teletherapy Interstitial and intra-cavity therapy Contact therapy	 3 5 5 4	 2 3 3 3	 3 5 2 3	 1 2 1 1	 2 4 1 2
Gamma measuring devices (medium- and high-energy) unshielded radiator shielded radiator	 4 4	 3 3	 3 2	 3 3	 3 2
Beta measuring devices, low-energy gamma measuring devices, and roentgen fluorescence analysis (except radiators containing radioactive gases)	3	3	2	2	2
Probes for deep well drilling	5	6	5	2	2
Portable moisture and density meters (also manual and mobile devices)	4	3	3	3	3
Neutron sources (except radiators for startup of reactors)	4	3	3	2	3
Calibration and test gauges with low activity ($1.11 \cdot 10^6$ to $3.7 \cdot 10^7 s^{-1}$) (30 µCi to 1 mCi)	2	2	2	1	2
Technical gamma radiation unshielded radiator shielded radiator	 4 4	 3 3	 4 3	 2 2	 4 3
X-ray generators (shielded and unshielded radiators) Gas chromatography Electrostatic eliminators Smoke detectors	 3 2 3	 2 2 2	 2 2 2	 1 2 2	 1 2 2

	MW	Cnb	G	M
	ZW	EW	P	L

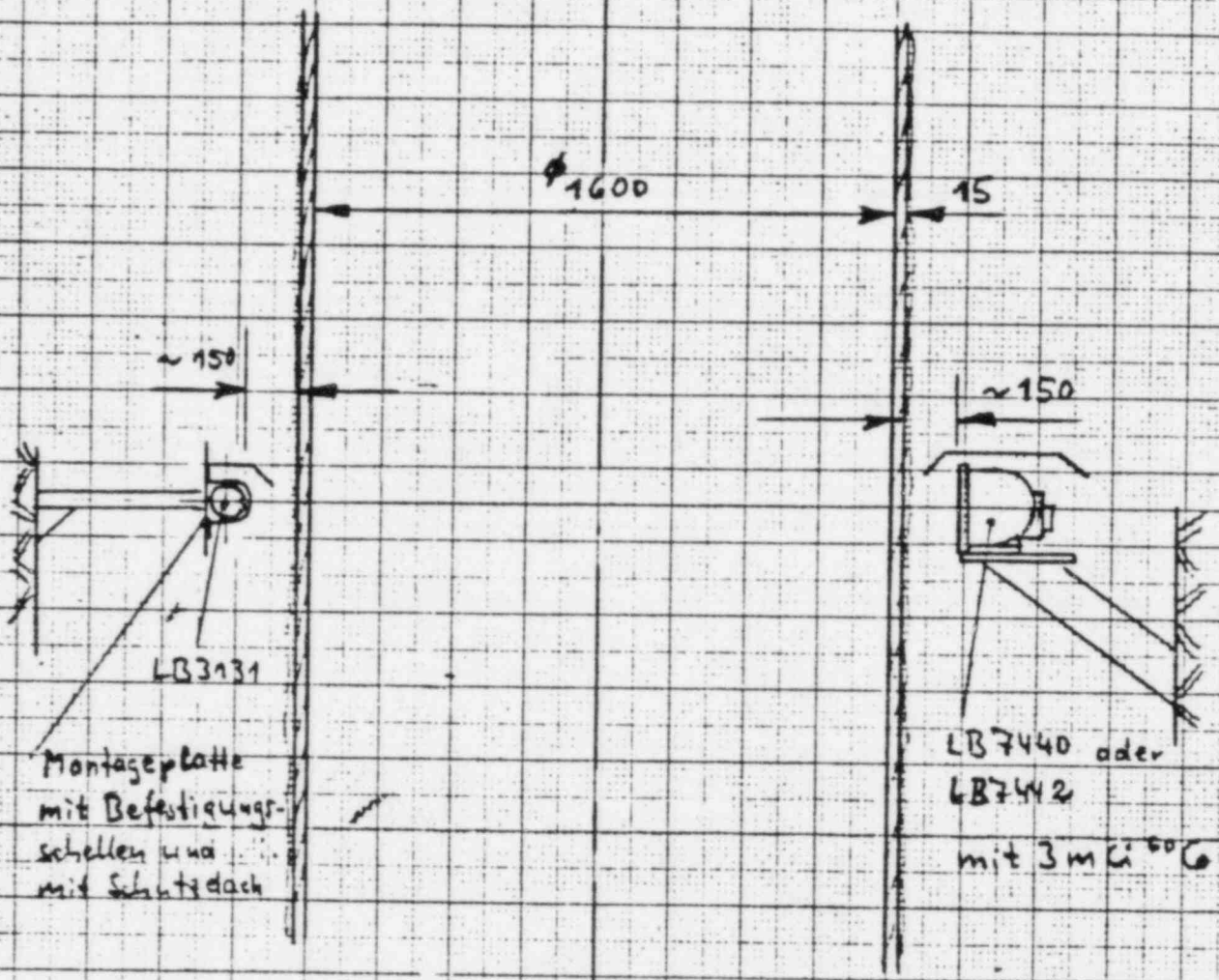


entspricht Z.Nr. A 61208-1

	Werkstoff Nr. 1.4541 oder 1.4571 Rd Toleranzen n. DIN 671				
	Sonderbearb. 6 kt Toleranzen n. DIN 176				
	Maße ohne Toleranzangabe DIN 7168 m				
	Diese Maße werden besonders geprüft		Paßmaß	Abmaße	verw. bei
	444 / 444 Laboratorium Prof. Dr. Berthold Wildbad / Schwarzwald			Tag	Name
0 Kleine Änderungen		28.11.61	gez.	1.3.61	Fröhlich
			gepr.		
Maßstab 2:1	Strahlerkapsel für ^{60}Co			Zeichn.-Nr. P 2602 – 100	

M 1:20

APPENDIX 6



Anordnung an einem

Kupolofen ohne Ausmauerung

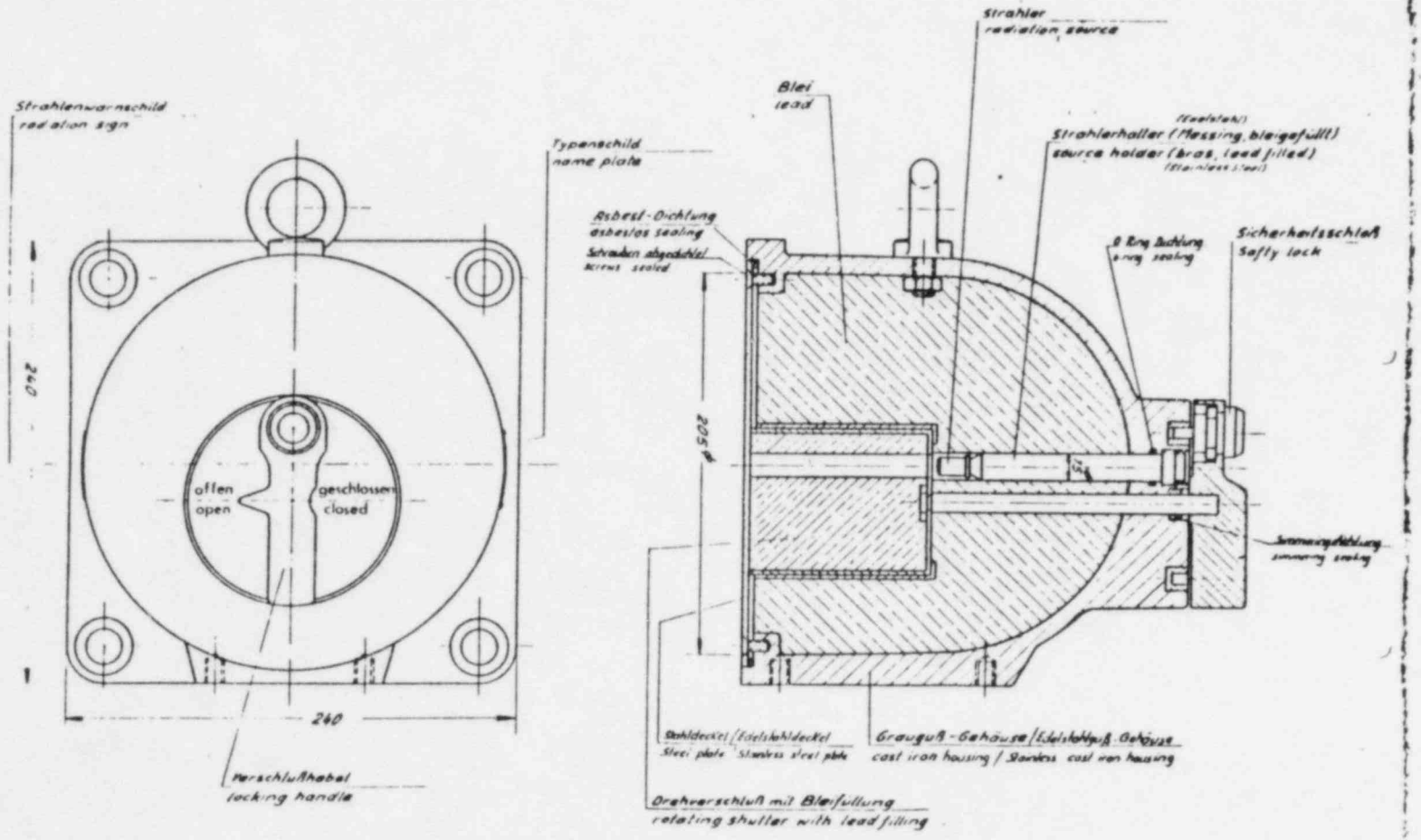
berthold

Labor Prof. Dr. Berthold
7547 Wildbad 1 (Schwarzwald)
Calmbacher Str. 22 — Postfach 180
Telefon 20 70 01 — Telex 07 54 816

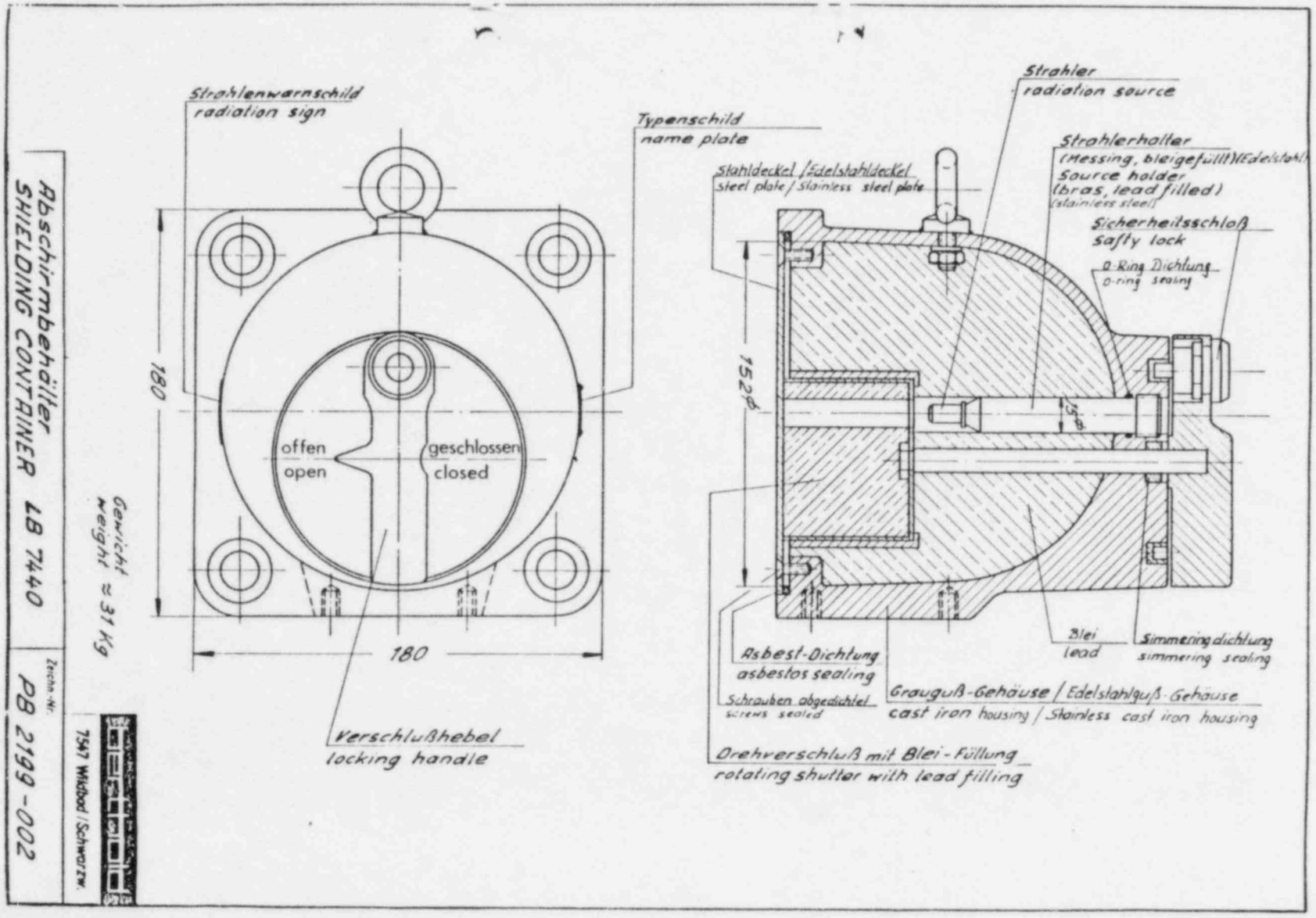
2.5.75 Hfl

A4 210 x 297 mm

MADE IN GERMANY



Abschirmbehälter
SHIELDING CONTAINER LB 7462
Gewicht
weight ≈ 81 kg
FS 2197-032


Strahlenwarnschild
radiation sign
Typenschild
name plate
Strahler
radiation source
Strahlerhalter
(Messing, bleigefüllt)(Edelstahl)
Source holder
(brass, lead filled)
(stainless steel)
Stahldeckel / Edelstahldeckel
steel plate / Stainless steel plate
Sicherheitsschloß
safty lock
O-Ring Dichtung
O-ring sealing
180
152
offen
open
geschlossen
closed
180
Verschlußhebel
locking handle
Blei
lead
Simmering dichtung
simmering sealing
Asbest-Dichtung
asbestos sealing
Schrauben abgedichtet
screws sealed
Grauguß-Gehäuse / Edelstahlguß-Gehäuse
cast iron housing / Stainless cast iron housing
Drehverschluß mit Blei-Füllung
rotating shutter with lead filling
Abschirmbehälter
SHIELDING CONTAINER LB 7440
PB 2199-002
Zeichn.-Nr.
Gewicht
weight ≈ 31 Kg
7547 Wildbad / Schwarzw.

OVERSIZE DOCUMENT PAGE PULLED

SEE APERTURE CARDS

NUMBER OF PAGES: 1

ACCESSION NUMBER(S):

8512090552-01

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STAATLICHES MATERIALPRÜFUNGSAMT
NORDRHEIN-WESTFALEN

TRANSLATION

Staatl. Materialprüfungsamt NW Postfach 410307 4600 Dortmund 41

Laboratorium Prof. Dr. Berthold
Postfach 160

7547 Wildbad 1

MY FILE 23 1048 3/81 DIRECT DIAL 4502 - 288 Dortmund, May 11, 1982

Orienting Small Fire Testing in Accordance with DIN 4102 Part 2
Your Letter of November 12, 1982 - bi - mu

Gentlemen,

as ordered, the test specimens (not radiators) delivered on 11-16-81 and on 12-10-81 were subjected on 12-11-81 for the 1st test series to an orienting fire testing in accordance with DIN Standard 4102 Part 2 (September 1977 Edition).

Please find the results of the testing in the test report enclosed as an attachment.

This report is prescribed for your own orientation only. Forwarding of the test results to third persons is not allowed, since publicity hereof can give rise to misleading conclusions.

A bill will be forwarded later.

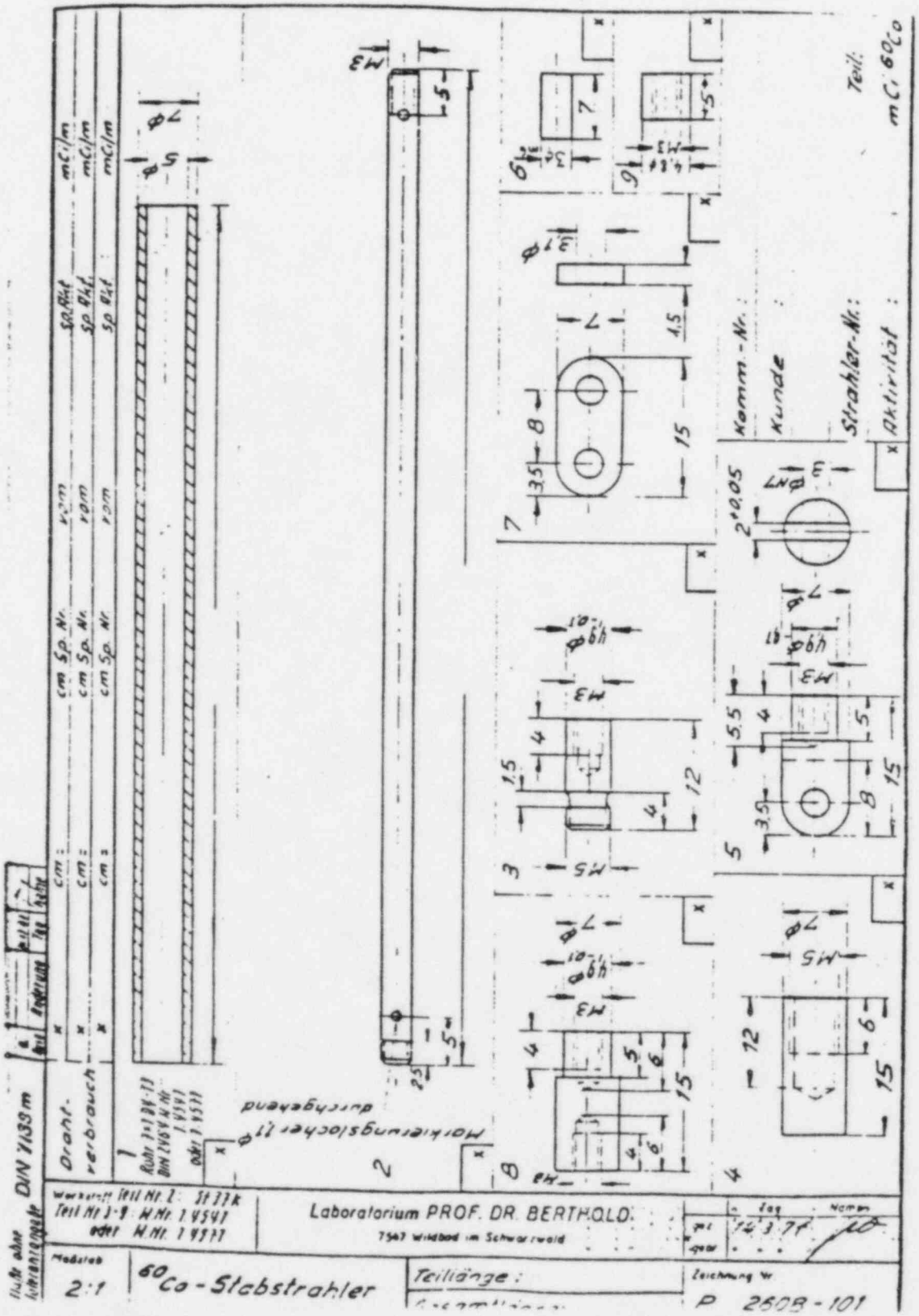
Very truly yours,
By order

Uberall

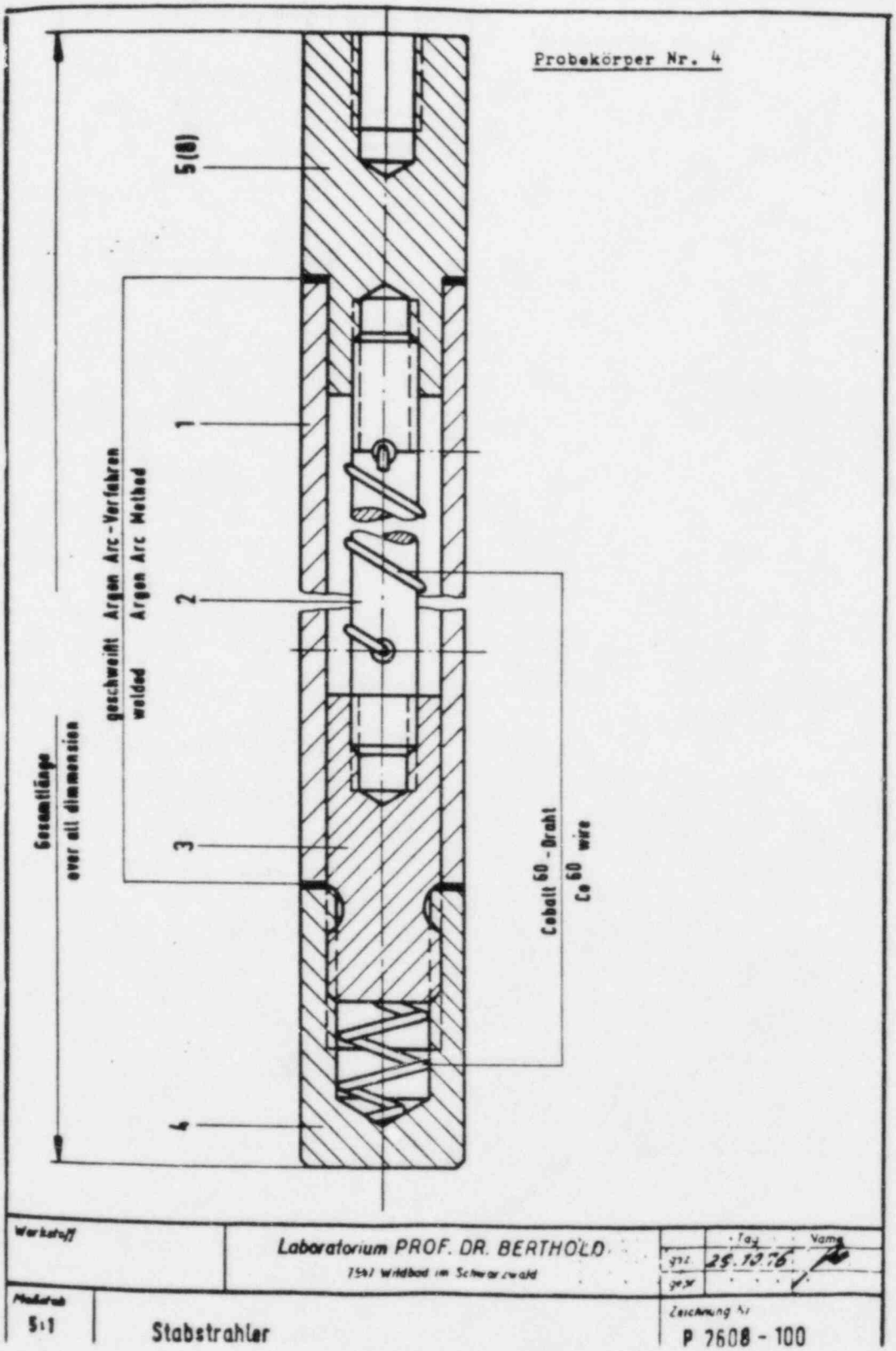
Dipl.-Phys. Uberall

23 Enclosures

Anlage 5 zum Schreiben vom 11.05.1982 Probekörper Nr. 4



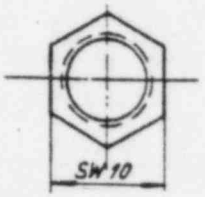
Anlage 4 zum Schreiben vom 11.05.1982



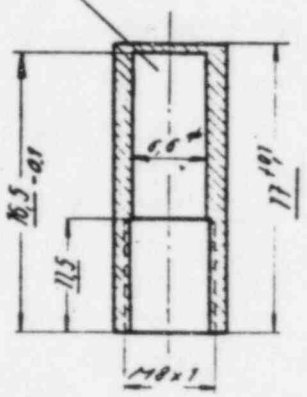
Anlage 3 zum Schreiben vom 11.05.1982

	MW	ChB	G	M
	ZW	EW	P	L

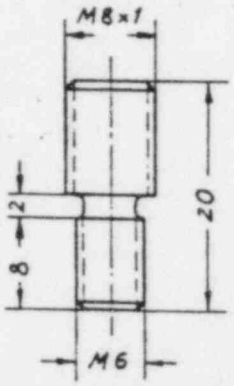
Probekörper Nr. 3



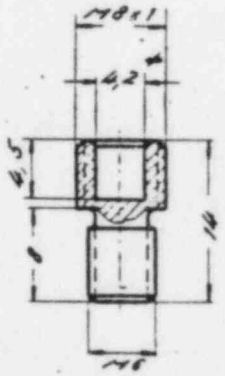
Raum f. Kapseln
Zeichng. Nr. P2623-100



Teil 1



Teil 3 für VZ 91



Teil 2 für VZ 79

Argonarc geschweißt

für Strahler nach Bürker-Kissl VZ 79 und VZ 91

Ausgabe	Änderung	Tag	Name
d	Länge M1	11.10	
c	Länge Teil 4	27.1	
b	75 u. 16,5	29.5	
a	6-Kant	26.9.81	

Laboratorium Prof. Dr. Berthold
Wildbad im Schwarzwald

Bearbeitung

Sonderbearbeitung

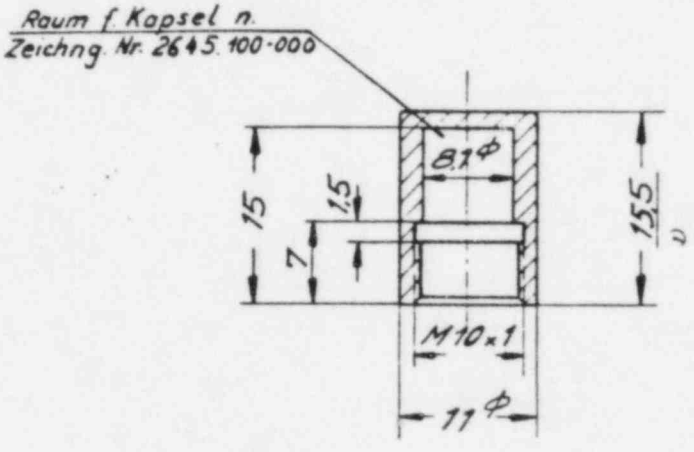
Werkstoff	Maße ohne Toleranzangabe	Diese Maße werden teilweise geprüft		Tag	Name
V2A 6-Kant			gez.	21.12	
			gepr.		

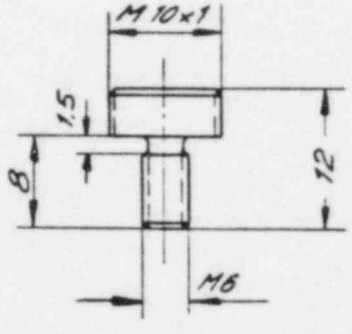
Maßstab	Adapter for Industrial - Point source Adapter für Industrie-~~Punktstrahler~~	Zeichnung Nr.
2:1		P 2601 - 101

Anlage 2 zum Schreiben vom 11.05.1982

	MW	Cha	G	M
	ZW	EW	P	L

Probekörper Nr. 2





Argonarc geschweißt

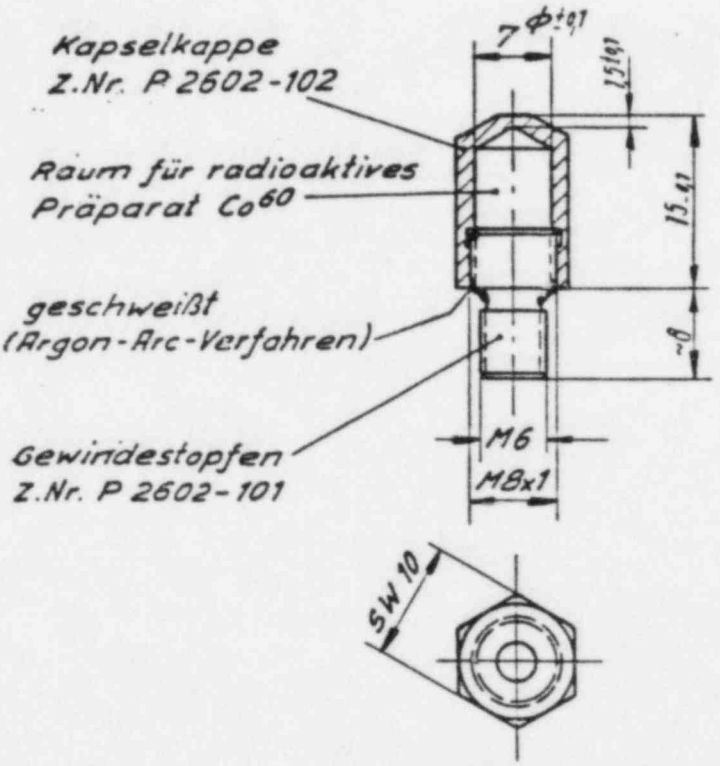
für Strahler nach Buchler-Rust IND 0233 Cs

	Werkstoff Nr. 1.4571			
	Sonderbearb.			
	Maße ohne Toleranzangabe			
	Diese Maße werden besonders geprüft	Paßmaß	Abmaße	verw. bei
	Laboratorium Prof. Dr. Barthold Wildbad / Schwarzwald		Tag	Name
		gez.	13.3.71	
		gepr.		
1 Ausgabe	2. Entf. 16,5 → 15,5 Änderung	6.8.4 Tag	Ja Name	
Maßstab 2:1	Adapter für ^{137}Cs-Punktstrahler 1.3 Ci		Zeichn.-Nr. P 2601 - 102	

Anlage 1 zum Schreiben vom 11.05.1962

MW	CHa	G	M
ZW	EW	P	L

Probekörper Nr. 1



entspricht Z.Nr. A 61208-1

	Werkstoff Nr. 1.4571 Rd Toleranzen n. DIN 671			
	Sonderbeschr. 6KT Toleranzen n. DIN 7168			
	Maße ohne Toleranzangabe DIN 7168 m			
	Diese Maße werden besonders geprüft	Paßmaß	Abmaße	verw. bei
	Laboratorium Prof. Dr. Berthold Wildbad / Schwarzwald		Tag	Name
		gez.	1.3.61	Fairley
		gepr.		
Maßstab 2:1	Strahlerkapsel für ^{60}Co		Zeichn.-Nr. P 2602 – 100	

Attachment 11 to letter of May 11, 1982

For the test, test specimens 1 to 5 were mounted on a U-shaped bent sample holder of 2 mm steel sheet, St 37 (400 x 90 x 70 mm) (see Fig. 1).

Test specimens 6 to 9 were screwed or plugged into a solid mounting (25 x 12 x 995 mm) of St 37 in the holes provided therefor (see Fig. 1).

The test specimens, including their mountings, were inserted in a small test stand per DIN 4102 Part 8 (Draft) for the test.

The test stand was heated up in accordance with uniform temperature curve DIN 4102 Part 2. The temperature was controlled according to measuring points No. 1 and 2.

The test arrangement and location of the measuring points, as well as the location of the test specimens, may be seen in Fig. 1.

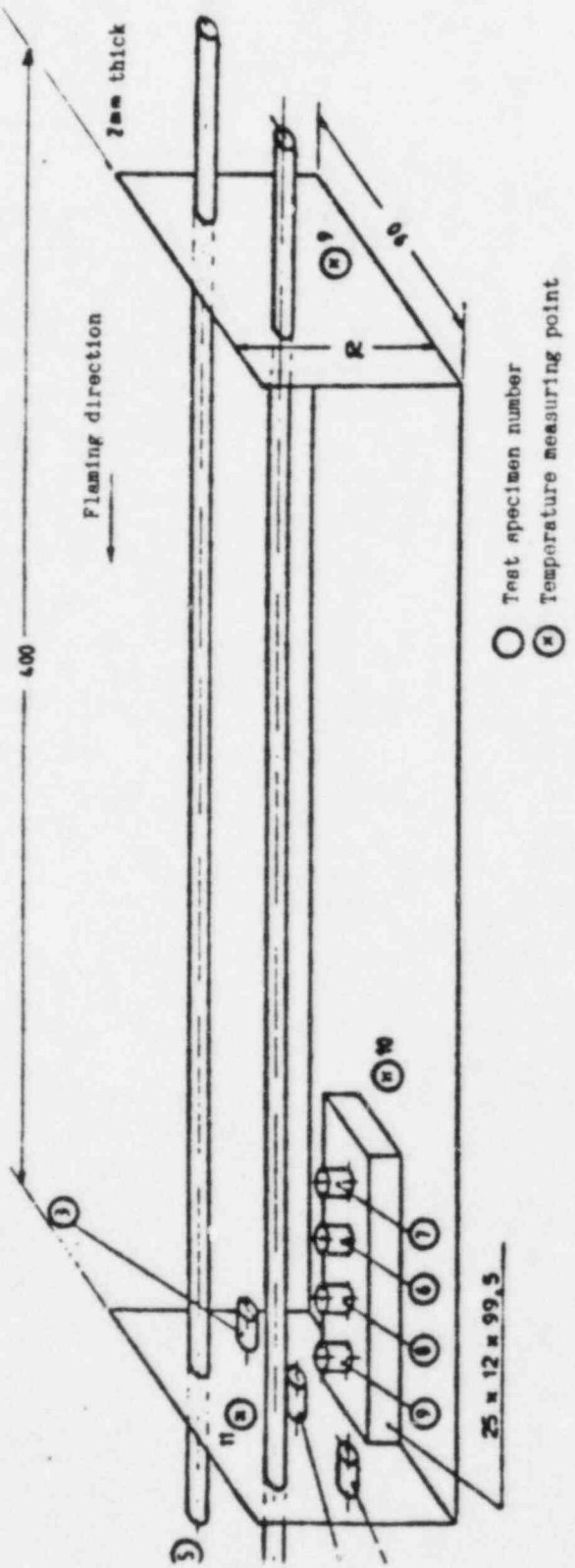


Fig. 1: Test arrangement and location of measuring points

Execution and observations during fire testing on 12-11-81

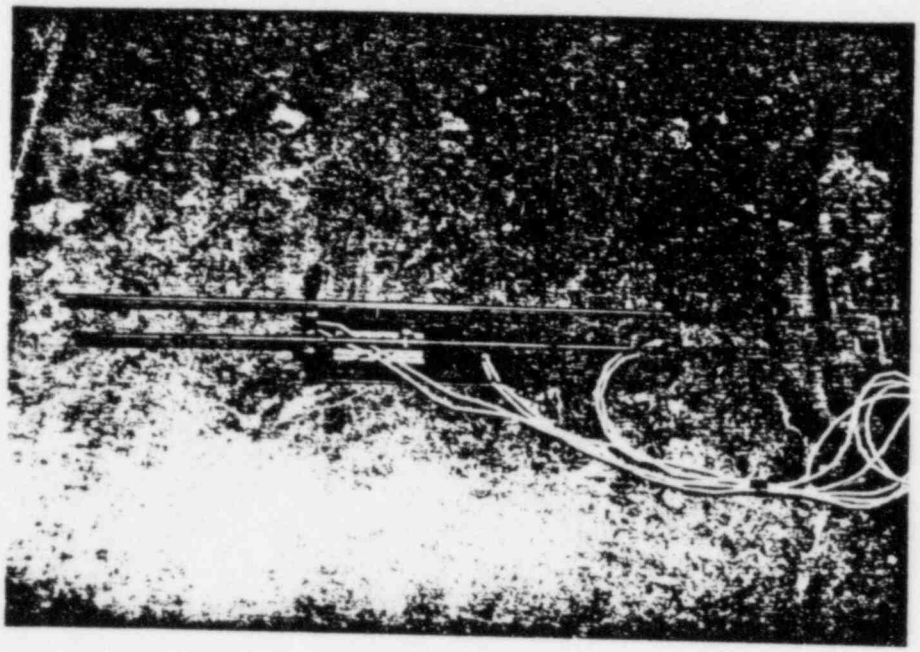


Fig. 2: Sample holder with test specimens before fire testing

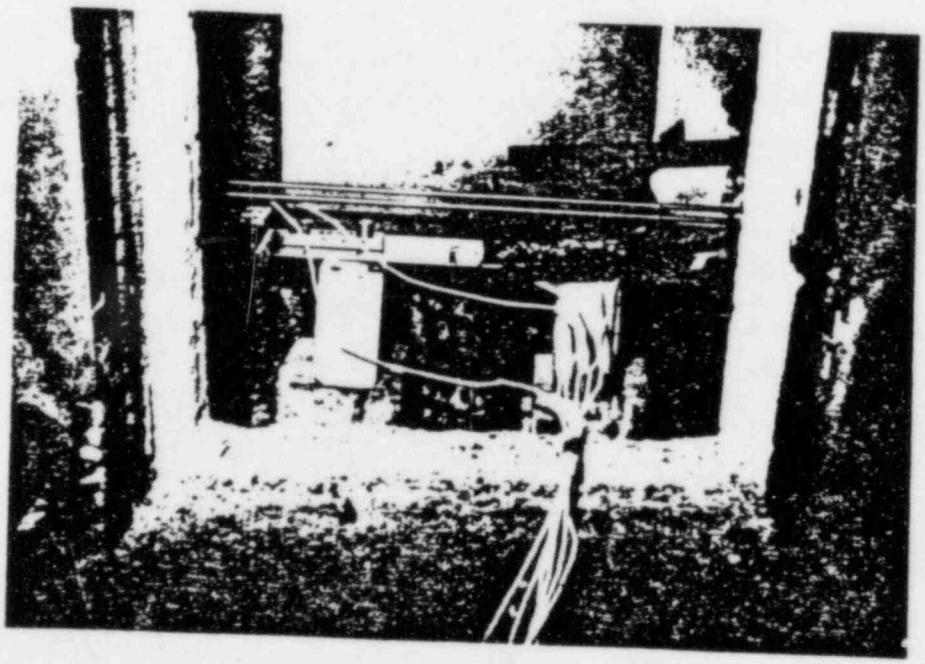


Fig. 3: Sample holder with empty capsule before fire testing
View in fire space

Attachment 14 to letter of May 11, 1982

Observations during fire testing:

Time in minutes	Observations
0	Ignition
20	The side of the rod radiator turned to the fire exhibits - as the color indicates - considerably higher temperatures than the remaining radiator
30	The radiators are slightly deformed.
45	The support plate for mounting the rod radiator is deformed.
60	The temperature on the radiators rises. The initially red coloring becomes progressively ever brighter.
125	End of fire testing.

Observations after fire testing:

The sample holders are heavily oxidized.

The surfaces of the test specimens are only slightly oxidized, those of test specimens 4 and 5 on the burner side somewhat heavier.

Neither by the naked eye nor with 40X magnification can external cracks be perceived on the test specimens. Investigation by means of the dye penetration method also produced no signs of crack formation.

TECHNICAL TRANSLATIONS INTERNATIONAL, INCORPORATED

Attachment 15 to letter of May 11, 1982

PRELIMINARY TEST/BLANK TESTS

TEST NO.: DATE: 12-11-81

TEST PIECE NO.:

TEMPERATURE MEASUREMENT RESULTS (INCREASE OVER INITIAL TEMPERATURE IN K) SHEET 01

MEASURING POINTS

TIME (MIN.)	01	02	03	04	05	06	07	08
005	0615	0475						
010	0738	0659						
015	0756	0685						
020	0769	0753						
025	0825	0798						
030	0769	0817						
035	0863	0845						
040	0888	0872						
045	0877	0868						
050	0909	0882						
055	0924	0897						
060	0932	0916						
065	0953	0929						
070	0962	0941						
075	0974	0956						
080	0983	0966						
085	0996	0975						
090	0995	0977						
095	0998	0984						
100	1009	0992						
105	1015	1003						

TECHNICAL TRANSLATIONS INTERNATIONAL, INCORPORATED

TEMPERATURE MEASUREMENT RESULTS 12-11-81 SHEET 02

MEASURING POINTS

TIME (MIN.)	01	02	03	04	05	06	07	08
110	1025	1013						
115	1029	1019						
120	1041	1028						
125	1051	1038						

TECHNICAL TRANSLATIONS INTERNATIONAL, INCORPORATED

Attachment 17 to letter of May 11, 1982

TEMPERATURE MEASUREMENT RESULTS 12-11-81 SHEET 03

MEASURING POINTS

TIME (MIN.)	09	10	11	12	13	14	15	16
005	0559	0433	0319					
010	0718	0562	0531					
015	0749	0616	0582					
020	0791	0693	0646					
025	0845	0751	0701					
030	0889	0800	0742					
035	0918	0832	0776					
040	0946	0867	0808					
045	0934	0860	0808					
050	0946	0875	0823					
055	0963	0889	0841					
060	0975	0904	0859					
065	0993	0927	0877					
070	1004	0933	0891					
075	1015	0947	0905					
080	1023	0956	0915					
085	1029	0963	0928					
090	1031	0970	0930					
095	1037	0974	0940					
100	1044	0980	0950					
105	1050	0984	0959					
110	1058	0997	0970					
115	1065	1010	0980					
120	1071	1017	0988					
125	1083	1032	1001					

Attachment 18 to letter of May 11, 1982

Fire side

Fig. 4: View in small fire oven in test arrangement (left side) after fire testing

Fig. 5: Test Specimen 1 after fire testing

Fig. 6: Test Specimen 2 after fire testing

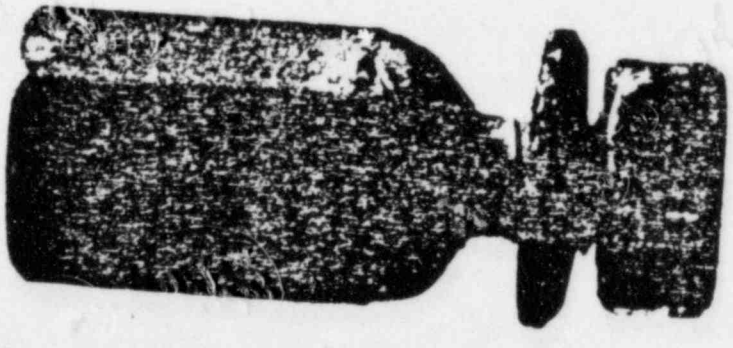


Fig. 7: Test Specimen 3 after fire testing

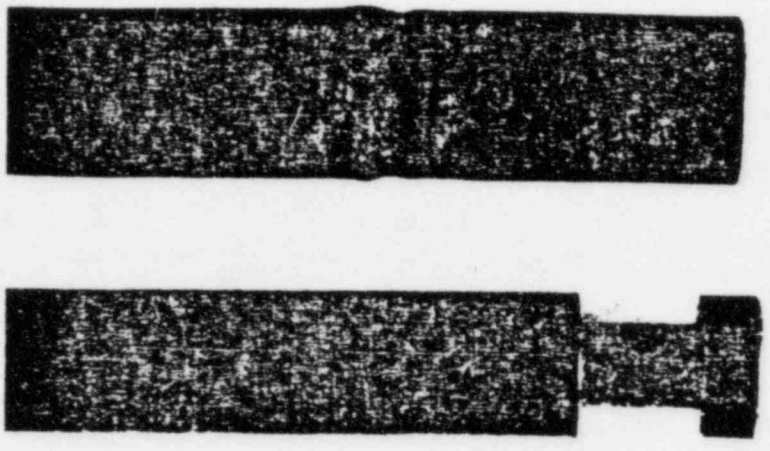


Fig. 8: Test Specimens 4 and 5 - View of the side turned away from the burner after fire testing

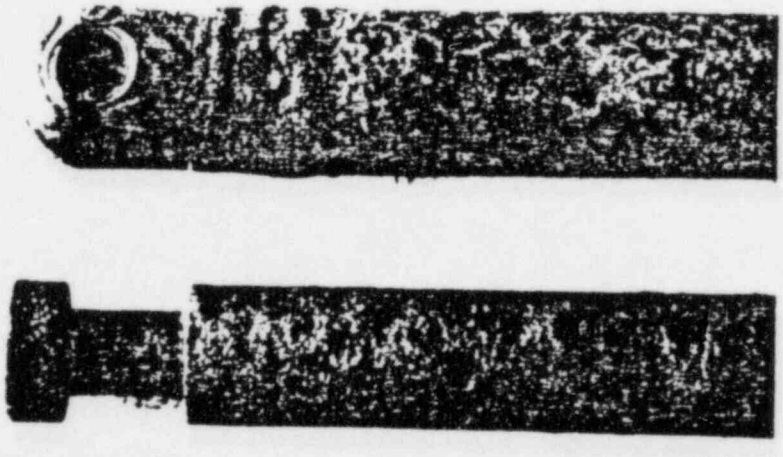


Fig. 9: Test Specimens 4 and 5 - View of the side turned toward the burner after fire testing

Attachment 21 to letter of May 11, 1982

Fig. 10: Mounting of Test Specimens 6 to 9 after fire testing

Fig. 11: Test Specimens 6 to 9 - View of the test specimens installed in the mounting after fire testing

Attachment 22 to letter of May 11, 1982

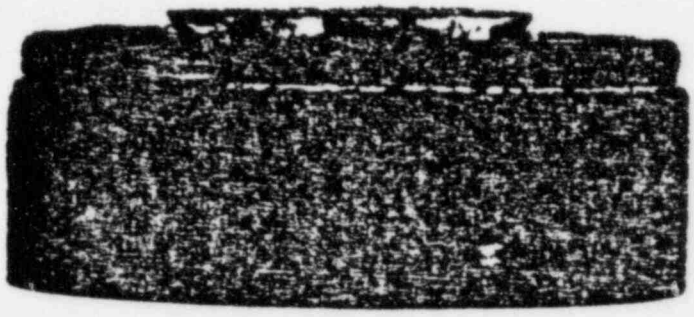


Fig. 12: Test Specimen No. 6 after fire testing

Fig. 13: Test Specimen No. 7 after fire testing

Attachment 23 to letter of May 11, 1982

Fig. 14: Test Specimen No. 8 after fire testing

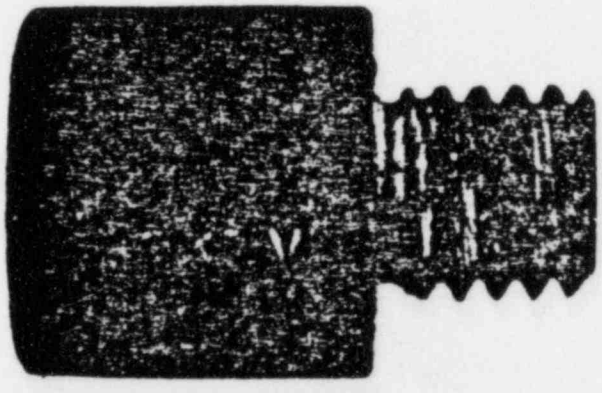


Fig. 15: Test Specimen No. 9 after fire testing

*ATTACHMENT # 3
*ITEM # 13

A) LABORATORY, PLANT FACILITIES, FUME HOODS

Our distribution, maintenance, repair and storage of nuclear detection instruments with associated by-product material are located at (refer to Form 313 - Item # 5). Since 70% of the activities at our facility is repair and check out of nuclear electronic instrumentation, (the remaining 30% being combined distribution and sales), using approved sealed sources. In light of this type of operation and it's Health Physics aspect, laboratory operation including fume hood are not required. We will comply with 10 cfr 20.203 regarding placarding.

B) STORAGE, CONTAINERS, SPECIAL SHIELDING

REFER TO ITEM # 9

C) Remote handling equipment such as forceps and tongs will be utilized in transfering high mCi amounts of Co and Cs from shield to sheild, 1% of operation, otherwise no remote handling equipment will be required for normal operation utilizing license exempt quantities.

D) RESPIRATORY PROTECTIVE EQUIPMENT WILL NOT BE NEEDED.

*ITEM # 14 - WASTE DISPOSAL

The only waste we feel will be generated are returns from customers of special devices which contain high mCi amounts of Cs or Co. The returns due to decay of isotope we estimate to be about every three years of Co-60 and 12 to 15 years for Cs137. The returns of damaged sources we estimate to be on an accidental basis and have contracted - Applied Health Physics Services located at 2986 Industrial Park, Bethel Park, Pittsburgh, Pennsylvania 15205, to handle this waste.

APPLICATION FOR REGISTRATION OF SEALED SOURCES

CAESIUM - 137 POINT SOURCE

A SUMMARY DATA

1 Date of Original Sumission - April 16, 1984

2 Sealed Source Type - "Point Source" - which is Cs-137 in a sealed stainless steel capsule.

3 Model - According to drawings P2623-100 and 2645.100-000, copies attached as Appendix 1.

4 Applicant

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

Berthold level control equipment will be furnished through us. We are not a manufacturer of this equipment.

For additional information, please contact at the above address:

Mr A McCabe - Managing Director
Mr J Welch - Assistant Sales Manager

5 Other Companies Involved

The sources are manufactured by:

Amersham Buchler GmbH & Co, KG
D-3300 Braunschweig
West Germany, FR

or

Isocommerz GmbH
Lindenberger Weg 70
DDR-1115 Berlin-Buch
East Germany

6 Isotope and Maximum Activity

Depending on requirements, the following activities would be used:

Caesium-137 1000 mCi - maximum
(normal requirements are usually less than 300 mCi)

7 Leak Test Frequency

Each individual source is given a leak test and wipe test at the Lab Berthold plant within the six months prior to shipment. These tests are performed according to DIN specification 25426 part 4. Results of these tests leave a removable activity of less than 5 nCi. A test certificate for this accompanies each source. (A sample certificate is shown in Appendix 2). Further testing is only recommended if the ambient temperature directly on the source exceeds 400 °C (750 °F). For data on this factor, see Appendix 3 which gives an authenticated report of 03.03.66 on this subject by the Physikalisch-Technische Bundesanstalt (PTB), certificate no 28245.65 VIB/RA. Please note that the tests done today are held to a 5 nCi level as described above.

Routine testing should not be required more frequently than once every five (5) years because the source is fixed mounted and well protected in its source holder (shielding).

8 Principal Use

Code "D": Gamma gauge to measure and control levels in all types of vessels.

9 Custom Source

No. The construction of these sources is essentially the same for all, with only the source activity as a variant.

10 Custom User

B DESCRIPTIVE DATA

1 Summary Description

The properties of the source and capsule are shown below:

A Description of the radioactive substance:

a)	Isotope (nuclide)	- Cs-137
b)	Chemical condition	- Cs
c)	Physical condition	- solid ceramic or glass
d)	Activity	- 1-1000 mCi

(usual installations require less than 300 mCi)

B Description of the capsule:

a) Design - point source, capsulized per drawings P-2623-100 and 2645.100-000 (see Appendix 1).

Manufacturer:

Amersham Buchler Braunschweig West Germany	or	Isocommerz Berlin-Buch East Germany

Supplier:

Labor Prof Dr Berthold
Wildbad
West Germany

c) Dimensions - 6,4 mm external diameter, 15,9 mm overall length.

d) Material - stainless steel per DIN specification 1.7440, material no 1.4541 or 1.4571 (Chrome, Nickel, Titanium alloy).

e) Wall thickness - 0,5 + 0,65 mm

f) Sealing - argon arc welding

g) Classification - ISO/C65444 according to DIN 25426 (same as ANSI N-542-1977) and "Special Form" according to IAEA regulations. Reports on this are given by the Bundesanstalt für Materialprüfung of the West German Government. See Appendix 4 for this report.

2 Labelling

Because the source is so small, a name plate is attached to the source holder (shielding). This name plate contains the following information:

a) The nuclide used (source type)

b) The source activity

c) The Berthold serial number which is a series of three (3) sets of numbers as follows:

1st number - sequential number of source made that year
2nd number - month of manufacture
3rd number - year of manufacture

Serial numbers, as in 2 (c), are also engraved on each source.

3 Diagram

Please refer to drawings no. P2623-100 and 2645.100-000 marked "Strahlerkapsel für Cs-137" (point source). This drawing is shown in Appendix 5 (as Appendix 1 but smaller).

4 Conditions of Normal Use

The shielding consists of a lead filled casting housing.

The source capsule is fastened in the middle of the casted housing with an adaptor so that even in the extremely remote case that the lead melts and runs out, the source is fastened to the casted housing and will not be lost. In front of the source is a lead filled cylinder with an off-centre drilled hole. This is attached to a spindle which is in turn connected to a locking handle. By turning the handle, thus the cylinder, through 180° the radiation beam can be closed.

In the normal case the shielding container and detector are diametrically positioned on opposite sides of the vessel. With an open shielding, the well collimated radiation beam irradiates the vessel via the slit in the shielding and the radiation is detected by the scintillation counter on the other side. The change of level in the vessel initiates an increase or decrease in the radiation intensity at the detector. Such measuring systems are installed in and are designed for environmental conditions in the following industrial areas:

- chemical industry
- refineries
- mines
- food industry
- steel industry
- wood and paper industry

The shieldings and sources are constructed in such a way that they can withstand such environmental conditions, for example humidity, dust, aggressive atmospheres etc. The typical assembly is schematically shown in Appendix 6.

The useful life of the source units, would be at least ten (10) years for Caesium-137 (half-life 30 years).

In the event that the container temperature would exceed 300 °C (572 °F), and the lead shielding would melt, the lead cannot leak out, so that even under these circumstances, the protection remains. The construction of the steel container is sufficiently strong enough to withstand the slight expansion of the lead at the 400-500 °C range. It is also impossible for the source to come loose and float at elevated temperature, because the source is securely held in place.

An additional certificate from the Staatliches Materialprüfungsamt, Nordrhein-Westfalen (State Material Testing Institute) gives the result of a fire test according to DIN Spec. 4102. The testing temperature went up over 1000 °C (1832 °F) with the following results:

- No evidence of cracking was evident in the dye test.

(see Appendix 7 for this certificate)

5 Supporting Detail

The detailed listing of the physical properties of the source along with the details of its construction are given in Items B.1.A and B.1.B.

C HEALTH & SAFETY DATA

1 Safety Analysis Summary

The Berthold source units are carefully constructed as indicated in Section B.1.B above. Sources are tested for:

a) Seal (weld) tightness by bubble testing in diethylene glycol at a reduced pressure of less than 100 mm Hg. Testing is commonly done at a pressure of only 3-5 mm Hg.

b) Wipe testing to a limiting value of 5 nano Curies (nCi).

c) Source jacketing is tested on the following points:

temperature range, pressure, impact, oscillation, puncture resistance.

These tests were as per ISO/DIN Spec 25476 part 1. The tests correspond to the ANSI specification N-542-1977. The results are shown in Appendix 8.

2 Manufacturing and Distribution Controls

a) Quality assurance and control:

During every step in the manufacture, the tests specified in the Berthold Sealed Radioactive Source Test Report (Appendix 2), are individually carried out for each and every source.

Testing for the source strength is done by the manufacturer. The leak testing procedure is given above in section A.7, see also Appendix 2. Interantional standards indicate a removal activity of less than 5 nCi.

b) Description of Lab Berthold's recommended maintenance, service and testing requirements for use:

i) Lab Berthold's procedure for leak testing has been fully described in Section A.7, see also Appendix 2.

ii) Unpacking:

I) In the normal case, the source is shipped in its use-container with the shutter in the closed position.

II) In certain cases, the source may be shipped separately, utilizing a specially designed lead shipping container. In this case, as would also be true for replacements, the placement is carried out as follows:

- 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 the disassembled parts (flanges).
- The old (decayed) source, is then put into the shipping container and returned either 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 body and source of approximately 1/2 meter (18"-20"), and a maximum source strength of 1000 mCi the whole body exposure can be calculated to a value of 24 mrem.

iii) Leak testing:

The construction of the sources is such, that under normal circumstances, replacement is not required more often than the useful life of the source (for Cs-137, this is approximately 10-years).

In the event that the ambient temperature of the source exceeds 400 °C (7520 °F) then it is recommended that the source be replaced.

c) Manufacturer's instructions to user:

Copies of the pertinent radiological safety and operating instructions for the source will be provided by the manufacture.

3 Manufacturer's Safety Analysis of Sealed Source Review

a) Safety Analysis:

Details of this are given above in Sections B.1.B, C.1.a, b and c and B.4.d.

b) Prototype testing and evaluation:

- Maximum radiation levels based on the maximum source strength of 500 mCi and using the specific dose rate constant for Cs-137 which is given as:

$$0.35 \frac{\text{mrem} \times a^2}{h \times \text{mCi}}$$

where a = distance in meters from the source to the point being measured
h = time in hours

For this radiation calculation, the source is assumed to be a point source (which would represent the worst case).

eg: where a = 5 cm
the maximum radiation level would be 140,000 mrem/h.

where a = 30 cm
the maximum radiation level would be 3,900 mrem/h.

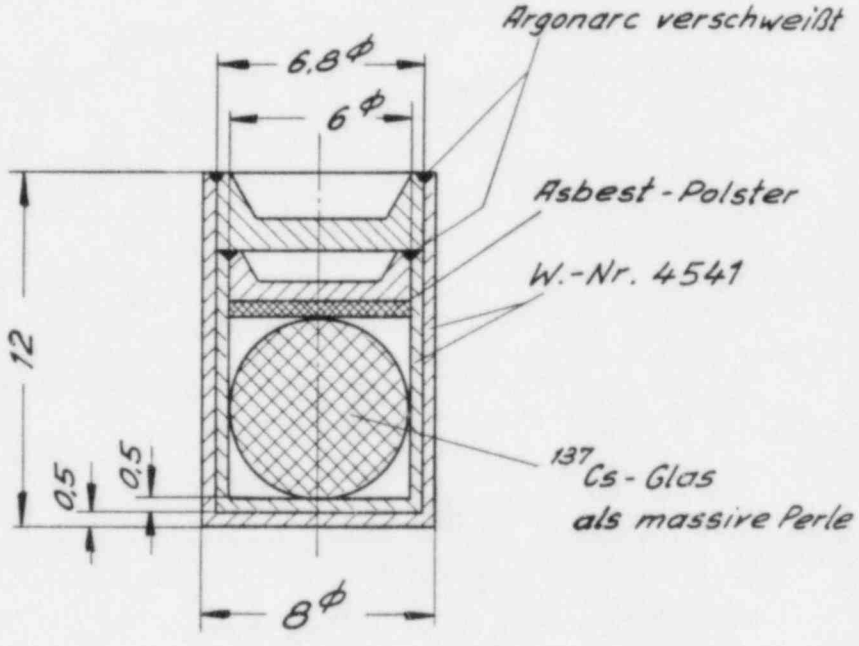
- Results of tests performed on prototype source capsule:

These test results are given above in item B.1.B. This classification is given by specification in ISO/C-65444 and this corresponds to ANSI spec N-542-1977.

c) Additional Information

As given in Section B.4.d above, additional information was presented on fire testing, see also Appendix 7.

	MW	Clb	G	M
	ZW	EW	P	L



Entspricht Buchler-Ausführung IND 92/Cs Bzw. VZ 0092

Ausgabe	Änderung	Tag	Name

Werkstoff

Sonderbearb.

Maße ohne Toleranzangabe

Diese Maße werden besonders geprüft

Paßmaß	Abmaße	verw. bei

Laboratorium
Prof. Dr. Berthold
Wildbad / Schwarzwald

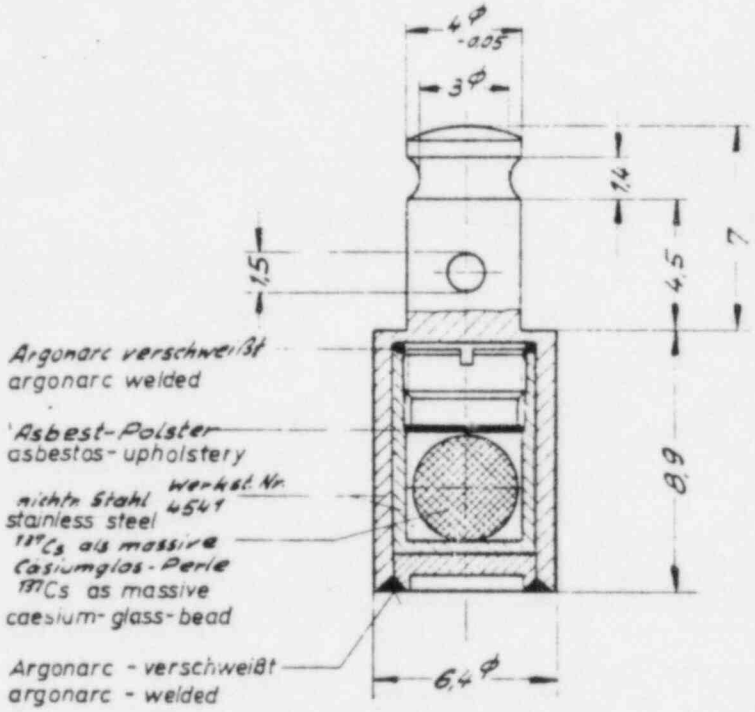
	Tag	Name
gez.	20.5.74	
gepr.		

Maßstab 5:1

137 Cs - Industrie - Strahler 1-3 Ci

Zeichn.-Nr. 2645.100-000

APPENDIX 1



Beschreibung der Hülle:

Bauartbeschreibung:	**doppelt umschlossen**
Material:	**Innen- und Außenkapsel Edelstahl W.Nr.4541**
Wanddicke:	**Innenkapsel: 0,5 mm**
	Außenkapsel: 0,65 mm
Art der Abdichtung:	**Argonarc-verschweißt**

Entspricht Buchler u. Co-Ausführ. VZ-0079 bzw. IN0.79/rs

Laboratorium Prof. Dr. Berthold
Wildbad im Schwarzwald

Bearbeitung

Oberflächenbearbeitung

Ausgabe | Änderung | Tag | Name

Werkstoff

Maße ohne Toleranzangabe

Diese Maße werden besonders geprüft

Datum 2.11.65 Name

Maßstab 5:1

Industrial - Point source to 500 mCi
137Cs-Industrie-Punktstrahler bis 500mCi

Zeichnung Nr. P 2623 - 100

berthold

LABORATORIUM PROF. DR. BERTHOLD
D-7547 WILDBAD 1 · Fernsprecher (07081) 3981 · Telex 0724019

KERNSTRAHLUNGSMESSGERÄTE FÜR INDUSTRIE, WISSENSCHAFT UND MEDIZIN

Empfänger:
RECEIVER:

Bestell-Nr.:
ORDER-NO.:

Komm.-Nr.:
OUR COMM.-NO.:

Zertifikat Nr.
CERTIFICATE NO.

über Dichtheit und Beanspruchbarkeit umschlossener radioaktiver Stoffe
SEALED RADIOACTIVE SOURCE TEST REPORT

Nuklid: Cs-137
NUCLIDE:

Typ: Punktstrahler
TYPE:

Beanspruchbarkeit: ISO/C 64444
CLASSIFICATION:

Zeichnung: P 2623
DRAWING:

Prüfungen: **I. Dichtheitsprüfung: Blasentest**
TESTS: LEAKAGE TEST: BUBBLE TEST

II. Kontaminations-Prüfung: Wischtest
CONTAMINATION TEST: WIPE TEST

Ergebnis: < 0,18 kBq
RESULT:

Strahler-Nr. SOURCE NO.	**Aktivität** ACTIVITY m Ci	M Bq	**Prüfdatum** DATE OF TESTS	**Ursprungs-Nr.** ORIGIN NO.

Hinweis: Die Strahlerausführung entspricht PTB-Gutachten Nr. 28245.65 VI B/Ra 6.3 - 10369/75

Die oben aufgeführten Strahler wurden individuell geprüft und gelten als dicht und kontaminationsfrei.
THE ABOVE LISTED SOURCES PASSED AN INDIVIDUAL TEST AND THEY ARE FREE OF LEAKAGE AND CONTAMINATION

LABORATORIUM PROF. DR. BERTHOLD

Prüfmethoden

I Blasenprüfung
Der Strahler wird in eine geeignete Flüssigkeit (Diäthylenglykol) eingetaucht und der Druck in dem Gefäß auf 100 mm Hg reduziert. Es dürfen keine Blasen entstehen.

II Wischprüfung
Die Hülle, die Oberfläche oder wesentliche Teile des zu prüfenden Strahlers werden mit saugfähigem Material abgewischt. Anschließend wird die Aktivität des abgelösten radioaktiven Stoffes bestimmt.

In Anlehnung an DIN 25426, Teil 4, gilt ein Strahler in der Regel als dicht und kontaminationsfrei, wenn bei den entsprechenden Prüfungen der Grenzwert von 5 nCi nicht überschritten wird.

Besondere Form (special form)

Ein radioaktiver Stoff in besonderer Form ist ein Strahler, der besonderen, über den üblichen Beanspruchungen liegenden thermischen und mechanischen Anforderungen und Prüfverfahren genügt, wie sie in den IAEA transport regulations beschrieben werden.

Die Prüfungen werden von der zuständigen Behörde durchgeführt, die dann ein entsprechendes Zeugnis ausstellt, wenn der Strahler die Anforderungen erfüllt.

Die besondere Form eines Strahlers kann bei der Auswahl eines Transportbehälters wichtig sein, wird aber auch häufig zur Beurteilung der Qualität eines Strahlers herangezogen.

ISO/DIN-Klassifikation

Die internationale Organisation for Standardisation (ISO) hat ein System zur Klassifikation von umschlossenen radioaktiven Stoffen vorgeschlagen, das inzwischen weltweit angewendet wird.

Auf die ISO-Norm aufbauend wurde die DIN-Norm 25426, Teil 1, „Umschlossene radioaktive Stoffe, Anforderungen und Klassifikation", erarbeitet. Die beiden Normen sind nahezu identisch.

Zweck dieser Normen ist es, Herstellern, Lieferanten, Anwendern und zuständigen Behörden einheitliche Kriterien zur Beurteilung der Sicherheit beim Umgang mit umschlossenen radioaktiven Stoffen zu geben.

Klassifikation der Strahler nach ihrer Beanspruchbarkeit (nach DIN 25426, Teil 1).

Klasse / Prüfung	1	2	3	4	5	6	X
Temperatur	ungeprüft	− 40 °C (20 min) und + 80 °C (1 h)	− 40 °C (20 min) und + 180 °C (1 h)	− 40 °C (20 min) und + 400 °C (1 h) und thermisches Abschrecken von 400 °C auf 20 °C	− 40 °C (20 min) und + 600 °C (1 h) und thermisches Abschrecken von 600 °C auf 20 °C	− 40 °C (20 min) und + 800 °C (1 h) und thermisches Abschrecken von 800 °C auf 20 °C	Sonderanforderung
Druck	ungeprüft	250 mbar	250 mbar und 20 bar	250 mbar und 70 bar	250 mbar und 700 bar	250 mbar und 1,7 kbar	Sonderanforderung
Schlag	ungeprüft	50 g aus 1 m Höhe	200 g aus 1 m Höhe	2 kg aus 1 m Höhe	5 kg aus 1 m Höhe	20 kg aus 1 m Höhe	Sonderanforderung
Schwingung	ungeprüft	3 mal 3 Zyklen je 10 min 25 bis 500 Hz bei 5 g Beschleunigungsamplitude	3 mal 3 Zyklen je 10 min 25 bis 50 Hz bei 5 g Beschleunigungsamplitude und 50 bis 90 Hz bei 0,32 mm Auslenkungsamplitude und 90 bis 500 Hz bei 10 g Beschleunigungsamplitude	3 mal 3 Zyklen je 30 min 25 bis 80 Hz bei 0,75 mm Auslenkungsamplitude und 80 bis 2000 Hz bei 20 g Beschleunigungsamplitude	entfällt	entfällt	Sonderanforderung
		zusätzlich 30 min bei jeder Resonanzfrequenz					
Durchstoß	ungeprüft	1 g aus 1 m Höhe	10 g aus 1 m Höhe	50 g aus 1 m Höhe	300 g aus 1 m Höhe	1 kg aus 1 m Höhe	Sonderanforderung

Die Forderung einer Klasse gilt als erfüllt, wenn die Prüflinge nach der Beanspruchung dicht geblieben sind.

Mindestanforderungen an Strahler der Aktivitätsklasse C bei normaler Verwendung (nach DIN 25426, Teil 1).

Strahleranwendung	Prüfung und Klasse der Strahler				
	Temperatur	Druck	Schlag	Schwingung	Durchstoß
Radiographie im industriellen Bereich					
ungeschützter Strahler	4	3	5	1	5
geschützter Strahler	4	3	3	1	3
Medizinischer Bereich					
Radiographie	3	2	3	1	2
Gamma-Teletherapie	5	3	5	2	4
Interstitielle und intrakavitäre Therapie	5	3	2	1	1
Kontakttherapie	4	3	3	1	2
Gamma-Meßanlagen (mittlere und hohe Energie)					
ungeschützter Strahler	4	3	3	3	3
geschützter Strahler	4	3	2	3	2
Beta-Meßanlagen, Gamma-Meßanlagen niedriger Energie und Röntgenfluoreszenzanalyse (ausgenommen radioaktive Gase enthaltende Strahler)	3	3	2	2	2
Sonden für Tiefbohrungen	5	6	5	2	2
Tragbare Feuchte- und Dichtemesser (auch Handgeräte und fahrbare Geräte)	4	3	3	3	3
Neutronenquellen (ausgenommen Strahler zum Anfahren von Reaktoren)	4	3	3	2	3
Kalibrier- und Prüfstrahler mit geringer Aktivität ($1 \cdot 10^5$ bis $3{,}7 \cdot 10^7$ s^{-1} (3 µCi bis 1 mCi))	2	2	2	1	2
Technische Gamma-Bestrahlung					
ungeschützter Strahler	4	3	4	2	4
geschützter Strahler	4	3	3	2	3
Ionengeneratoren (ungeschützte und geschützte Strahler)					
Gaschromatographie	3	2	2	1	1
Elektrostatische Eliminatoren	2	2	2	2	2
Rauchdetektoren	3	2	2	2	2

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LABORATORIUM PROF. DR. BERTHOLD
D-7547 WILDBAD 1 · Fernsprecher (07081) 3981 · Telex 0724019

KERNSTRAHLUNGSMESSGERÄTE FÜR INDUSTRIE, WISSENSCHAFT UND MEDIZIN

Empfänger:
RECEIVER:

Bestell-Nr.:
ORDER-NO.:

Komm.-Nr.:
OUR COMM.-NO.:

Zertifikat Nr.
CERTIFICATE NO.

über Dichtheit und Beanspruchbarkeit umschiossener radioaktiver Stoffe
SEALED RADIOACTIVE SOURCE TEST REPORT

Nuklid: Cs-137
NUCLIDE:

Typ: Punktstrahler
TYPE:

Beanspruchbarkeit: ISO/C 65344
CLASSIFICATION:

Zeichnung: P 2623
DRAWING:

Prüfungen: **I. Dichtheitsprüfung: Blasentest**
TESTS: LEAKAGE TEST: BUBBLE TEST

II. Kontaminations-Prüfung: Wischtest
CONTAMINATION TEST: WIPE TEST

Ergebnis: < 0,18 kBq
RESULT:

Strahler-Nr. SOURCE NO.	**Aktivität** ACTIVITY m Ci	M Bq	**Prüfdatum** DATE OF TESTS	**Ursprungs-Nr.** ORIGIN NO.

Hinweis: Die Strahlerausführung entspricht PTB-Gutachten Nr. 6.31-8785/78

Die oben aufgeführten Strahler wurden individuell geprüft und gelten als dicht und kontaminationsfrei.
THE ABOVE LISTED SOURCES PASSED AN INDIVIDUAL TEST AND THEY ARE FREE OF LEAKAGE AND CONTAMINATION.

LABORATORIUM PROF. DR. BERTHOLD

Prüfmethoden

I Blasenprüfung
Der Strahler wird in eine geeignete Flüssigkeit (Diäthylenglykol) eingetaucht und der Druck in dem Gefäß auf 100 mm Hg reduziert. Es dürfen keine Blasen entstehen.

II Wischprüfung
Die Hülle, die Oberfläche oder wesentliche Teile des zu prüfenden Strahlers werden mit saugfähigem Material abgewischt. Anschließend wird die Aktivität des abgelösten radioaktiven Stoffes bestimmt.

In Anlehnung an DIN 25426, Teil 4, gilt ein Strahler in der Regel als dicht und kontaminationsfrei, wenn bei den entsprechenden Prüfungen der Grenzwert von 5 nCi nicht überschritten wird.

Besondere Form (special form)

Ein radioaktiver Stoff in besonderer Form ist ein Strahler, der besonderen, über den üblichen Beanspruchungen liegenden thermischen und mechanischen Anforderungen und Prüfverfahren genügt, wie sie in den IAEA transport regulations beschrieben werden.

Die Prüfungen werden von der zuständigen Behörde durchgeführt, die dann ein entsprechendes Zeugnis ausstellt, wenn der Strahler die Anforderungen erfüllt.

Die besondere Form eines Strahlers kann bei der Auswahl eines Transportbehälters wichtig sein, wird aber auch häufig zur Beurteilung der Qualität eines Strahlers herangezogen.

ISO/DIN-Klassifikation

Die internationale Organisation for Standardisation (ISO) hat ein System zur Klassifikation von umschlossenen radioaktiven Stoffen vorgeschlagen, das inzwischen weltweit angewendet wird.

Auf die ISO-Norm aufbauend wurde die DIN-Norm 25426, Teil 1, „Umschlossene radioaktive Stoffe; Anforderungen und Klassifikation", erarbeitet. Die beiden Normen sind nahezu identisch.

Zweck dieser Normen ist es, Herstellern, Lieferanten, Anwendern und zuständigen Behörden einheitliche Kriterien zur Beurteilung der Sicherheit beim Umgang mit umschlossenen radioaktiven Stoffen zu geben.

Klassifikation der Strahler nach ihrer Beanspruchbarkeit (nach DIN 25426, Teil 1).

Klasse / Prüfung	1	2	3	4	5	6	X
Temperatur	ungeprüft	− 40 °C (20 min) und + 80 °C (1 h)	− 40 °C (20 min) und + 180 °C (1 h)	− 40 °C (20 min) und + 400 °C (1 h) und thermisches Abschrecken von 400 °C auf 20 °C	− 40 °C (20 min) und + 600 °C (1 h) und thermisches Abschrecken von 600 °C auf 20 °C	− 40 °C (20 min) und + 800 °C (1 h) und thermisches Abschrecken von 800 °C auf 20 °C	Sonderanforderung
Druck	ungeprüft	250 mbar	250 mbar und 20 bar	250 mbar und 70 bar	250 mbar und 700 bar	250 mbar und 1,7 kbar	Sonderanforderung
Schlag	ungeprüft	50 g aus 1 m Höhe	200 g aus 1 m Höhe	2 kg aus 1 m Höhe	5 kg aus 1 m Höhe	20 kg aus 1 m Höhe	Sonderanforderung
Schwingung	ungeprüft	3 mal 3 Zyklen je 10 min 25 bis 500 Hz bei 5 g Beschleunigungsamplitude	3 mal 3 Zyklen je 10 min 25 bis 50 Hz bei 5 g Beschleunigungsamplitude und 50 bis 90 Hz bei 0,32 mm Auslenkungsamplitude und 90 bis 500 Hz bei 10 g Beschleunigungsamplitude	3 mal 3 Zyklen je 30 min 25 bis 80 Hz bei 0,75 mm Auslenkungsamplitude und 80 bis 2000 Hz bei 20 g Beschleunigungsamplitude	entfällt	entfällt	Sonderanforderung
		zusätzlich 30 min bei jeder Resonanzfrequenz					
Durchstoß	ungeprüft	1 g aus 1 m Höhe	10 g aus 1 m Höhe	50 g aus 1 m Höhe	300 g aus 1 m Höhe	1 kg aus 1 m Höhe	Sonderanforderung

Die Forderung einer Klasse gilt als erfüllt, wenn die Prüflinge nach der Beanspruchung dicht geblieben sind.

Mindestanforderungen an Strahler der Aktivitätsklasse C bei normaler Verwendung (nach DIN 25426, Teil 1).

Strahleranwendung	Prüfung und Klasse der Strahler				
	Temperatur	Druck	Schlag	Schwingung	Durchstoß
Radiographie im industriellen Bereich					
ungeschützter Strahler	4	3	5	1	5
geschützter Strahler	4	3	3	1	3
Medizinischer Bereich					
Radiographie	3	2	3	1	2
Gamma-Teletherapie	5	3	5	2	4
Interstitielle und intrakavitäre Therapie	5	3	2	1	1
Kontakttherapie	4	3	3	1	2
Gamma-Meßanlagen (mittlere und hohe Energie)					
ungeschützter Strahler	4	3	3	3	3
geschützter Strahler	4	3	2	3	2
Beta-Meßanlagen, Gamma-Meßanlagen niedriger Energie und Röntgenfluoreszenzanalyse (ausgenommen radioaktive Gase enthaltende Strahler)	3	3	2	2	2
Sonden für Tiefbohrungen	5	6	5	2	2
Tragbare Feuchte- und Dichtemesser (auch Handgeräte und fahrbare Geräte)	4	3	3	3	3
Neutronenquellen (ausgenommen Strahler zum Anfahren von Reaktoren)	4	3	3	2	3
Kalibrier- und Prüfstrahler mit geringer Aktivität ($1{,}11 \cdot 10^6$ bis $3{,}7 \cdot 10^7\ s^{-1}$ (30 µCi bis 1 mCi))	2	2	2	1	2
Technische Gamma-Bestrahlung					
ungeschützter Strahler	4	3	4	2	4
geschützter Strahler	4	3	3	2	3
Ionengeneratoren (ungeschützte und geschützte Strahler)	3	2	2	1	1
Gaschromatographie	2	2	2	2	2
Elektrostatische Eliminatoren	3	2	2	2	2
Rauchdetektoren					

Prüfmethoden = Test Methods

Test Methods

I. Bubble testing (LEAK TEST)
The radiator is immersed in a suitable fluid (diethylene glycol) and the pressure in the vessel is reduced to 100 mm Hg. No bubbles must be produced.

II. Wipe testing
The casing, surface, or substantial portions of the radiator to be tested are wiped off with an absorbent material. Subsequently, the activity of the radioactive material removed is determined.

In accordance with DIN 25 426, Part 1, a radiator is considered as a rule to be tight and contamination-free when the limiting value of 5 nCi is not exceeded in the corresponding tests.

Special Form

A radioactive material in special form is a radiator which meets thermal and mech nical requirements and test methods above the usual requirements as described in the IAEA Transport Regulations.

The tests are performed by the competent authority, which then issues a corresponding certificate when the radiator meets the requirements.

The special form of a radiator can be important in the selection of a transport container; however, it is also frequently considered for evaluation of the quality of a radiator.

ISO/DIN Classification

The International Organization for Standardization (ISO) has recommended a system for th classification of sealed radioactive materials which meanwhile is employed worldwide.

Building up on the ISO Standard, the DIN Standard 25 426, Part 1, "Sealed Radioactive Ma terials, Requirements, and Classification", was prepared. Both standards are nearly ide tical.

It is the purpose of this Standard to provide uniform criteria to manufacturers, supplie users, and responsible authorities for the evaluation of safety in handling radioactive terials.

Classification of Radiators According to their Load Capacity (per DIN 25 426, Part 1).

Class / Test	1	2	3	4	5	6	x
Temperature	not tested	- 40°C (20 min) and + 80°C (1 h)	- 40°C (20 min) and + 180°C (1 h)	- 40°C (20 min) and + 400°C (1 h) and thermal quench from 400 to 20°C	- 40°C (20 min) and + 600°C (1 h) and thermal quench from 600 to 20°C	- 40°C (20 min) and + 800°C (1 h) and thermal quench from 800 to 20°C	Special requirement
Pressure	not tested	250 mbars	250 mbars and 20 bars	250 mbars and 70 bars	250 mbars and 700 bars	250 mbars and 1.7 kbars	Special requirement
Impact	not tested	50 g from 1 m ht.	200 g fr. 1 m ht.	2 kg from 1 m ht.	5 kg from 1 m ht.	20 kg fr. 1 m ht.	Special requirement
Oscillation	not tested	3 x 3 cycles every 10 min: 25-500 Hz at 5 g acceleration amplitude	3 x 3 cycles every 10 min: 25-50 Hz at 5 g acceleration amplitude and 50 to 90 Hz at 0.32 mm deflection amplitude and 90 to 500 Hz at 10 g acceleration amplitude	3 x 3 cycles every 30 min: 25-80 Hz at 0.75 mm deflection amplitude and 80 to 2000 Hz at 20 g acceleration amplitude	omitted	omitted	
		In addition: 30 min at each resonance frequency					
Puncture	not tested	1 g from 1 m ht.	10 g from 1 m ht.	50 g from 1 m ht.	300 g fr. 1 m ht.	1 kg from 1 m ht.	Special requirement

Translations from Technical and Commercial Afrikaans, Bulgarian, Czech, Danish, Dutch, French, German, Italian, Norwegian, Polish, Portuguese, Romanian, Russian, Serbo-Croatian, Slovenian, Spanish, Swedish, and Ukrainian

The requirement for a class is considered as met when the specimens have remained tight after stressing.

Minimum Requirements for Radiators of Activity Class C in Normal Use (per DIN 25 426, Part 1).

Radiator Application	Test and Class of Radiator				
	Temperature	Pressure	Impact	Oscillation	Puncture
Radiography in industrial field					
unprotected radiator	4	3	5	1	5
protected radiator	4	3	3	1	3
Medical field					
Radiography	3	2	3	1	2
Gamma-teletherapy	5	3	5	2	4
Interstitial and intra-cavity therapy	5	3	2	1	1
Contact therapy	4	3	3	1	2
Gamma measuring devices (medium- and high-energy)					
unprotected radiator	4	3	3	3	3
protected radiator	4	3	2	3	2
Beta measuring devices, low-energy gamma measuring devices, and roentgen fluorescence analysis (except radiators containing radioactive gases)	3	3	2	2	2
Probes for deep well drilling	5	6	5	2	2
Portable moisture and density meters (also manual devices and mobile devices)	4	3	3	3	3
Neutron sources (except radiators for the startup of reactors)	4	3	3	2	3
Calibration and test gauges with little activity ($1.11 \cdot 10^6$ to $3.7 \cdot 10^7 s^{-1}$) (30 µCi to 1 mCi)	2	2	2	1	2
Technical gamma radiation					
unprotected radiator	4	3	4	2	4
protected radiator	4	3	3	2	3
Ion generators (unprotected and protected radiators)	3	2	2	1	1
Gas chromatography	2	2	2	2	2
Electrostatic eliminators	3	2	2	2	2
Smoke detectors					

Physikalisch-Technische
Bundesanstalt

Abteilung VI

Gesch.-Nr. 28245.65 VI B/Ra

33 Braunschweig, Bundesallee 100
Fernsprecher: 5911, Durchwahl 3362
Fernschreiber: 0 52822 (nicht Amt)
Telegramme: Bundesanstalt Braunschweig
Fachgebiet: Braunschweig Lehndorf
Expreßgut: Braunschweig Hbf.

den 3. 3. 1966
Bearbeiter
Dipl.-Phys. Bohne

Firma
Buchler und Co.

33 Braunschweig
Frankfurter Str. 294

Betreff: ^{137}Cs-Industriepräparate nach Vz 0079, Vz 0087, Vz 0090, Vz 0091, Vz 0092; Überprüfung in Bezug auf § 44 der Ersten Strahlenschutzverordnung
Ihr Schreiben Se/sei vom 21. 10. 1965

Zur Frage der Fristen für Dichtigkeitsprüfungen an ^{137}Cs-Industriepräparaten der oben genannten Ausführungen nimmt die Physikalisch-Technische Bundesanstalt (PTB) wie folgt Stellung:

1. Aufbau der Präparate: Im Gegensatz zu früheren Ausführungen liegt bei den neuen Präparaten die aktive Substanz nicht als wasserlösliches Salz, sondern in Form kompakter Perlen aus Cäsiumglas vor (^{137}Cs als Zusatz zur Glasschmelze). Die Perlen sind doppelwandig in verschweißte Edelstahlhüllen (Stahl DIN 4541) eingeschlossen; lediglich bei Präparaten vom Typ Vz 0091 besteht die innere Hülle aus einer hartverlöteten Monelkapsel.

2. Prüfungen: Um festzustellen, in welchem Maße sich ^{137}Cs von Cäsiumglas ablösen läßt, wurden an zwei Perlen von etwa 2 mm Durchmesser, deren Aktivitäten zu 95 mCi bestimmt worden waren, in der Zeit vom 19.1. bis 25.2.1966 laufende Tauchversuche vorgenommen (26 Einzelprüfungen je Präparat). Als Immersionslösung diente eine Wasser-Methanol-Mischung (1:1) mit 100 mg Cs-Ionen je Liter. Zwischendurch wurde bei einigen Prüfungen destilliertes Wasser verwendet. Die Eintauchzeiten lagen zwischen 17 und 94 Stunden, die Temperatur betrug 20-25 °C.

Nach einem anfänglichen Abfall um nahezu zwei Größenordnungen stellte sich nach etwa 7 Tagen eine zeitlich konstante Aktivitätsabgabe ein, die bei einem der Präparate 1 µCi/Tag, beim anderen 0,1 µCi/Tag betrug. Mit destilliertem Wasser war bei beiden Präparaten die Aktivitätsabgabe um eine Größenordnung höher.

Ein fertig gefaßtes Präparat der Type Vz 0079 (Gravur Q 325, Aktivität etwa 12 mCi) wurde einem dreimaligen Schlagtest mit einer Schlagarbeit von jeweils 1,5 mkp ausgesetzt. Das Präparat war dazu auf einer Unterlage aus Weichholz bzw. Blei aufgespannt; als Schlagkörper diente eine Stahlkugel von 30 mm Radius, die frei aus über 1,5 m auf das Präparat fallen gelassen wurde. Obwohl das Präparat dabei deutlich deformiert wurde, ließ eine anschließende Wisch- und Tauchprüfung keinen Austritt radioaktiver Substanz erkennen (Nachweisgrenze 0,2 nCi).

3. Schlußfolgerungen: Durch das Einbringen des radioaktiven Stoffs in den Glasfluß wird der Austritt radioaktiver Substanz bei kleinen Undichtigkeiten merklich reduziert und die Gefahr des Verstreuens größerer Mengen bei einer groben Zerstörung vermindert. Die Frist für Wiederholungsprüfungen nach § 44 der 1. SVO kann daher auf 3 Jahre, bei besonders sicherem, festem Einbau in Meßanlagen auf 5 Jahre heraufgesetzt werden, wenn folgende Bedingungen erfüllt sind:

a) Die Glasperlen sind vor dem Einbringen in die Umhüllung gründlich zu reinigen.
b) Innerhalb von 6 Monaten vor Abgabe an den Verwender sind die Strahlenquellen auf Dichtigkeit und Kontaminationsfreiheit der Umhüllung zu prüfen. Dabei darf die Aktivität der ablösbaren Substanz 0,01 µCi nicht überschreiten. Über diese Abnahmeprüfung ist dem Verwender eine Bescheinigung mit Angabe von Gravur der Strahlenquelle, Prüfverfahren sowie Zeitpunkt und Ergebnis der Prüfung auszuhändigen.
c) Die Strahlenquellen dürfen nur bei Umgebedingungen verwendet werden, bei denen gewährleistet ist, daß die Dichtigkeit der Umhüllung erhalten bleibt.
d) Eine Dichtigkeitsprüfung ist unverzüglich dann vorzunehmen, wenn Verdacht auf Undichtigkeit besteht.

Diese Stellungnahme gilt nur für Strahlenquellen, die in ihren wesentlichen Merkmalen (physikalische und chemische Beschaffenheit des radioaktiven Stoffes, Material- und Wanddicke der Umhüllung, Art der Abdichtung und Aktivität) den bei der Bundesanstalt hinterlegten Konstruktionszeichnungen entsprechen.

Die eingereichten Prüfgegenstände können abgeholt werden.

Im Auftrage

(Dr. W.)

Anlage:
Kostenrechnung

APPENDIX 3

Physikalisch-Technische
Bundesanstalt

Abteilung 6

33 Braunschweig, den 4.7.1975
Bundesallee 100

Fernsprecher: (0531) 5921; Durchwahl über 592 3350
Fernschreiber: 952827 (ptb d)
Telegramme: Bundesphysik Braunschweig
Frankiergut: Braunschweig Hptbf. 1952
Expreßgut: Braunschweig Hbf

Gesch.-Nr. 6.3 - 10369/75

Physikalisch-Technische Bundesanstalt · 33 Braunschweig · Postfach 3345

Firma
Amersham Buchler GmbH u. Co KG
33 Braunschweig
Postfach 1120

Betreff: ^{137}Cs-Industriepräparate nach Vz 0259 und Vz 0271
Stellungnahme im Hinblick auf §44 der Ersten Strahlenschutzverordnung

Bezug: Ihr Schreiben Ku/st vom 21.3.75 mit beigefügten Konstruktionszeichnungen

Die von der Firma Amersham Buchler, Braunschweig, hergestellten ^{137}Cs-Industriepräparate nach Vz 0259 und Vz 0271 enthalten ^{137}Cs in Form von kompakten Perlen aus Cäsiumglas mit einer Aktivität von maximal 500 mCi. Ihr mechanischer Aufbau entspricht in den für die Dichtheit wesentlichen Punkten - doppelte Umhüllung aus nichtrostendem Stahl der Werkstoff-Nr. 4541, Wanddicke und Argonarc-Verschweißung - den seit 1965 gefertigten ^{137}Cs-Industriepräparaten nach Vz 0079. Der einzige Unterschied besteht in der Art der Halterung.

Die Stellungnahme der Phys.-Techn. Bundesanstalt vom 3.3.1966, Gesch.-Nr.: 28245.65 VI B/Ra wird daher hiermit auf ^{137}Cs-Industriepräparate nach Vz 0259 und Vz 0271 ausgedehnt. Sie wird gleichzeitig dahingehend abgeändert, daß bei besonders sicherem festem Einbau der Präparate in Meßanlagen auf Wiederholungsprüfungen verzichtet werden kann (bisher Prüffrist von 5 Jahren). Hierunter ist ein Einbau zu verstehen, bei dem das Präparat gegen Stoß, Druck und Abrieb geschützt ist und das Eindringen von agressiven Dämpfen, Feuchtigkeit und Staub verhindert wird. Die Strahlenaustrittsöffnung der Anlage muß mit einer Metallplatte verschlossen sein, deren Unversehrtheit leicht kontrolliert werden kann.

Im Auftrage

(Prof.Dr.H.H.Weiß)

702/77/R200

Physikalisch-Technische
Bundesanstalt

Abteilung 6

Physikalisch-Technische Bundesanstalt · 33 Braunschweig · Postfach 3345

33 Braunschweig, Bundesallee 100

Fernsprecher: (0531) *5921; Durchwahl über 592 3360
Fernschreiber: 9-52822 (ptb d)
Telegramme: Bundesphysik Braunschweig
Frachtgut: Braunschweig-Hgbf. 1957
Expreßgut: Braunschweig-Hbf.

den 8.11.1978

Gesch.-Nr. 6.31-8785/78

Firma
Isocommerz GmbH
Lindenberger Weg 70

DDR 1115 Berlin-Buch

Betreff: Stellungnahme zu radioaktiven Strahlenquellen der Type H und I
Bezug: Antrag vom 27.2.1978 mit Anlagen
Schreiben vom 9.6.1978, 121-El/Lau, mit Anlagen

Die nachfolgende Stellungnahme bezieht sich nur auf die Sicherheit der Strahlenquellen gegen einen möglichen Austritt radioaktiver Substanz; Fragen des Strahlenschutzes gegen Bestrahlung von außen durch die austretende Gammastrahlung werden nicht behandelt.

1.) Allgemeine Angaben

Hersteller: Akademie der Wissenschaften der DDR
Zentralinstitut für Isotopen- und Strahlenforschung - Bereich Strahlenquellen und Nuklearpharmaka
Lindenberger Weg 70
DDR 1115 Berlin-Buch

Radioaktiver Stoff: Typ H ^{137}Cs max. 500 mCi
Typ I ^{60}Co max. 500 mCi

2.) Radioaktiver Inhalt

Typ H bis 100 mCi ^{137}Cs: Das ^{137}Cs ist Bestandteil eines bei 1000°C getemperten Keramikzylinders von 3 mm Durchmesser und 3 mm Höhe.
Vom Hersteller an ungekapselten Keramikzylindern durchgeführte Auslaugversuche ergaben für eine 48-stündige Lagerung in unbewegtem Wasser von Zimmertemperatur eine Ablösung von weniger als 10-4 der Gesamtaktivität, sodaß der radioaktive Inhalt als "gering extrahierbar" im Sinne von DIN 25 426 Teil 1 (identisch mit ISO/DIS 2919.2, Februar 1975) anzusehen ist.

Typ H, 100 bis 500 mCi ^{137}Cs: Das ^{137}Cs ist Bestandteil einer Glasperle von 3 mm Durchmesser.
Auslaugversuche ergaben hier, bezogen auf eine 48-stündige Wasserlagerung, eine Ablösung von etwa $4 \cdot 10^{-3}$ der Gesamtaktivität. Der radioaktive Inhalt ist in diesem Falle nicht mehr als "gering extrahierbar" anzusprechen.

-2-

Da jedoch die maximale Aktivität weit unter dem Grenzwert von 30 Ci (Toxizitätsgruppe 2) liegt, sind die Bedingungen für die Aktivitätsklasse C nach DIN 25 426 Teil 1 erfüllt.

Typ I bis 500 mCi ^{60}Co: Der radioaktive Stoff liegt in fester, kompakter Form als vernickelter Co-Metallzylinder von 3 mm Durchmesser und 3 mm Höhe vor.

3.) Umhüllung

Die Umhüllung ist bei beiden Strahlertypen (H und I) identisch. Ihr Aufbau geht aus den eingereichten Konstruktionszeichnungen Nr. 6.134.01(3) vom 23.2.1978 und 6.149.01(4) vom 23.2.1978 hervor. Der radioaktive Stoff ist doppelwandig eingeschlossen. Die innere Hülle besteht aus einer stirnseitig verschweißten Edelstahlkapsel (Stahl X8 CrNiTi 18.10) von 4 mm Durchmesser, 6 mm Höhe und einer Wanddicke von 0,4 mm. Die aus dem gleichen Material gefertigte äußere Kapsel hat einen Durchmesser von 6,4 mm und eine Gesamtlänge - einschließlich des Halterungnippels - von 15,9 mm. Sie ist ebenfalls stirnseitig verschweißt. Die geringste Wanddicke der äußeren Hülle beträgt an der versenkten Stirnfläche 0,3 mm.

Aus Belastungsversuchen nach ISO/DIS 2919, die vom Hersteller an einem vergleichbaren Quellentyp vorgenommen wurden, läßt sich für die oben beschriebenen Strahlenquellen vom Typ H und I die Klasse

ISO/C 65344

ableiten, die für den vorgesehenen Einsatz in Gamma-Meßanlagen ausreichend ist.

4.) Folgerungen

Beide Hüllen sind nach der Fertigung gründlich zu reinigen und einzeln auf Dichtheit zu prüfen. Die Oberfläche der äußeren Hülle ist auf ausreichende Dekontamination zu prüfen. Liegt die ablösbare Aktivität unterhalb von 185 Bq (5nCi), so gilt der betreffende Strahler als umschlossener radioaktiver Stoff im Sinne von Anlage I der StrlSchV. vom 13. Okt. 1976.

Ist der Strahler fest in eine Meß- oder Regelanlage eingebaut und sind die Bedingungen des Abschn. 4.4.4 der"Richtlinien über Prüffristen bei Dichtheitsprüfungen an umschlossenen radioaktiven Stoffen vom 15. Juni 1976" erfüllt, so kann nach einer ersten Überprüfung durch eine behördlich bestimmte Prüfstelle nach zwölfmonatiger betriebsmäßiger Verwendung auf weitere Dichtheitsprüfungen verzichtet werden, wenn sich bei der Erstprüfung keine Einwirkungen feststellen ließen, die ein Undichtwerden des Strahlers befürchten lassen.

Die Kosten für die Stellungnahme sind durch die geleistete Vorauszahlung abgegolten.

Im Auftrag

(Prof. Dr. H.M. Weiß)

Translation of letter of

PHYSIKALISCH-TECHNISCHE BUNDESANSTALT
Department 6, Braunschweig

Messrs.
Buchler & Co.

3300 Braunschweig
Frankfurter Str. 294

D-33 Braunschweig
3rd March, 1966

No. 28245.65 VI B/Ra

Re.: Cs-137 industry sources according to Vz 0079, Vz 0087, Vz 0090, Vz 0091, Vz 0092;
Examination in respect to § 44 of the Erste Strahlenschutzverordnung,
Your letter Se/sei of October 21, 1965

As regards the question of terms for seal-testings at Cs-137 industry sources of the above models, the Physikalisch-Technische Bundesanstalt (PTB) says as follows :

1. Source Construction

Compared with former models the new models have the active substance not as water-soluble salt but in the form of compact pearls out of Caesium-glass (Cs-137 as addition to the glass smelt). The pearls are enclosed into welded stainless steel coatings (steel DIN 4541) with double walls; only with sources of type Vz 0091 the internal covering is consisting of a hard soldered Monel capsule.

2. Examinations

From 19.1. till 25.2.1966 continuous immersion tests have been undertaken at two pearls of approx. 2 mm Ø whose activities had been destinated to 95 mCi, in order to find out the Cs-137 separation capacity from Caesium glass (26 separate tests per source). A water-methanol-mixture (1:1) with 100 mg Cs-ions per 1 have served as immersion solution. In between distilled water was used with some tests. Immersion times have been between 17 and 94 hours, temperature was 20-25°C.
After a beginning decay by nearly two dimensions, a timely constant activity emission happened after about 7 days, being 1 /uCi/day with one of the sources and 0,1 /uCi/day with the other. At both sources the activity was by one dimension higher with distilled water.

A ready-made source of type Vz 0079 (engraving Q 325, activity about 12 mCi) was set out 3 times to a blow test, each blow being 1,5 mkp. For this test the source was fastened on a ground of soft wood or lead; the blow subject was a steel bowl of 30 mm radius, which fell down freely from 1,5 m on the source. Although the source has been remarkably deformed the following wipe and immersion test did not indicate any coming out radioactive substance (indication limit 0,2 nCi).

3. Final Decisions

By bringing the radioactive substance into the glass smelt the radioactive substance flowing off small leaks is noticeable reduced and the danger of loosing larger quantities at a rough damage is reduced. Terms for repeated tests according to § 44 of the 1. SVO can therefore be set to 3 years, and - with an especially secure firm mounting into measuring equipments - to 5 years, if the following conditions are fulfilled :

a) The glass pearls must be thoroughly cleaned before coming into the coating.

b) Within 6 months before handling them to the applicant the covering of the sources must be examinated on leakage and contamination. The activity of the substance may not exceed 0,01 uCi. The applicant must receive a certificate containing the engraving of the source, examination method as well as date and result of the test.

c) The sources may only be applicated with environmental conditions, granting the covering to be free of leakage.

d) A seal-test must be effected without delay when there is suspicion on leakage.

This statement is only for sources which correspond to the construction drawings at the Bundesanstalt in its essential features (physical and chemical condition of the radioactive substance, material- and wall thickness of the covering, kind of sealing and activity).

The handed in test subjects can be picked up.

By order

(Dr. Weiss)

Enclosure
bill of costs

Translation of letter of

PHYSIKALISCH-TECHNISCHE BUNDESANSTALT
Department 6, Braunschweig

Amersham Buchler
GmbH & Co. KG

P. O. Box 1120
D-33 Braunschweig

D-33 Braunschweig
4th July, 1975

No. 6.3 - 10369/75

Re.: Cs-137 industry sources according to Vz 0259 and Vz 0271; Reference in respect to §44 of the Erste Strahlenschutzverordnung

Ref.: Your letter Ku/st dated 21/03/75 with enclosed construction drawings

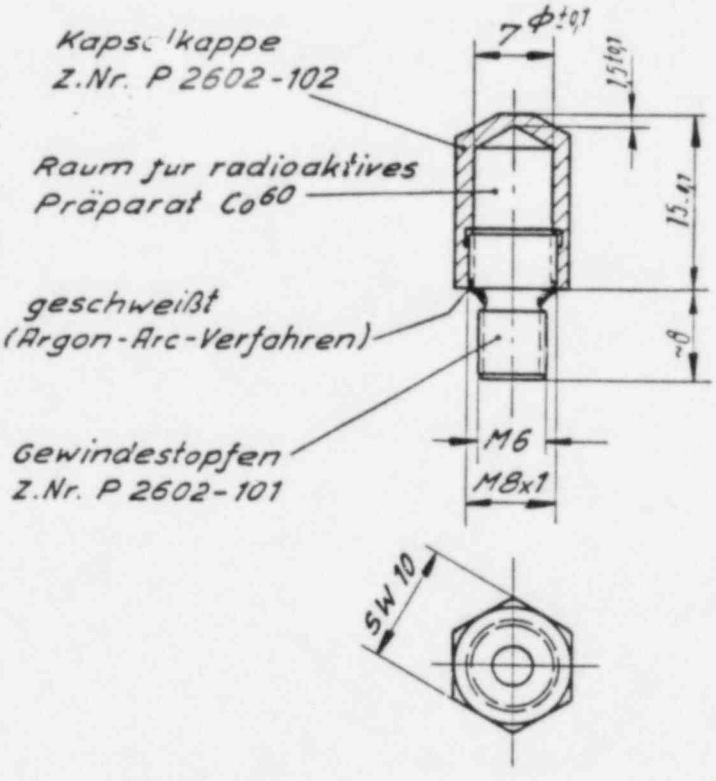
The Cs-137 industry sources manufactured by Messrs. Amersham Buchler, Braunschweig, according to Vz 0259 and Vz 0271 are containing Cs-137 in the form of compact pearls out of Caesium-glass with an activity of max. 500 mCi. In its mechanics it corresponds in the essential points for the tightness - double coating out of stainless steel of material no. 4541, wall thickness and Argon-Arc welding - to the Cs-137 industry sources according to Vz 0079 manufactured since 1965. The only difference lies in the kind of clamping device.

The reference of the Physikalisch.Technische Bundesanstalt of 03/03/66, No. 28245.65 VI B/Ra hence is extended to the Cs-137 industry sources according to Vz 0259 and Vz 0271. At the same time it is altered, that repeat examinations may be renounced when the sources are especially secure and fixed mounted into the measuring equipments (examination period 5 years up till now). Here, a mounting must be understood, protecting the source against shocks, pressure and corrosion, and where penetration of aggressive vapours, moisture and dust is avoided. The radiation output opening of the equipment must be closed with a metal plate, whose integrity may be easily controlled.

By order

(Prof. Dr. H. M. Weiss)

	MW	Cob	G	M
	ZW	EW	P	L



entspricht Z.Nr. A 61208-1

	Werkstoff Nr. 1.4541 oder 1.4571 Rd Toleranzen n. DIN 671		
	Sonderbearb. 6 KI Toleranzen n. DIN 7168		
	Maße ohne Toleranzangabe DIN 7168 m		
	Diese Maße werden besonders geprüft	Paßmaß / Abmaße	verw. bei
	Laboratorium Prof. Dr. Berthold Wildbad / Schwarzwald	Tag	Name
		gez. 1.3.61	Fäßler
		gepr.	
Ausgabe / Änderung / Tag / Name: a) div. Änderungen 28.11.61			

Maßstab		Zeichn.-Nr.
2:1	Strahlerkapsel für ^{60}Co	P 2602 – 100

Basis of this standard is the USA Standard "Classification of sealed radioactive sources"[1]), the ISO Standard "Sealed radioactive sources - Classification"[2]) deriving therefrom, as well as the ISO Standard "Sealed radioactive sources - General"[3]).

Classification as "special form radioactive material" per IAEA[4])- "Safety Standard Regulations for the safe transport of radioactive materials"[5]) or as similarly defined "highly safe radiator" per DIN 54 115 Part 2[6]) calls for slightly differing test methods.

Contents

1 Scope

The rules of this standard apply to the manufacture and use of sealed radioactive sources.

Excepted are sealed radioactive sources used in nuclear reactors (e.g., fuel elements, neutron sources for startup) and other sealed radioactive sources for which special regulations apply (e.g., radionuclide batteries, tritium gas light sources).

2 Purpose

It is the purpose of this standard to provide manufacturers, suppliers, users, and responsible authorities with uniform criteria for the evaluation of safety in dealing with sealed radioactive sources. For this purpose, sealed radioactive sources are classified in accordance with their radioactive content, physico-chemical condition, and thermal and mechanical load capacity.

3 Definitions

3.1 Sealed radioactive source

A sealed radioactive source (hereinafter designated as "radiator") in the sense of this standard is a component in which the radioactive material is continuously enclosed by an all-around tight, rigid, inactive casing or is so embedded in rigid, inactive material that an escape of radioactive material is safely prevented under ordinary operating load. A dimension must amount to at least 0.5 cm.

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1) ANSI N5.10-1968
2) Currently ISO/DIS 2919.2 as of February, 1975
3) Currently ISO/DIS 1677.3 as of October, 1975
4) International Atomic Energy Agency
5) Safety Series No. 6, 1967 Edition or 1973 Revised Edition
6) Currently being revised

Continued on pages 2-6

Standards Committee - Nuclear Engineering (NKe) in DIN
Standards Committee - Radiology (NAR) in DIN
Specialty Standards Committee - Material Testing (FNM) in DIN

3.2 Casing

A casing is the tight enclosure of the radioactive material which cannot be opened without its destruction.

3.3 Shielded Radiator

A shielded radiator is a radiator which even during use remains constantly in a device protecting it against external effects.

3.4 Unshielded radiator

An unshielded radiator is a radiator which is not constantly surrounded by a device protecting it against external effects or in which essential parts of the protective device are removed during use.

3.5 Type sample

A type sample is an example of a type which serves as a sample for the manufacture of all radiators of the same type.

3.6 Substitute sample

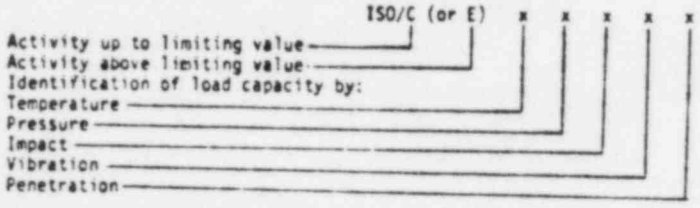
A substitute sample is an example similar in design and manufacture of a type which, however, instead of the proposed radioactive material, contains an inactive or considerably less active material which corresponds to it in other physical and chemical properties to the extent practicable.

3.7 Type testing

Type testing is the testing of type samples or substitute samples before radiators of this type have been placed in use.

4 Classification

The class in which a radiator is to be classified is identified by the symbol ISO with a subsequent letter and five figures. The letter denotes Activity Class per Table 2. The figures denote load capacity per Table 3, in which larger numbers correspond to higher requirements.



According to Appendix A, ISO/C 43515, for example, would denote a radiator which is suitable in unshielded condition for industrial radiography.

If the radiator also meets the requirements for "special form radioactive material" per IAEA "Regulations for the safe transport of radioactive materials[5]) or for similarly defined "highly safe radiators" per DIN 54115 Part 2[6]), this can be so identified by the appended letter S.

5 Arrangement by activity and load capacity (classifying)

5.1 Classification methods

5.1.1 The manufacturer first determines the Activity Class (C or E) with regard to toxicity of the radionuclide in accordance with Table 1, as well as the extractability or reaction possibility of the radioactive content in the physical and chemical form to be employed with its proposed dimensions in accordance with Table 2. Radionuclides not listed in Table 1 are to be classified in accordance with their free limits according to the Radiation Protection Regulation. Activity at the time of manufacture is governing.

Table 1. Classification of radionuclides frequently used in radiators according to their toxicity (excerpted from ICRP[7]) Publication No. 5 and IAEA Technical Report No. 15)

Group 1 Very high toxicity; free limits: $3.7 \cdot 10^3 s^{-1}$ (10^{-7} Ci) ^{241}Am, ^{252}Cf, ^{210}Pb, ^{210}Po, ^{238}Pu, ^{239}Pu, ^{226}Ra, ^{228}Th
Group 2 High toxicity; free limits: $3.7 \cdot 10^4 s^{-1}$ (10^{-6} Ci) ^{110m}Ag, ^{210}Bi, ^{144}Ce, ^{36}Cl, ^{60}Co, ^{134}Cs, ^{137}Cs, ^{152}Eu, ^{192}Ir, ^{54}Mn, ^{22}Na, ^{106}Ru, ^{124}Sb, ^{125}Sb, ^{46}Sc, ^{89}Sr, ^{182}Ta, ^{204}Tl, ^{170}Tm
Group 3 Medium toxicity; free limits: $3.7 \cdot 10^5 s^{-1}$ (10^{-5} Ci) ^{198}Au, ^{14}C, ^{109}Cd, ^{57}Co, ^{58}Co, ^{55}Fe, ^{95}Nb, ^{63}Ni, ^{147}Pm, ^{113}Sn, ^{65}Zn
Group 4 Low toxicity; free limits: $3.7 \cdot 10^6 s^{-1}$ (10^{-4} Ci) ^{3}H, ^{85}Kr

Table 2. Upper limiting values for Activity Class C[8])

Toxicity group per Table 1	Limiting value of activity	
	Extractable (1) or reactive (3)	Slightly extractable (2) or slightly reactive (4)
1	$1.11 \cdot 10^{10} s^{-1}$ (0.3 Ci)	$1.11 \cdot 10^{11} s^{-1}$ (3 Ci)
2	$1.11 \cdot 10^{12} s^{-1}$ (30 Ci)	$1.11 \cdot 10^{13} s^{-1}$ (300 Ci)
3	$1.11 \cdot 10^{13} s^{-1}$ (300 Ci)	$1.11 \cdot 10^{14} s^{-1}$ (3000 Ci)
4	$1.85 \cdot 10^{13} s^{-1}$ (500 Ci)	$1.85 \cdot 10^{14} s^{-1}$ (5000 Ci)

(1) Extractable means elimination of more than 10^{-4} of the total activity in at least 100 m³ of still water at 20°C in 48 h. Powdery materials are equated to the extractable.

(2) Slightly extractable means elimination of less than 10^{-4} of the total activity in at least 100 ml of still water at 20°C in 48 h.

(3) Reactive means reactive in air or water (e.g., the metals Na, K, U, Cs).

(4) Slightly reactive means not reactive in air or water (e.g., noble metals).

5) and 6) See Page 1.

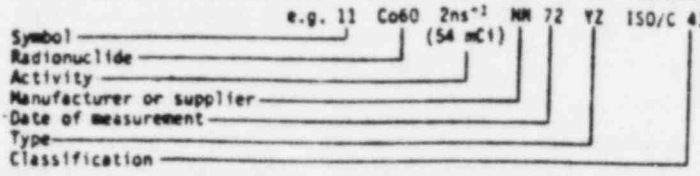
7) International Commission on Radiological Protection.

5.1.2 Then, the manufacturer determines the load capacity of the radiator by temperature, pressure, impact, vibration, and penetration in accordance with Table 3.

5.2 Identification and cover letter (certificate)

5.2.1 The radiator must be clearly identifiable by identification (e.g., engraved serial number) durably attached by the manufacturer if its dimensions and load capacity in accordance with its classification permit this.

Insofar as possible, the radiator identification should include additional information, arranged by importance:



Note on units of measurement. The following is valid by Resolution of the 15th General Conference for Measurement and Weight of June 2, 1975: 1 Becquerel (Bq) = 1 s^{-1}; for the stated example: 2 ns^{-1} = 2 · $10^9 s^{-1}$ = 2 GBq = 54 mCi.

5.2.2 A cover document (certificate) on which, in addition, the information deemed necessary per Section 5.2.1 must be restated.

a) Description of radioactive content

Activity in neutron emission source strength (identified in each case as nominal value or measured value) and target material, chemical and physical form, radioactive impurities if applicable, mass or volume, dimensions if applicable

b) Description of casing

Dimensions, materials, type of sealing, if applicable area, material, and thickness of outlet window

c) Dose rate in a defined interval (e.g., 0.1 m)

d) Date, method, and results of acceptance test on contamination freedom and tightness[9])

e) Information on maximum allowable temperature in continuous operation and on special corrosion sensitivity, if applicable, instructions for cleaning and sterilization

f) In case tests with special requirements (Class X) or special tests take place: basis, method, and results

g) Instructions for transport, e.g., license as "special form radioactive material"

5.3 Selection of requirements

According to the intended purpose, the requirements on load capacity of the radiator may be taken from Table 3.

6 General data for type tests

6.1 Prerequisites for tests

Each individual test for classification of a radiator per Table 3 must be performed on at least two specimens (type samples or substitute samples). For each test, new specimens may be used. In case identification is provided for mass production, corresponding marking of the specimens must take place before loading, in which figures that cannot be determined before classification may be replaced by general symbols. Shielded radiators must be tested without their protective devices. All tests, other than temperature tests, must be conducted at normal ambient temperature.

Other test methods may be employed when their equivalence has been demonstrated. The classification may also be inferred from corresponding test results on comparable specimens.

6.2 Evaluation of tests

The requirement of a class is considered to be met when the specimens have remained tight under load. With multiple enclosure of a radiator, it is sufficient when at least one casing has remained tight under load.

7 Test methods

7.1 Temperature test

7.1.1 Slow temperature changes

7.1.1.1 Test method

The specimens are to be brought to the test temperature within the time intervals indicated in Table 4 and maintained at this temperature for at least the time intervals prescribed in Table 3; then, they must gradually reassume the ambient temperature in air.

Table 4. Maximum allowable time interval up to attainment of test temperature

Test temperature, °C	-40	80	180	400	600	800
Time interval, min	45	5	10	25	40	70

7.1.1.2 Requirements on test device

The chamber for cooling or heating the specimens must be at least five times as large as the volume of the specimens.

Heating tests must be performed in air; low-temperature test may be performed in a CO_2 atmosphere. In ovens fired with oil or gas, an oxidizing atmosphere must be maintained constantly.

7.1.2 Thermal quenching

7.1.2.1 Test method

The specimens are to be heated to the test temperature according to Section 7.1.1.1 and maintained at this temperature for at least 15 minutes. Then they must be immersed within 15 seconds in water with a maximum temperature of 20°C.

Either new specimens or those used in the temperature test per Section 7.1.1 may be used.

7.1.2.2 Requirements on test device

The water in the immersion bath must either flow with a velocity of at least ten times the radiator volume per minute or, if it is still, must have at least twenty times the radiator volume.

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[9]) An additional part of DIN 25 426 on suitable test methods with the data of tightness criteria, coordinated with ISO Technical Report 4826, "Sealed radioactive sources - leak test methods", is being prepared.

Table 3. Classification of radiators according to their load capacity

Class / Test	1	2	3	4	5	6	X
Temperature	not tested	-40°C(20 min) and +80°C(1 h)	-40°C(20 min) and +180°C(1 h)	-40°C(20 min) and +400°C(1 h) and thermal quench from 400 to 20°C	-40°C(20 min) and +600°C(1 h) and thermal quench from 600 to 20°C	-40°C(20 min) and +800°C(1 h) and thermal quench from 800 to 20°C	special requirement
Pressure	not tested	250 mbars	250 mbars and 20 bars	250 mbars and 70 bars	250 mbars and 700 bars	250 mbars and 1.7 kbars	special requirement
Impact	not tested	50 g from 1 m height	200 g from 1 m height	2 kg from 1 m height	5 kg from 1 m height	20 kg from 1 m height	special requirement
Vibration	not tested	3 x 3 cycles every 10 min: 25-500 Hz at 5 g acceleration amplitude	3 x 3 cycles every 10 min: 25-50 Hz at 5 g acceleration amplitude and 50-90 Hz at 0.32 mm deflection amplitude and 90-500 Hz at 10 g acceleration amplitude	3 x 3 cycles every 30 min: 25-80 Hz at 0.75 mm deflection amplitude and 80-2000 Hz at 20 g acceleration amplitude	omitted	omitted	special requirement
		in addition:	30 min at each resonant frequency				
Penetration	not tested	1 g from 1 m height	10 g from 1 m height	50 g from 1 m height	300 g from 1 m height	1 kg from 1 m height	special requirement

7.2 Pressure test

7.2.1 Test method

The specimens are to be subjected twice successively to the prescribed test pressure for a duration of 5 minutes at a time in a test chamber. Between the two pressure loadings, the test chamber is to be brought to atmospheric pressure.

7.2.2 Requirements on test device

The vacuum test must take place in air. The pressure test for Classes 3 to 6 must take place hydraulically; in these cases, the specimen must be surrounded by water.

7.3 Impact test

7.3.1 Test method

The specimen is to be laid on an impact plate so that it sustains the maximum damage in the impact of the hammer (e.g., a cylindrical falling body) falling from 1 m height. The height of fall is the distance between the upper side of the specimen lying on the impact plate and the underside of the hammer in the tripping position.

The weight of the hammer is to be selected in accordance with Table 3.

7.3.2 Requirements on test device

The hammer must have a suspension device above and a flat impact surface of steel of 25 mm diameter with a rounded edge of 3 mm radius of curvature beneath. Suspension point, center of gravity of the hammer, and center of the impact surface must lie on one axis.

The impact plate of steel must have at least ten times the weight of the hammer and be rigidly anchored so that it is not moved appreciably by the impact of the hammer. Its flat, horizontal surface must be large enough to encompass the entire radiator.

7.4 Vibration test

Each specimen is to be stimulated to forced vibrations by a vibration transmitter with which it - with respect to any mountings - is to be rigidly connected by means of a suitable clamping device successively along three axes standing perpendicular to each other.

For the test for Classes 2 and 3, the frequency cycle must be passed through three times after each clamping from the minimum to the maximum and back with uniform time frequency change within at least 10 minutes. For the test for

Class 4, the duration has to amount to a frequency cycle of at least 30 minutes. In addition, for all classes, it must be maintained for 30 minutes at each established resonant frequency.

7.5 Penetration test

7.5.1 Test method

Each specimen is to be laid on an impact plate so that it sustains the maximum possible damage in the impact of the hammer (which ends below with a pin) falling from 1 m height. With several equally sensitive points, the test is to be performed on each.

The height of fall is the distance between the upper side of the specimen lying on the impact plate and the lower end of the pin in the tripping position of the hammer.

The weight of the hammer is to be selected in accordance with Table 3.

7.5.2 Requirements on test device

The hammer must have a suspension device above and a rigidly mounted pin beneath. This pin must have a free length of 6 mm, a diameter of 3 mm, and a hemispherical underside and consist of a material with a Rockwell hardness between C50 and C60. Its axis must pass through the center of gravity and the suspension point of the hammer.

The impact plate of hardened steel must have at least ten times the weight of the hammer and be rigidly mounted. The contact area between specimen and impact plate must be so large that it is not deformed by the impact. If necessary, a mounting of suitable form may be attached between specimen and impact plate.

Should the dimensions of the radiator to be tested not permit the desired free fall of the corresponding hammer, the hammer can be linked to the impact point by a suitable guide, which must not appreciably hinder its fall.

Quality control in mass production

The manufacturer must assure, by suitable quality control during manufacture, that all examples of a type correspond to the classified type sample. In particular, the manufacturer must test each finished radiator as to contamination freedom and tightness[9]).

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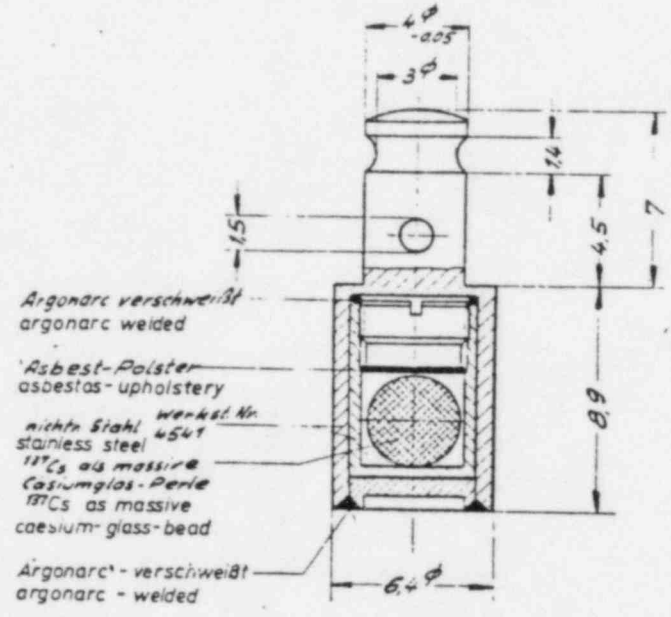
[9]) See Page 3.

Appendix A

the following tables, taken over essentially unchanged from ISO/DIS 2919.2, examples are listed for minimum requirements on radiators of Activity Class C for some typical applications. For shielded radiators, the additional protective device is thereby taken into account.

The test conditions corresponding to these minimum requirements cover normal radiator application, including possible minor incidents in handling and use. For application at constant high temperatures, under the influence of aggressive substances, and increased probability of fire and explosion, as well as in each use of radiators of Activity Class E, supplier, user, and responsible authorities must critically evaluate these special risks. This can lead to increased requirements and possibly to special tests or additional safety measures. Also for the case of anticipated special mechanical loadings, e.g., in bending with needle-shaped radiators, additional suitable special tests may be called for.

Radiator Application	Test and Class of Radiator				
	Temperature	Pressure	Impact	Vibration	Penetration
Radiography in industrial applications					
unshielded radiator	4	3	5	1	5
shielded radiator	4	3	3	1	3
Medical applications					
Radiography	3	2	3	1	2
ma teletherapy	5	3	5	2	4
cerstitial and intra-cavity therapy	5	3	2	1	1
ntact therapy	4	3	3	1	2
Gamma measuring devices (medium- and high-energy)					
unshielded radiator	4	3	3	3	3
shielded radiator	4	3	2	3	2
Beta measuring devices, low-energy gamma measuring devices, and roentgen fluorescence analysis (except radiators containing radioactive gases)	3	3	2	2	2
Probes for deep well drilling	5	6	5	2	2
table moisture and density meters (also manual and mobile devices)	4	3	3	3	3
Neutron sources (except radiators for startup of reactors)	4	3	3	2	3
Calibration and test gauges with low activity ($1.11 \cdot 10^6$ to $3.7 \cdot 10^7 s^{-1}$) (30 µCi to 1 mCi)	2	2	2	1	2
chnical gamma radiation					
shielded radiator	4	3	4	2	4
elded radiator	4	3	3	2	3
Ion generators (shielded and unshielded radiators)					
Gas chromatography	3	2	2	1	1
Electrostatic eliminators	2	2	2	2	2
Smoke detectors	3	2	2	2	2



Beschreibung der Hülle:
Bauartbeschreibung: doppelt umschlossen
Material: Innen- und Außenkapsel Edelstahl W.Nr.4541
Wanddicke: Innenkapsel: 0,5 mm
Außenkapsel: 0,65 mm
Art der Abdichtung: Argonare-verschweißt

Entspricht Buchler u. Co-Ausführ. VZ-0079 bzw. IN-0.79/1-S

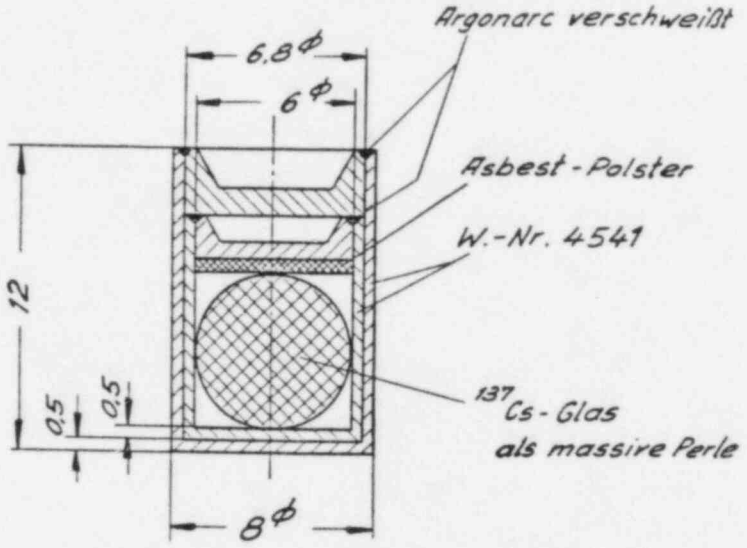
Laboratorium Prof. Dr. Berthold
Wildbad im Schwarzwald

Maßstab 5:1

137Cs-Industrie-Punktstrahler bis 500mCi
Industrial - Point source to 500 mCi

Zeichnung Nr. P 2623 - 100

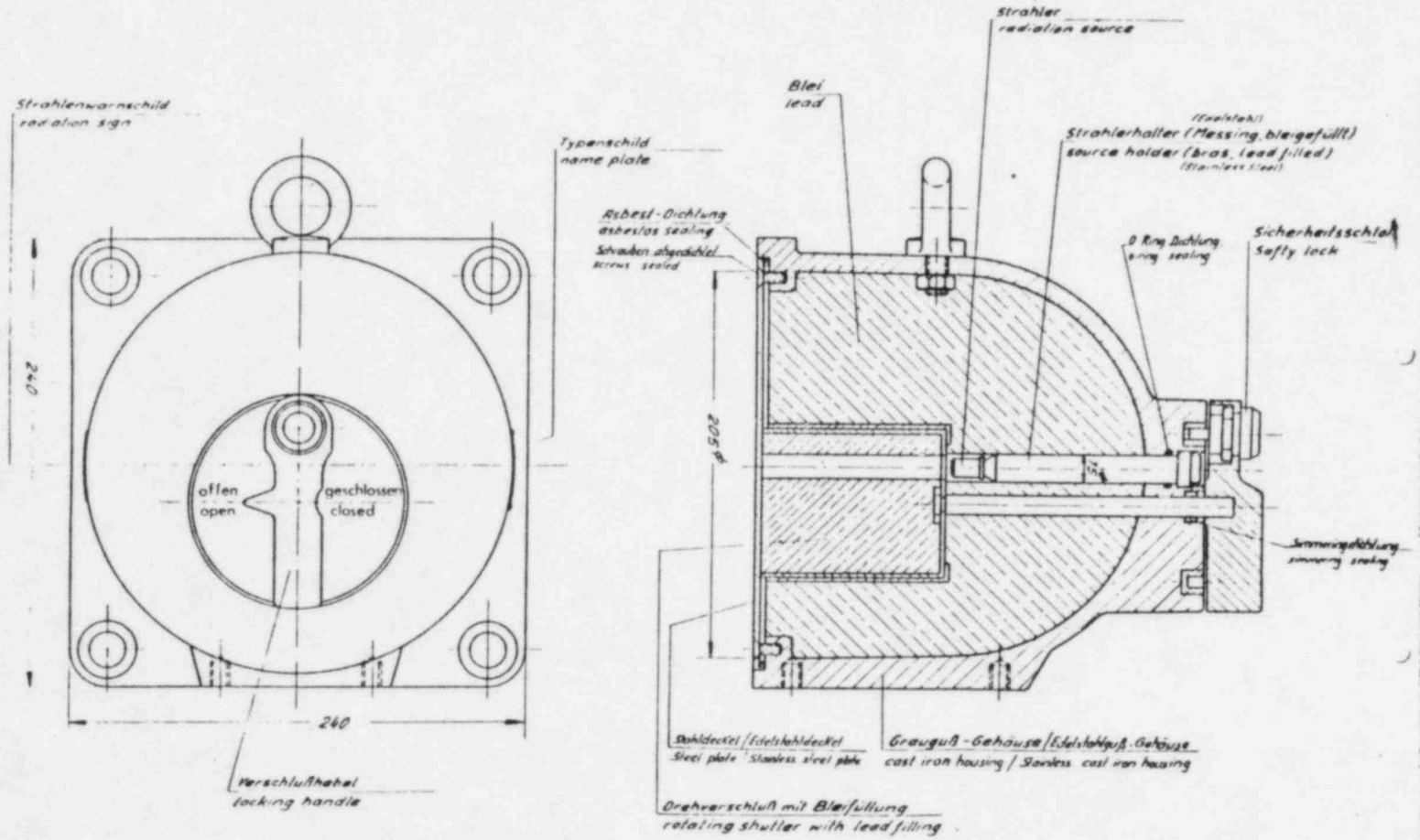
	MW	CAb	G	M
	ZW	EW	P	L



Entspricht Buchler-Ausführung IND 92/Cs Bzw. VZ 0092

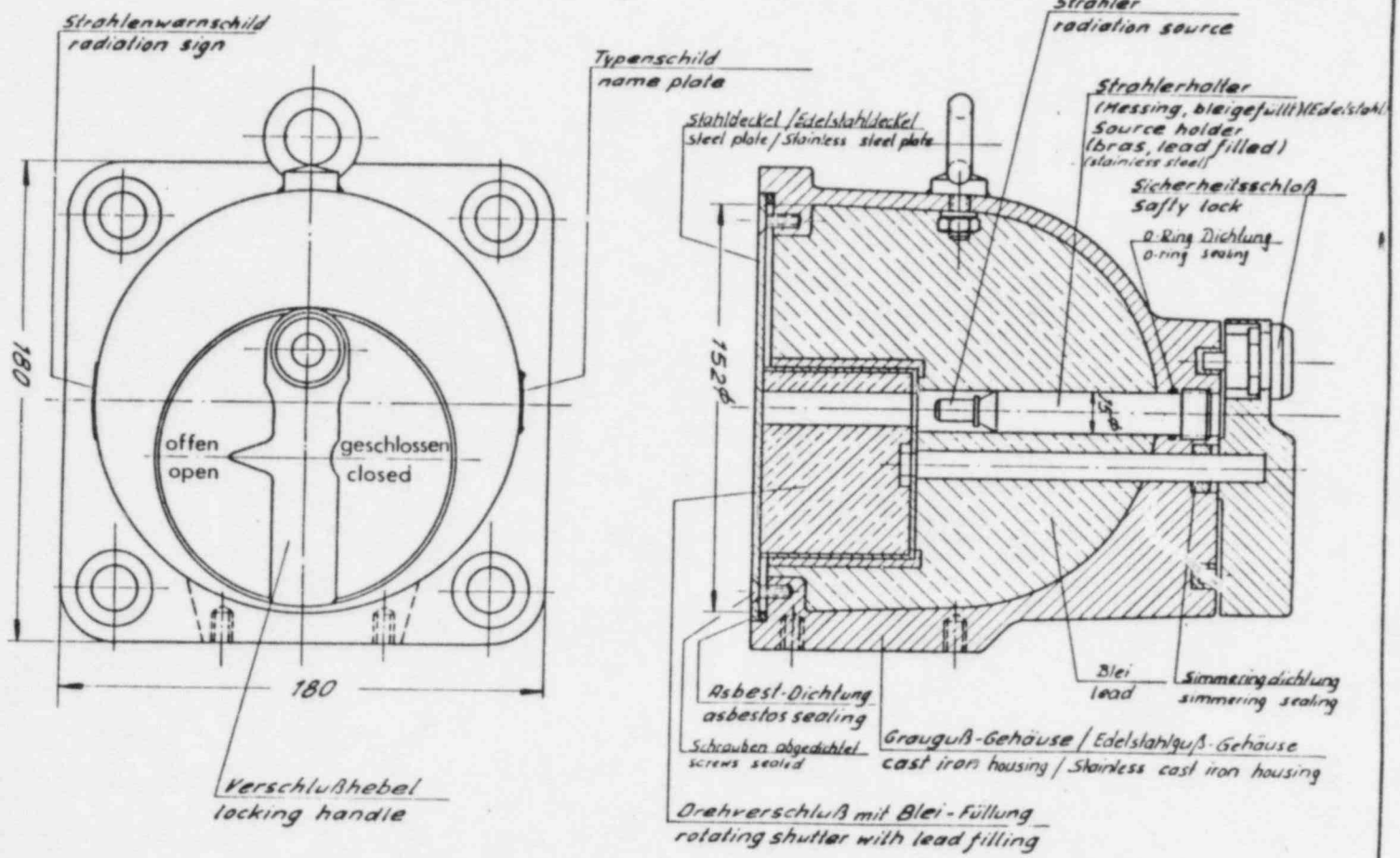
Ausgabe	Änderung	Tag	Name	Werkstoff	
				Sonderbearb.	
				Maße ohne Toleranzangabe	
				Diese Maße werden besonders geprüft	Paßmaß / Abmaße / verw. bei
				Laboratorium Prof. Dr. Berthold Wildbad / Schwarzwald	Tag / Name
					gez. 20.5.74
					gepr.

Maßstab		Zeichn.-Nr.
5:1	137 Cs - Industrie - Strahler 1-3 Ci	2645.100-000



Abschirmbehälter
SHIELDING CONTAINER LB 7462 FZ 2157-002

Gewicht / weight ≈ 81 kg



Abschirmbehälter
SHIELDING CONTAINER LB 7440

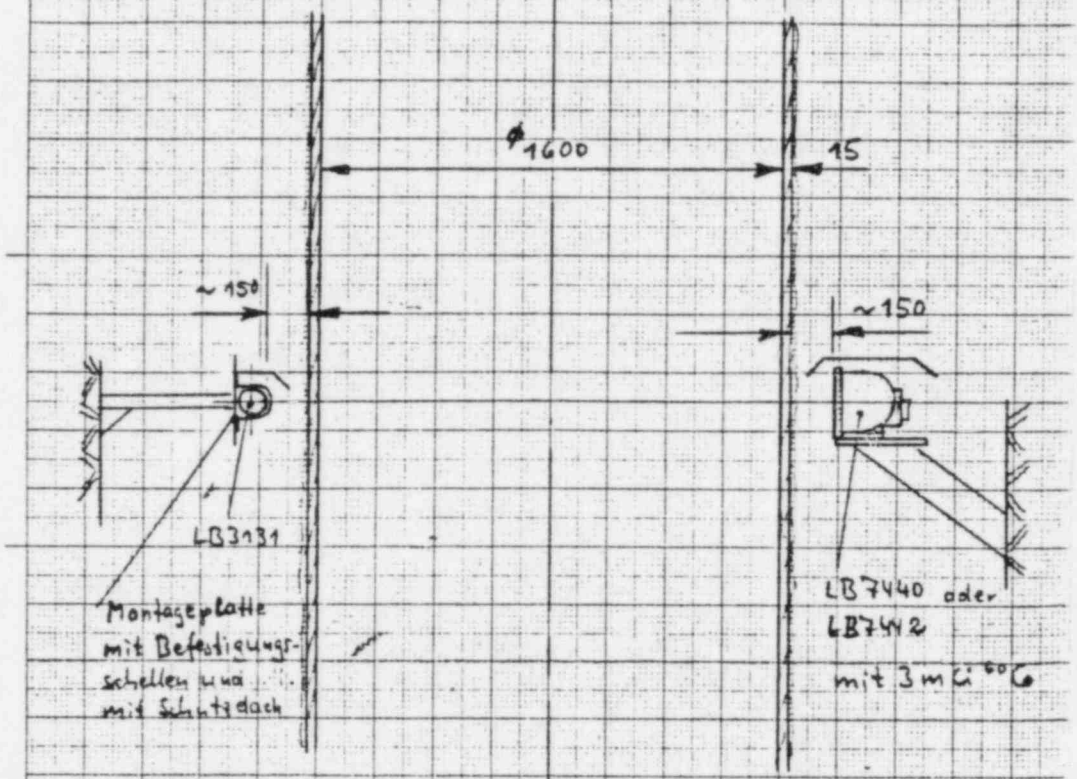
Gewicht
weight ≈ 31 Kg

Zeichn.-Nr.
PB 2199-002

7547 Wildbad / Schwarzw.

M 1:20

APPENDIX 6



Anordnung an einem

Kupolofen ohne Ausmauerung

berthold

Labor Prof. Dr. Berthold
7547 Wildbad 1 (Schwarzwald)
Calmbacher Str. 22 – Postfach 460
Telefon (07081) 2091 – Telex 0724816

2.5.75 Hfl.

STAATLICHES MATERIALPRÜFUNGSAMT
NORDRHEIN-WESTFALEN

TRANSLATION

Staatl. Materialprüfungsamt NW Postfach 410307 4600 Dortmund 41

Laboratorium Prof. Dr. Berthold
Postfach 160

7547 Wildbad 1

MY FILE 23 1048 3/81 DIRECT DIAL 4502 - 288 Dortmund, May 11, 1982

Orienting Small Fire Testing in Accordance with DIN 4102 Part 2
Your Letter of November 12, 1982 - bi - mu

Gentlemen,

as ordered, the test specimens (not radiators) delivered on 11-10-81 and on 12-10-81 were subjected on 12-11-81 for the 1st test series to an orienting fire testing in accordance with DIN Standard 4102 Part 2 (September 1977 Edition).

Please find the results of the testing in the test report enclosed as an attachment.

This report is prescribed for your own orientation only. Forwarding of the test results to third persons is not allowed, since publicity hereof can give rise to misleading conclusions.

A bill will be forwarded later.

Very truly yours,
By order

Überall

Dipl.-Phys. Überall

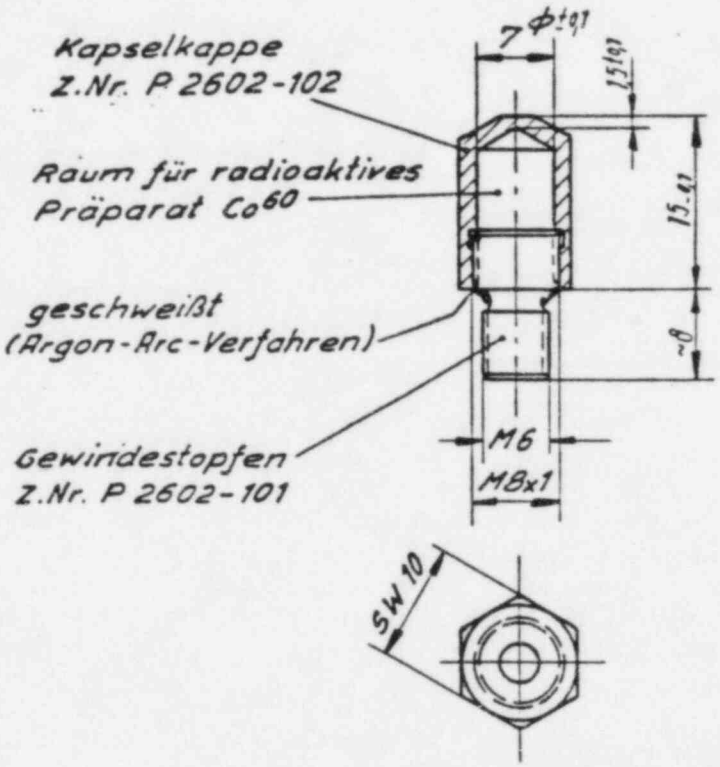
STAATLICHES MATERIALPRÜFUNGSAMT NORDRHEIN-WESTFALEN

23 Enclosures

Anlage 1 zum Schreiben vom 11.05.1982

	MW	CrNi	G	M
	ZW	EW	P	L

Probekörper Nr. 1



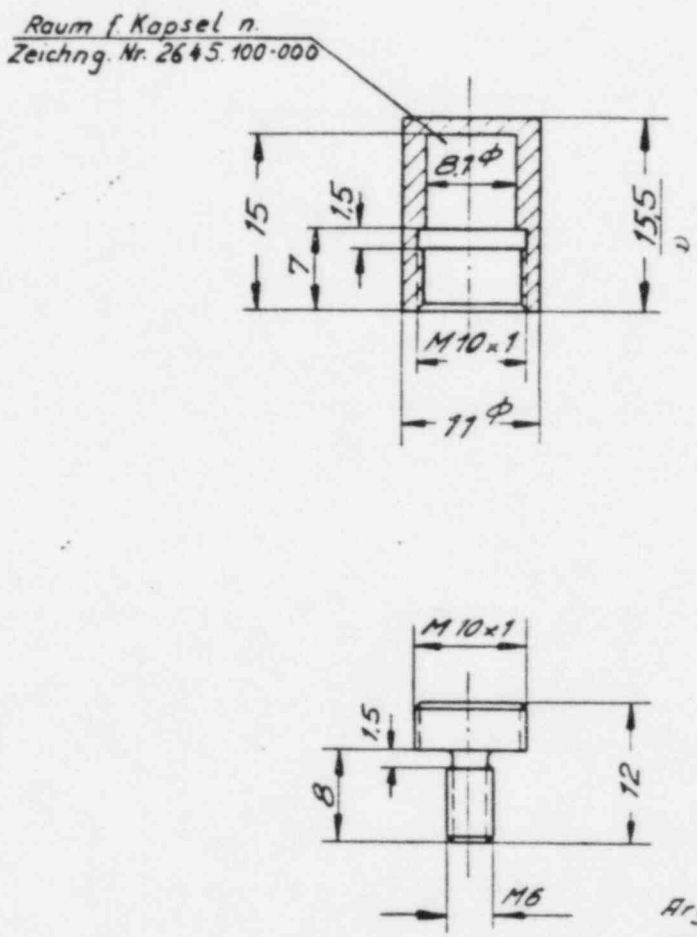
entspricht Z.Nr. A 61208-1

	Werkstoff Nr. 1.4571			
	Sonderbearb. Rd. Toleranzen n. DIN 671 6Kt Toleranzen n. DIN 176			
	Maße ohne Toleranzangabe DIN 7168 m			
	Diese Maße werden besonders geprüft	Paßmaß	Abmaße	verw. bei
	Laboratorium Prof. Dr. Berthold Wildbad/Schwarzwald		Tag	Name
		gez.	1.3.61	Faiber
		gepr.		
Maßstab 2:1	Strahlerkapsel für ^{60}Co		Zeichn.-Nr. P 2602 – 100	

Anlage 2 zum Schreiben vom 11.05.1982

	MW	CMo	G	M
	ZW	EW	P	L

Probekörper Nr. 2



Argonarc geschweißt

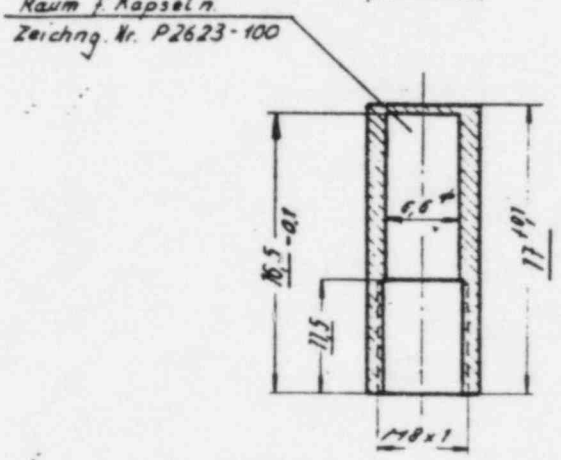
für Strahler nach Buchler Austl. IND 0033 Cs

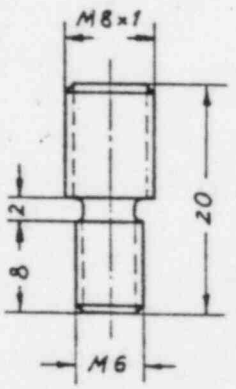
	Werkstoff Nr 1.4571			
	Sonderbearb.			
	Maße ohne Toleranzangabe			
	Diese Maße werden besonders geprüft	Paßmaß	Abmaße	verw. bei
	Laboratorium Prof. Dr. Berthold Wildbad / Schwarzwald		Tag	Name
		gez.	13.3.71	
		gepr.		
1 Ausgabe	2° entf. 16,5 → 15,5 Änderung	6.8.4 Tag	fo Name	
Maßstab 2:1	Adapter für ^{137}Cs-Punktstrahler 1.3 Ci		Zeichn.-Nr. P 2601 - 102	

Anlage 3 zum Schreiben vom 11.05.1982

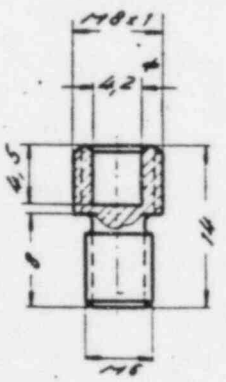
	MW	ChB	G	M
	ZW	EW	P	L

Probekörper Nr. 3





Teil 3 für VZ 91



Teil 2 für VZ 79

Argonarc geschweißt

für Strahler nach Bunker-Kat. VZ 79 und VZ 91

d	Länge M11	11,8	
c	Länge Teil 4,7	4,7	
b	15 u. 16,5	29,5	
a	6-Kant	26,0	
Ausgabe	Änderung	Tag	Name

Laboratorium Prof. Dr. Berthold
Wildbad im Schwarzwald

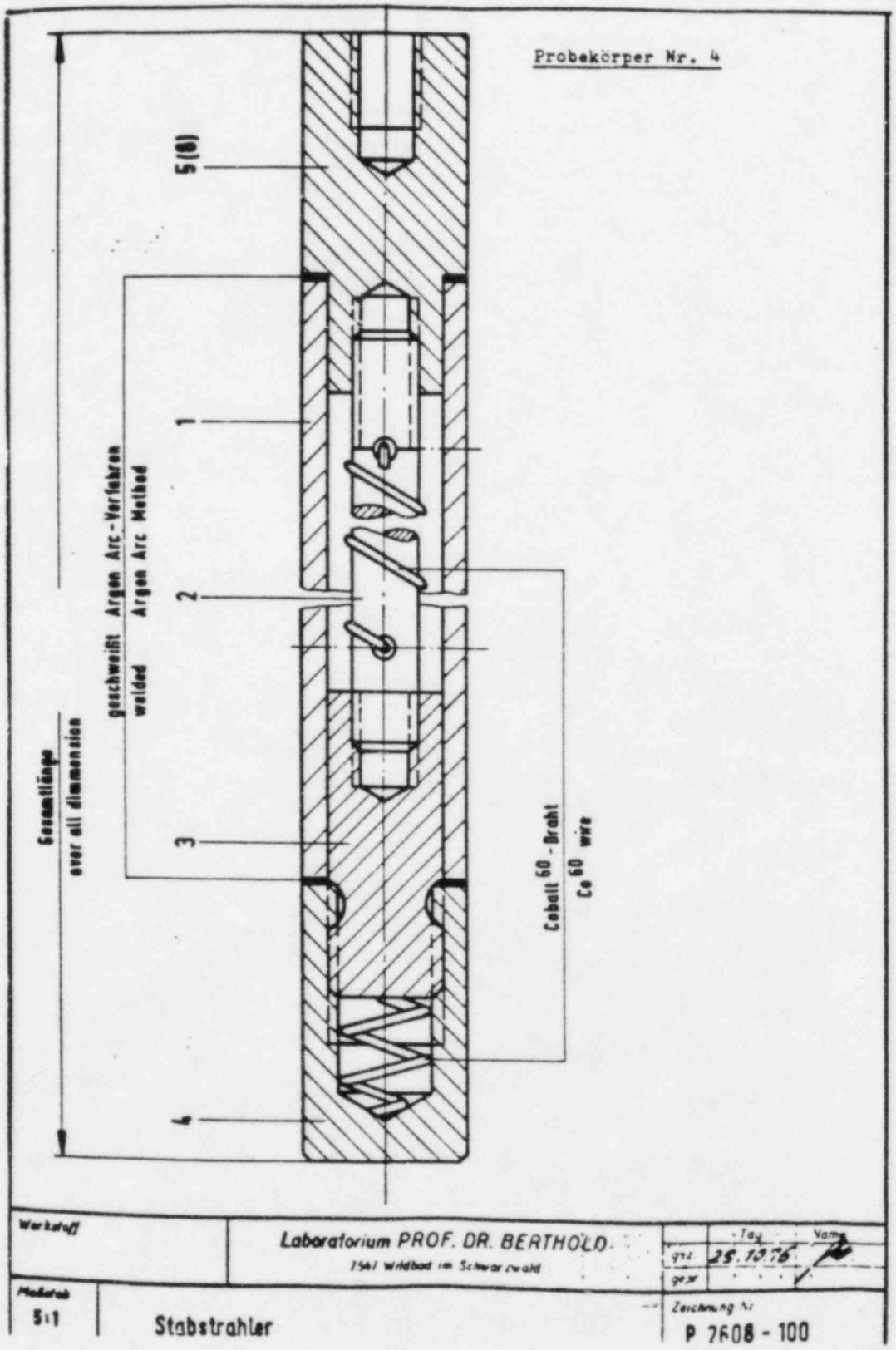
Bearbeitung

Sonderbearbeitung

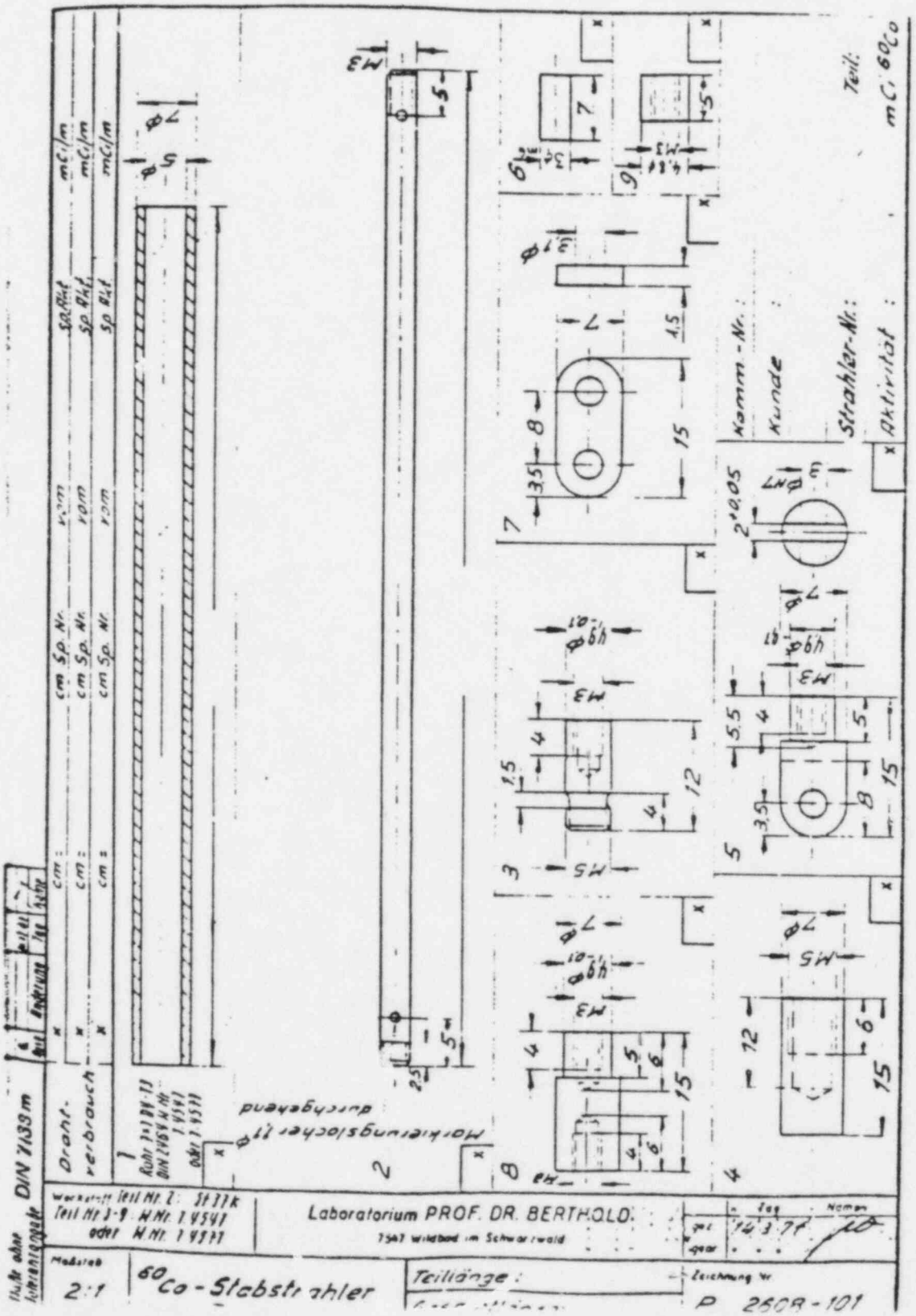
Werkstoff	Maße ohne Toleranzangabe	Diese Maße werden besonders geprüft		Tag	Name
V2A 6-Kant			gez.	21.12.	Gall
			gepr.		

Maßstab	Adapter for Industrial - Point source Adapter für Industrie-~~Punktstrahler~~	Zeichnung Nr.
2:1		P 2601 - 101

Anlage 4 zum Schreiben vom 11.05.1982



Anlage 5 zum Schreiben vom 11.05.1982 Probekörper Nr. 4



Attachment 11 to letter of May 11, 1982

For the test, test specimens 1 to 5 were mounted on a U-shaped bent sample holder of 2 mm steel sheet, St 37 (400 x 90 x 70 mm) (see Fig. 1).

Test specimens 6 to 9 were screwed or plugged into a solid mounting (25 x 12 x 995 mm) of St 37 in the holes provided therefor (see Fig. 1).

The test specimens, including their mountings, were inserted in a small test stand per DIN 4102 Part 8 (Draft) for the test.

The test stand was heated up in accordance with uniform temperature curve DIN 4102 Part 2. The temperature was controlled according to measuring points No. 1 and 2.

The test arrangement and location of the measuring points, as well as the location of the test specimens, may be seen in Fig. 1.

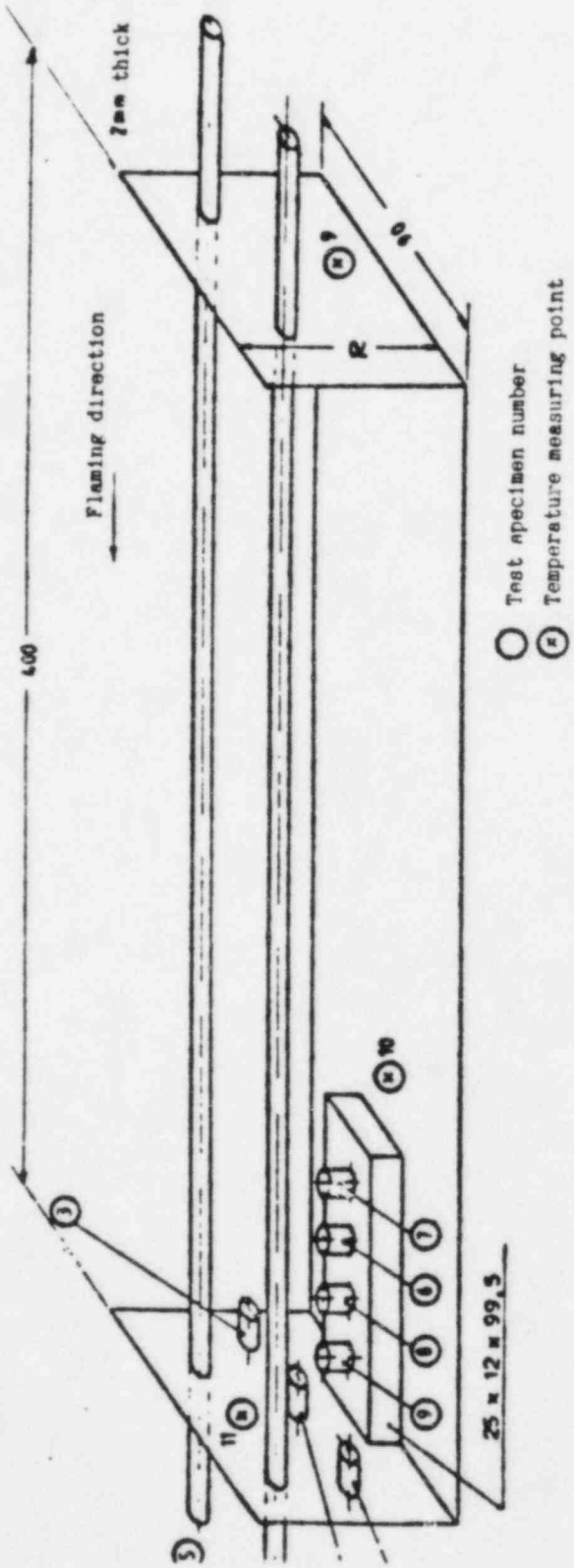


Fig. 1: Test arrangement and location of measuring points

Execution and observations during fire testing on 12-11-81

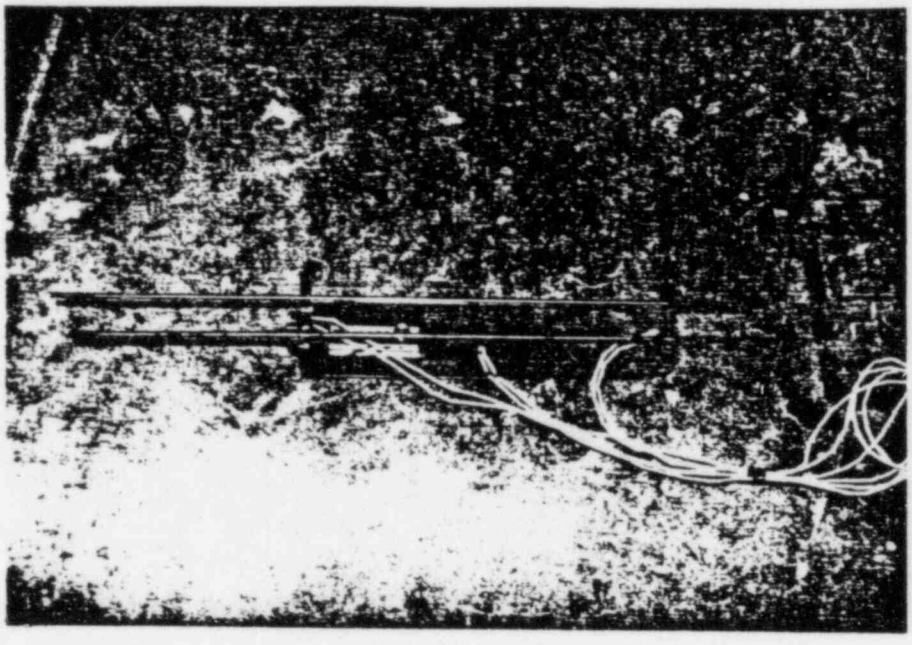


Fig. 2: Sample holder with test specimens before fire testing

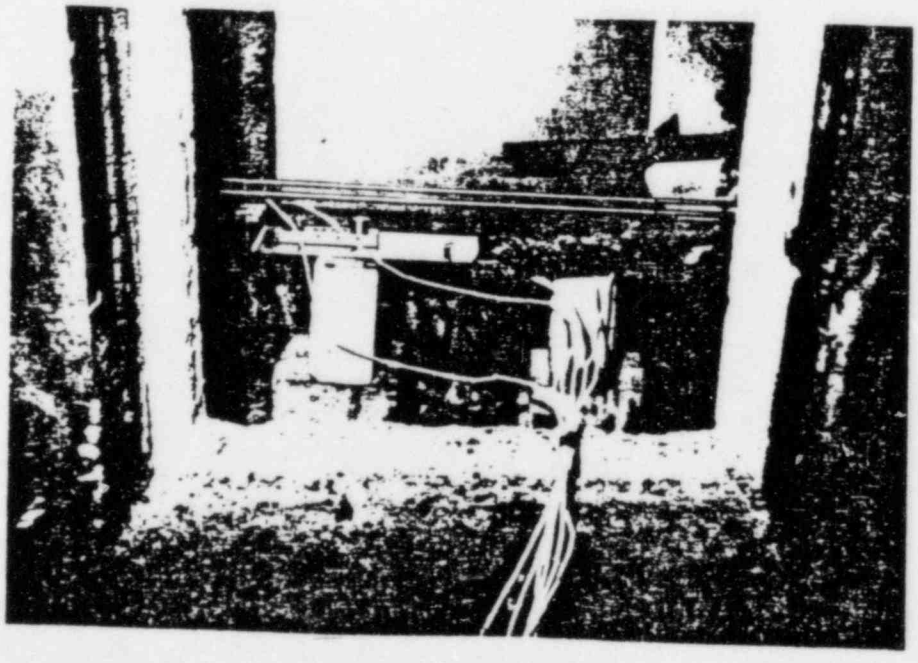


Fig. 3: Sample holder with empty capsule before fire testing
View in fire space

Attachment 14 to letter of May 11, 1982

Observations during fire testing:

Time in minutes	Observations
0	Ignition
20	The side of the rod radiator turned to the fire exhibits - as the color indicates - considerably higher temperatures than the remaining radiator
30	The radiators are slightly deformed.
45	The support plate for mounting the rod radiator is deformed.
60	The temperature on the radiators rises. The initially red coloring becomes progressively ever brighter.
125	End of fire testing.

Observations after fire testing:

The sample holders are heavily oxidized.

The surfaces of the test specimens are only slightly oxidized, those of test specimens 4 and 5 on the burner side somewhat heavier.

Neither by the naked eye nor with 40X magnification can external cracks be perceived on the test specimens. Investigation by means of the dye penetration method also produced no signs of crack formation.

TECHNICAL TRANSLATIONS INTERNATIONAL, INCORPORATED

Attachment 15 to letter of May 11, 1982

PRELIMINARY TEST/BLANK TESTS

TEST NO.: DATE: 12-11-81

TEST PIECE NO.:

TEMPERATURE MEASUREMENT RESULTS (INCREASE OVER INITIAL TEMPERATURE IN K) SHEET 01

MEASURING POINTS

TIME (MIN.)	01	02	03	04	05	06	07	08
005	0615	0475						
010	0738	0659						
015	0756	0685						
020	0769	0753						
025	0825	0798						
030	0769	0817						
035	0863	0845						
040	0888	0872						
045	0877	0868						
050	0909	0882						
055	0924	0897						
060	0932	0916						
065	0953	0929						
070	0962	0941						
075	0974	0956						
080	0983	0966						
085	0996	0975						
090	0995	0977						
095	0998	0984						
100	1009	0992						
105	1015	1003						

TECHNICAL TRANSLATIONS INTERNATIONAL, INCORPORATED

TEMPERATURE MEASUREMENT RESULTS 12-11-81 SHEET 02

MEASURING POINTS

TIME (MIN.)	D1	D2	D3	D4	D5	D6	D7	D8
110	1025	1013						
115	1029	1019						
120	1041	1028						
125	1051	1038						

TECHNICAL TRANSLATIONS INTERNATIONAL, INCORPORATED

Attachment 17 to letter of May 11, 1982

TEMPERATURE MEASUREMENT RESULTS 12-11-81 SHEET 03

MEASURING POINTS

TIME (MIN.)	09	10	11	12	13	14	15	16
005	0559	0433	0319					
010	0718	0562	0531					
015	0749	0616	0582					
020	0791	0693	0646					
025	0845	0751	0701					
030	0889	0800	0742					
035	0918	0837	0776					
040	0946	0867	0808					
045	0934	0860	0808					
050	0946	0875	0823					
055	0963	0889	0841					
060	0975	0904	0859					
065	0993	0927	0877					
070	1004	0933	0891					
075	1015	0947	0905					
080	1023	0956	0915					
085	1029	0963	0928					
090	1031	0970	0930					
095	1037	0974	0940					
100	1044	0980	0950					
105	1050	0984	0959					
110	1058	0997	0970					
115	1065	1010	0980					
120	1071	1017	0988					
125	1083	1037	1001					

Attachment 18 to letter of May 11, 1982

Fire side

Fig. 4: View in small fire oven in test arrangement (left side) after fire testing

Fig. 5: Test Specimen 1 after fire testing

Attachment 19 to letter of May 11, 1982

Fig. 6: Test Specimen 2 after fire testing

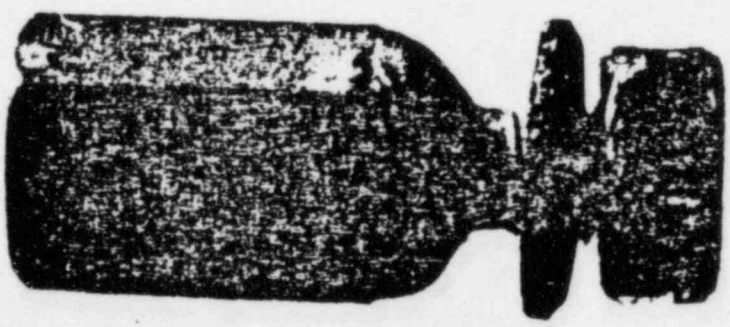


Fig. 7: Test Specimen 3 after fire testing

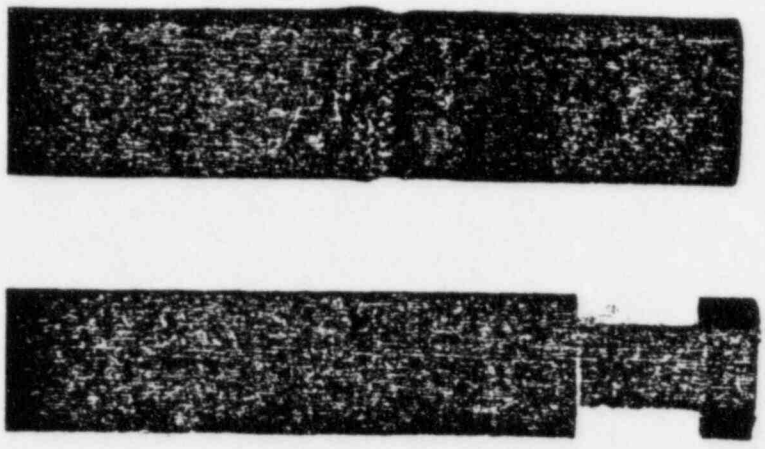


Fig. 8: Test Specimens 4 and 5 - View of the side turned away from the burner after fire testing

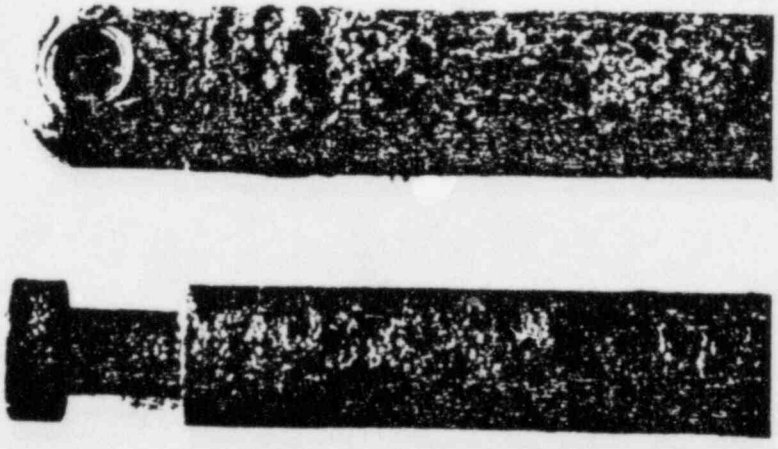


Fig. 9: Test Specimens 4 and 5 - View of the side turned toward the burner after fire testing

Attachment 21 to letter of May 11, 1982

Fig. 10: Mounting of Test Specimens 6 to 9 after fire testing

Fig. 11: Test Specimens 6 to 9 - View of the test specimens installed in the mounting after fire testing

Attachment 22 to letter of May 11, 1982

Fig. 12: Test Specimen No. 6 after fire testing

Fig. 13: Test Specimen No. 7 after fire testing

Attachment 23 to letter of May 11, 1982

Fig. 14: Test Specimen No. 8 after fire testing

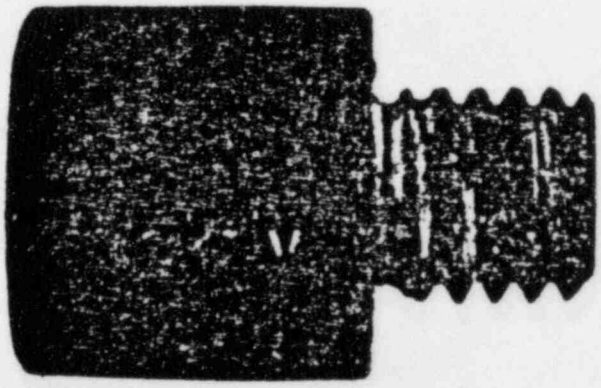


Fig. 15: Test Specimen No. 9 after fire testing

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

I. EMPLOYEE TRAINING PROGRAM

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

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

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

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

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

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

IV. Sources will be leak tested by a wipe test on a six month period and analyzed by a Berthold contamination monitor LB 12108 or C depending on type of activity.

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

(a) A wipe test of sources indicates leakage.

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

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

Continuation

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

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

APPLICATION FOR REGISTRATION OF DEVICES (SOURCE HOUSINGS)

A SUMMARY DATA

1 Date of Original Submission - April 16, 1984

2 Device Type

The device is a lockable shielding unit for either Cobalt-60 or Caesium-137 sources, used in level gauges.

3 Model

The basic internal design remains essentially the same for all units - as far as general construction is concerned. The outside of the device or source holder will vary from one installation to another. This would also apply to the method of mounting the devices on the equipment.

In view of this type of construction, we feel that there is really only one model type and this is typically shown in drawing no 21157.001. Actual model numbers will change with the type of installation eg length and diameter depending on source activity.

4 Applicant

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

Berthold level control equipment will be furnished through us. We are not a manufacturer of this equipment.

For additional information, please contact at the above address:

Mr A McCabe - Managing Director
Mr J Welch - Assistant Sales Manager

5 Other Companies Involved

The devices (source holders), are manufactured either directly by Berthold or under the supervision of Berthold.

Berthold's address: Laboratorium Prof Dr Berthold
Calmbacher Strasse 22 - Postfach 22
D-7547 Wildbad 1
West Germany, FR
Tel: 7081-3981 Tlx: 724019

Other than the user companies themselves, the only other companies would be the freight companies involved and the freight forwarder.

6 Sealed Source Model Designation

a) Types:

Cobalt 60 (rod source)	solid wire in a sealed stainless steel tube
Caesium 137 (point source)	glass pellets of caesium in sealed capsules which are in turn sealed into a stainless steel tube.
Cobalt 60 (point source)	solid wire in a sealed stainless steel capsule
Caesium 137 (point source)	glass pellet in a sealed stainless steel capsule

b) Model/Drawing Number:

Cobalt 60 (rod source)	according to drawings P-2608-100 and P-2608-101, copies attached as Appendix 2
Caesium 137 (rod source)	according to drawings VZ-287 and SK-1208, Appendix 3
Cobalt 60 (point source)	according to drawing P2602-100 copies attached as Appendix 4
Caesium 137 (point source)	according to drawings P2623-100 and 2645.100-000, Appendix 5

For further details please refer to the individual source applications of December 10, 1982 which are on file in your office.

7 Isotope and Maximum Activity

a) For rod sources:

Cobalt-60	maximum activity	50 mCi
Caesium-137	maximum activity	500 mCi

b) For point sources:

Cobalt-60	maximum activity	200 mCi
Caesium-137	maximum activity	1000 mCi

8 Leak Test Frequency

A six (6) month leak test has been done for all sources at the manufacturer's plant.

9 Code "D": Gamma gauge to measure and control levels in all types of vessels.

10 Custom Device

Inasmuch as the essential construction of all these devices is the same, especially from the standpoint of overall safety, we feel that these units should not be classified as custom devices.

11 Custom User

We feel the classification should be that of non-custom user.

B DESCRIPTIVE DATA

1 A distinction is made between two (2) types of shieldings:

a) Shieldings for point sources

b) Shieldings for rod sources

to a) The shieldings for Co-60 and Cs-137 point sources are identical.

The shielding consists of a lead filled casted housing.

The source capsule is fastened in the middle of the casted housing with an adaptor so that even in the extremely remote case that the lead melts and runs out, the source is fastened to the casted housing and will not be lost. In front of the source is a lead filled cylinder with an off-centre drilled hole. This is attached to a spindle which is in turn connected to a locking handle. By turning the handle, thus the cylinder, through 180° the radiation beam can be closed.

"Open" and "Closed/locked" are clearly marked on the back of the shielding.

An automatic locking system, in the form of an air motor, can be fitted as an option. The positions "Closed" and "Open" can be safeguarded by a safety-lock

to b) The shielding for rod sources consists of a lead filled steel cylinder on which, to the left and to the right, rectangular steel constructions are fixed. The left rectangular steel construction is filled with lead. The three units are held together with a rectangular flange from above and below.

The lead filled steel cylinder has a centrally drilled hole, to accommodate the rod source, and a radiation emission slit vertical to its axis. By turning the steel cylinder through 90° the radiation emission channel can be closed.

The positions "Closed" and "Open" are clearly marked. Both positions can be safeguarded by a lock.

2 Labelling

Each device is furnished with a label on the outside surface with the standard radiation symbol and the word "Radioactive".

Additionally, there is a metal name plate which contains the following information:

- International Radiation Symbol
- Word "RADIOACTIVE"
- Source no (which incorporated the sequential manufacturing numbers, the month of manufacture and the year of manufacture).
- Activity
- Nuclide (source material)
- Precise manufacturing date
- Thickness and kind of shielding
- Dose rate at 1 m (40") distance
- Other specialized information about the device if required.
- Name and address of the manufacturer.

3 Diagram

A small drawing of a typical device is shown, for both point and rod source shieldings, in drawings PB 2199-002 and 21157.000-001 respectively.

4 These devices are mounted on various kinds of vessels. The units are tightly sealed to prevent the intrusion of dirt, dust, smoke, water and aggressive atmospheres. If, during an accident or fire, the temperature increases casuing the lead to melt, the molten lead cannot escape because it is completely surrounded by a steel shell.

5 Supporting Details

Drawings showing detailed characteristics of the device, including the source and source housing, are given in drawings PB 2199.002 and 21157.000-001, Appendix 1. The source housing for both Cobalt Caesium are shown in the drawings in Appendices 2 and 3. A drawing of a typical installation is shown in the application for the sealed source (Cobalt 60), Appendix 6.

C HEALTH & SAFETY DATA

1 Safety Analysis Summary

The basic construction of both types of shieldings consists of a heavy outer steel container, the inside of which is filled with lead. The sources are secured in such a way that even in the highly unlikely event that the lead becomes liquid, due to an accident, the sources will not be lost.

The lead itself, cannot escape - even if molten - as the container is completely closed. This permits full radiation protection, even if the temperature is higher than the melting point of lead and the lead has been turned to liquid. The outer steel container is also sufficiently strong enough to withstand the expansion of the lead at the 400-500 °C range. The overall construction of these units is such as to maintain full containment integrity.

2 Manufacturing and Distribution Controls

a) Qualitiy assurance and control:

For each device, on completion of manufacture, the controls are tested for function and the entire unit is then tested for radiation leakage by a radiation survey meter. Checking of the source has been fully described in our application for Cobalt and Caesium sources and as stated therein and are under the classification specification ISO/DIN C-65444which has been met.

Leakage and wipe tests have demonstrated a removal of less than 5 nCi.

b) Description of Lab Berthold's recommended maintenance, servicing and testing requirements for use:

Maintenance on the device or source holder is not required. Maintenance of any external features such

as the air motor (if present in an automatic system), can be done safely by the customer's maintenance personnel, however, who would be doing such work, would be given instructions in general radiological safety procedures, as well as specific information on the Berthold equipment.

When the device must be moved or replaced, the shutter is turned to the closed position.

The exchange of radioactive sources will only be carried out by Berthold or one of its authorized subsidiary companies. If the source is delivered in a transport shielding, the exchange will be carried out as follows:

i) Point source shielding

- open safety lock
- locking handle turn to "exchange" position (this is situated between "open" and "closed")
- unscrew adaptor and lift out source
- unscrew capsule
- screw on new source capsule
- replace and screw adaptor in again
- set locking handle in required "open" or "closed" position
- relock safety lock

ii)
- 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)

In both the above cases the old (decayed) source, is then put into the shipping container and returned either 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, is approximately one (1) minute or less. Whole body exposure: based on a time exposure of 1 minute and an average distance between body and source of approximately 1/2 meter (18"-20") and a maximum source strength of 50 mCi, the whole body exposure can be calculated to a value of 4.5 mrem.

iii) Leak testing:

The construction of the sources is such that under normal circumstances, replacement is not required more often tnan the normal half-life

of the Cobalt source which is approximately 5 years or the useful life for caesium sources which is approximately 10 years.

In the event that the ambient temperature of the source exceeds 400 °C (752 °F) it is recommended that the source be replaced. For emergency procedures, where the shutter is no longer operable, the source must be removed by specially trained personnel and the housing removed for repairs.

c) Lab Berthold's instructions to users:

For general instructions in radiological safety, instructions are shown under the title "Instructions for Radiological Protection" in Appendix 7.

- a certification of the sealed source leakage and contamination assay is supplied with each source furnished.
- instruction for the safe usage for the source and device will also be supplied

3 Lab Berthold's Safety Analysis of Device Review

a) Safety analysis:

Construction is such as to provide sufficient strength to withstand all normal operating conditions. The design is such to maintain container integrity, even under adverse conditions.

b) Prototype testing and evaluation:

Inasmuch as a large number of these units are in operation throughout the world, our experience shows that the construction and safety of the units demonstrates their durability and long, trouble-free life.

- radiation isodose values are precalculated and are given in the technical data sheets supplied for each installation. On request, additional special information can be supplied, as for example the data sheets shown in Appendix 8.

- the devices can be safely operated by persons not having had training in radiological protection.

Therefore, based on the above, the exposure limits under normal handling conditions will be far lower than the values given below:

whole body, head and trunk, active blood forming organs, gonads lense of eye — 0.5 rem

hands and forearms, feet and ankles, localized areas of skin average over areas no larger than 1 cm^2 — 7.5 rem

other organs — 3.0 rem

Under accidental conditions, even involving the direct handling (using tongs) of the unshielded source for a short time, the total exposure is well under the limits set in the table below:

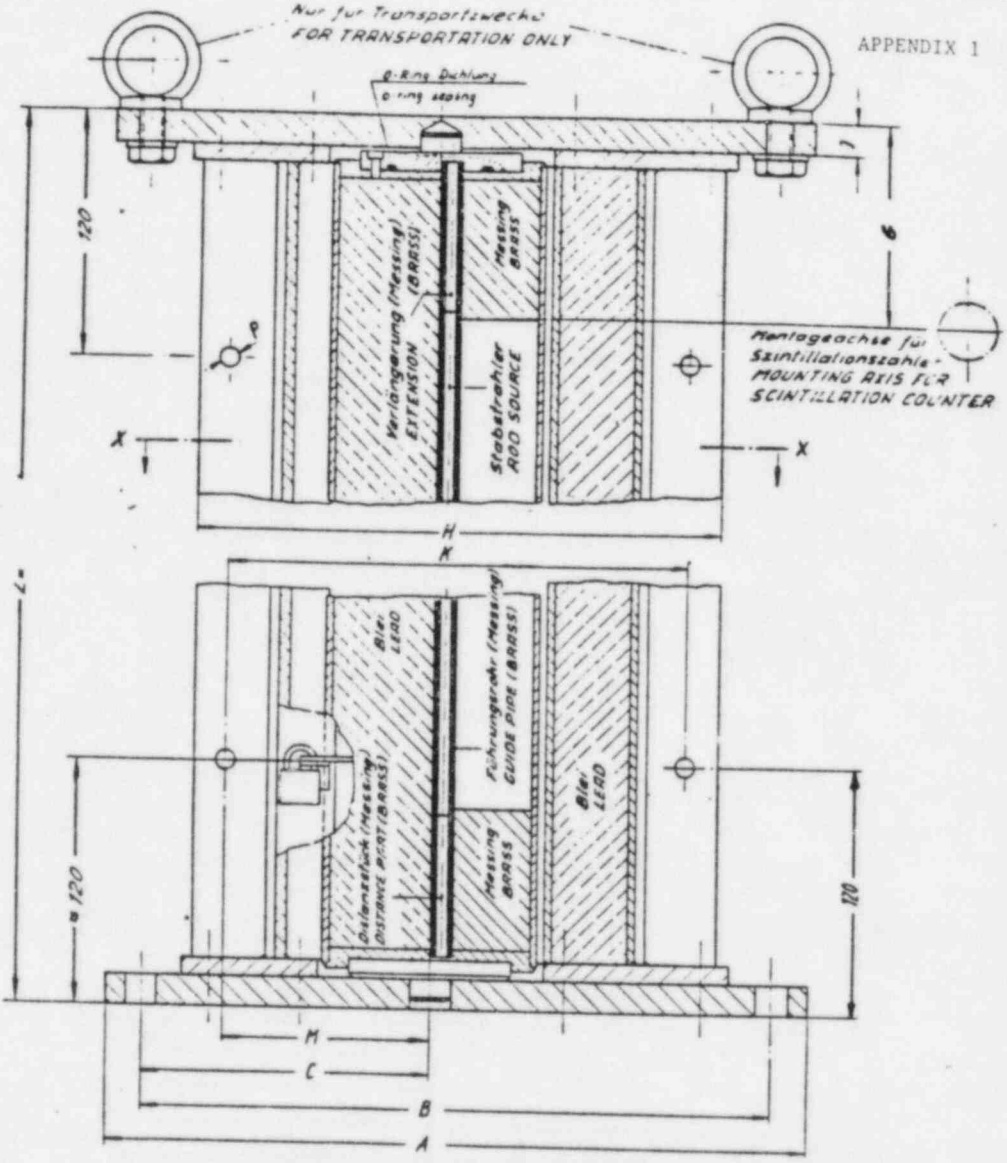
whole body, head and trunk, active blood forming organs, gonads, lense of eye — 15.0 rem

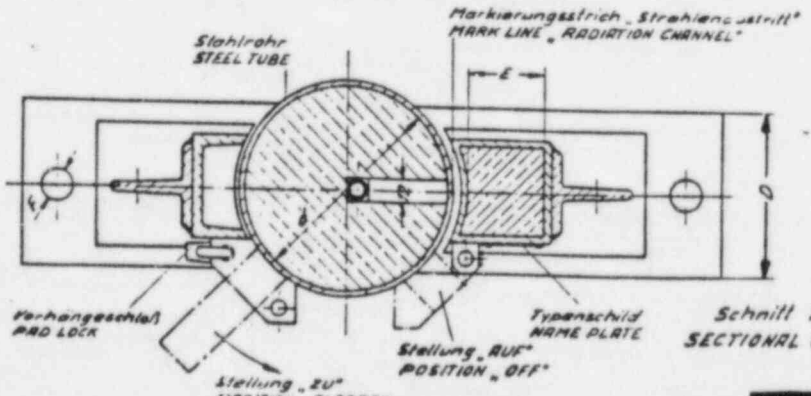
hands and forearms, feet and ankles, localized areas of skin average over areas no larger than 1 cm^2 — 200.0 rem

other organs — 50.0 rem

c) Additional information:

No additional data should be necessary.



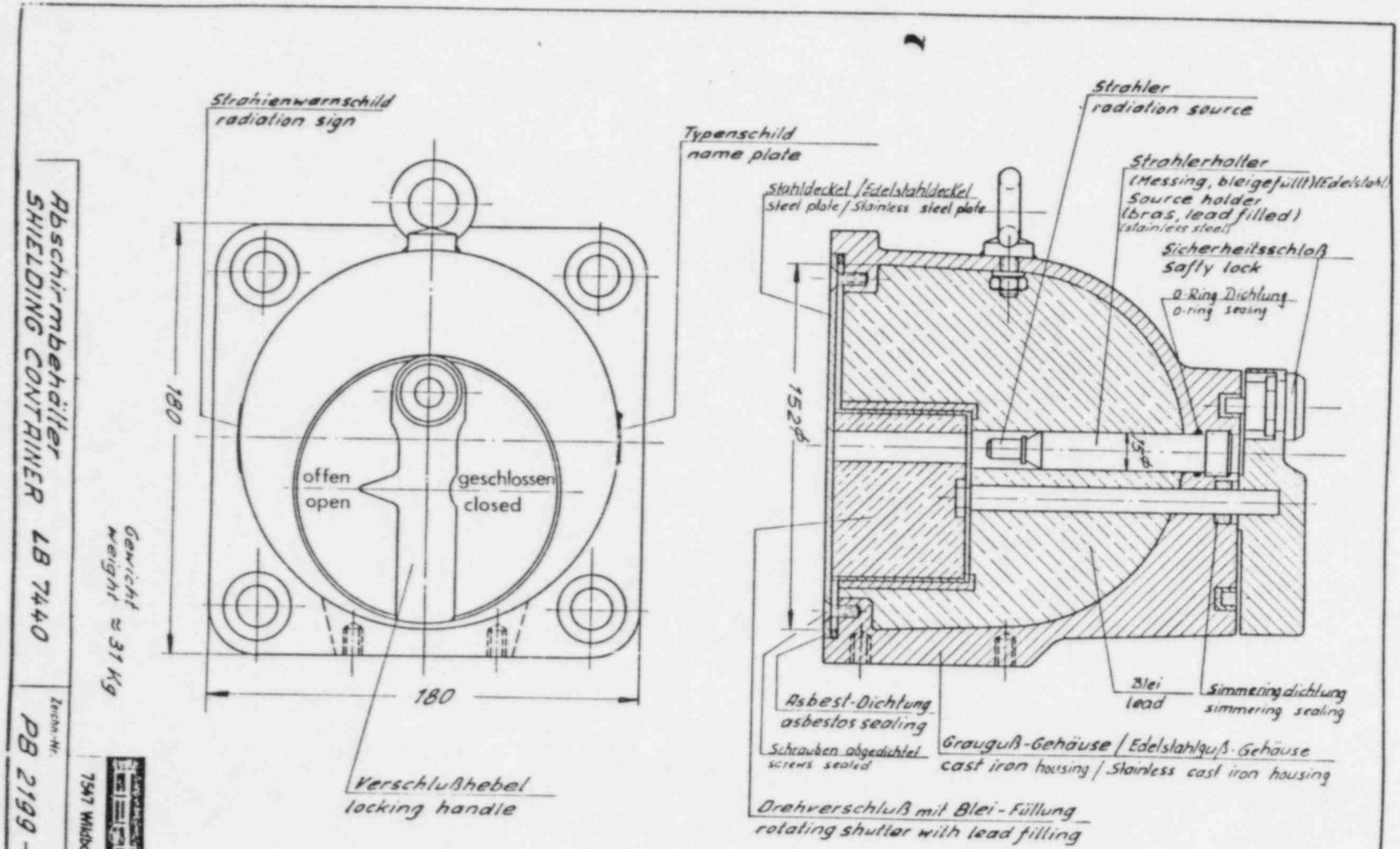


Schnitt X-X
SECTIONAL VIEW X-X

P	115	115	115	14	14	
M	80	100	120	150	180	
A	205	225	261	312	379	
J	15	15	20	20	25	
H	235	255	310	375	450	
E	93	107	128	147	164	
F	16	16	18	18	25	
G	47	47	67	65	65	
D	80	80	80	100	120	
C	130	140	165	195	235	
B	285	305	340	425	515	
A	320	340	420	485	562	
d	80	100	119	150	190	
d*	80	100	120	150	200	

1778	Abschirmung für Stabstrahler SHIELDING FOR ROD SOURCE	Dwg. no.	21157-001

berthold
7547 Wildbad / Schwarzw.



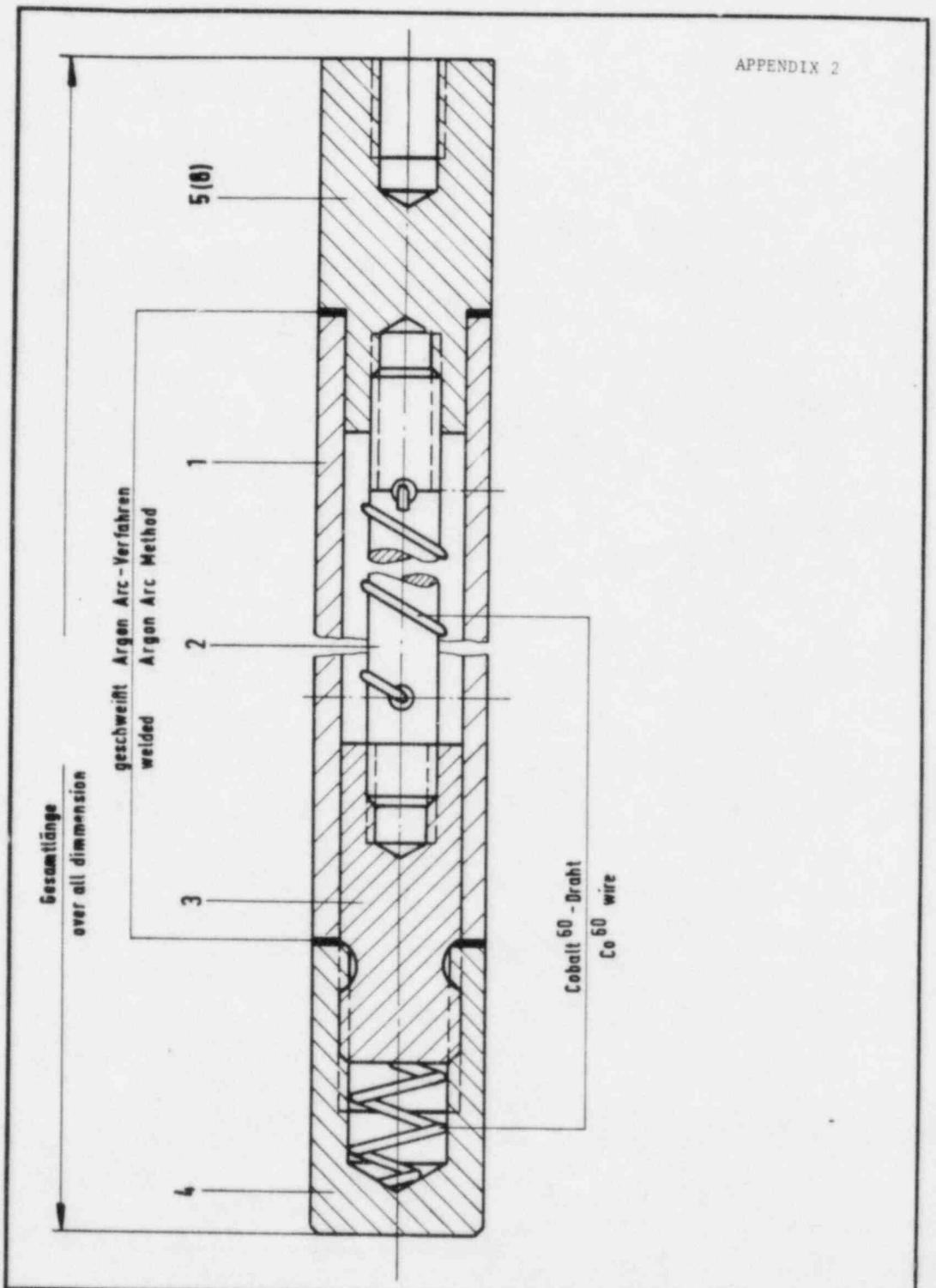
Abschirmbehälter
SHIELDING CONTAINER LB 7440

Gewicht
weight ≈ 31 Kg

Techn.-Nr.
PB 2199-002

7547 Wildbad/Schwarzw.

APPENDIX 2



Werkstoff	Laboratorium PROF. DR. BERTHOLD 7541 Wildbad im Schwarzwald		Tag	Name
		gez.	29.10.76	
		gepr.		
Maßstab 5:1	Stabstrahler	Zeichnung Nr. P 2608 - 100		

Maßstab ohne Fahrenzugabe DIN 7168 m

Maßstab 2:1

^{60}Co - Slabstrahler

Teillänge:

Gesamtlänge:

Laboratorium PROF. DR. BERTHOLD
7547 Wildbad im Schwarzwald

Zeichnung Nr. P 2608-101

Werkstoff Rö/ Nr. 2: 1.4571K
Teil Nr. 3-9: W.Nr. 1.4541
oder W.Nr. 1.4571

Draht-verbrauch

x	cm:	cm Sp. Nr.	vom	Sp. Akt	mCi/m
x	cm:	cm Sp. Nr.	vom	Sp. Akt.	mCi/m
x	cm:	cm Sp. Nr.	vom	Sp. Akt	mCi/m

1 Rohr 7x1 DH-13 DIN 2462 W.Nr. 1.4541 oder 1.4571

2 Verschweißung durchgehend

3

4

5

6

7

8

9

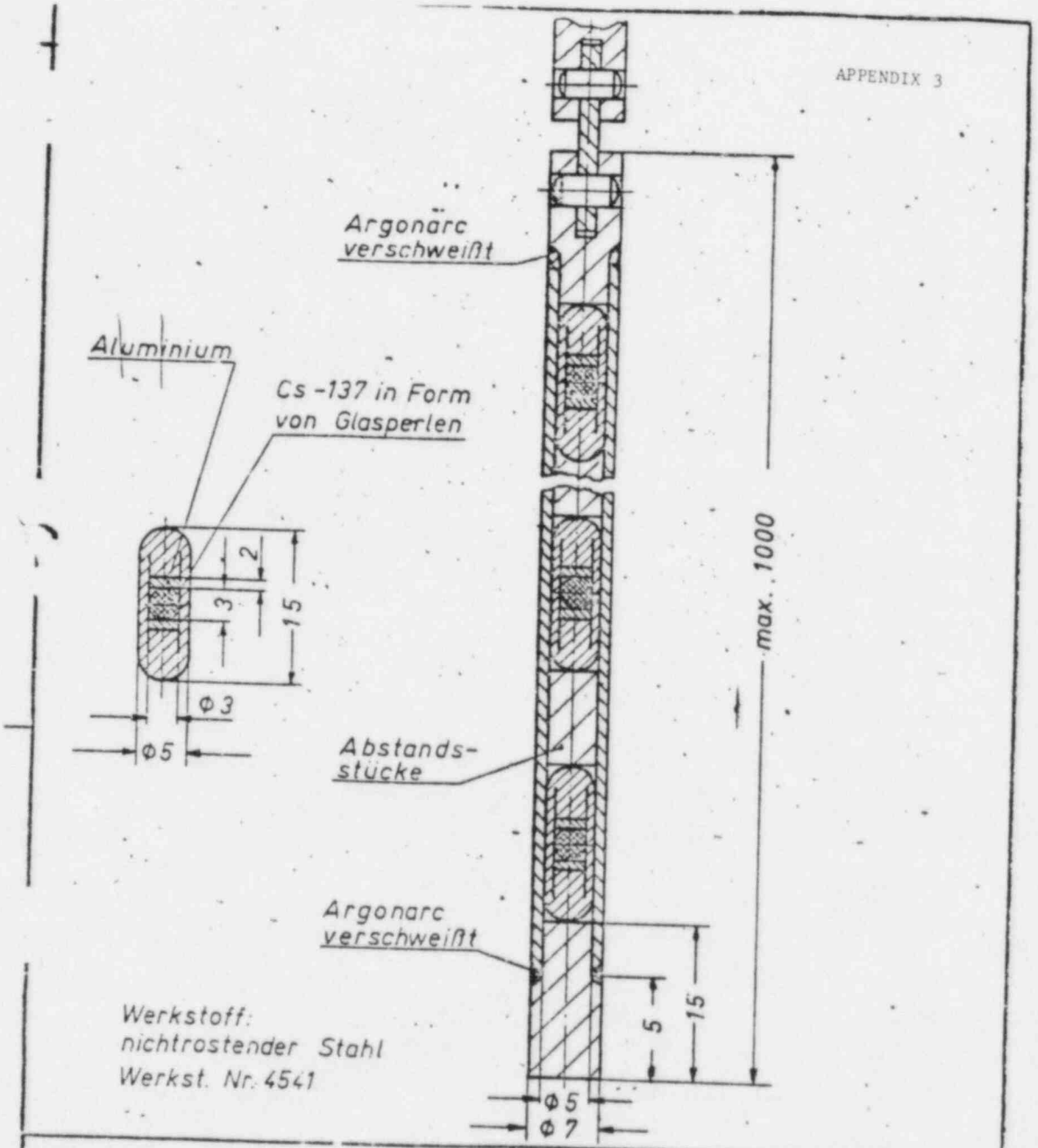
Komm.-Nr.:

Kunde :

Strahler-Nr.: Teil:

Aktivität : mCi ^{60}Co

APPENDIX 3



Änderungsvermerke		
- 1976	Tag	Name
Gezeichn.:	6. 9.	
Geprüft:		
Estab: 2.1		
Werkstoff:		

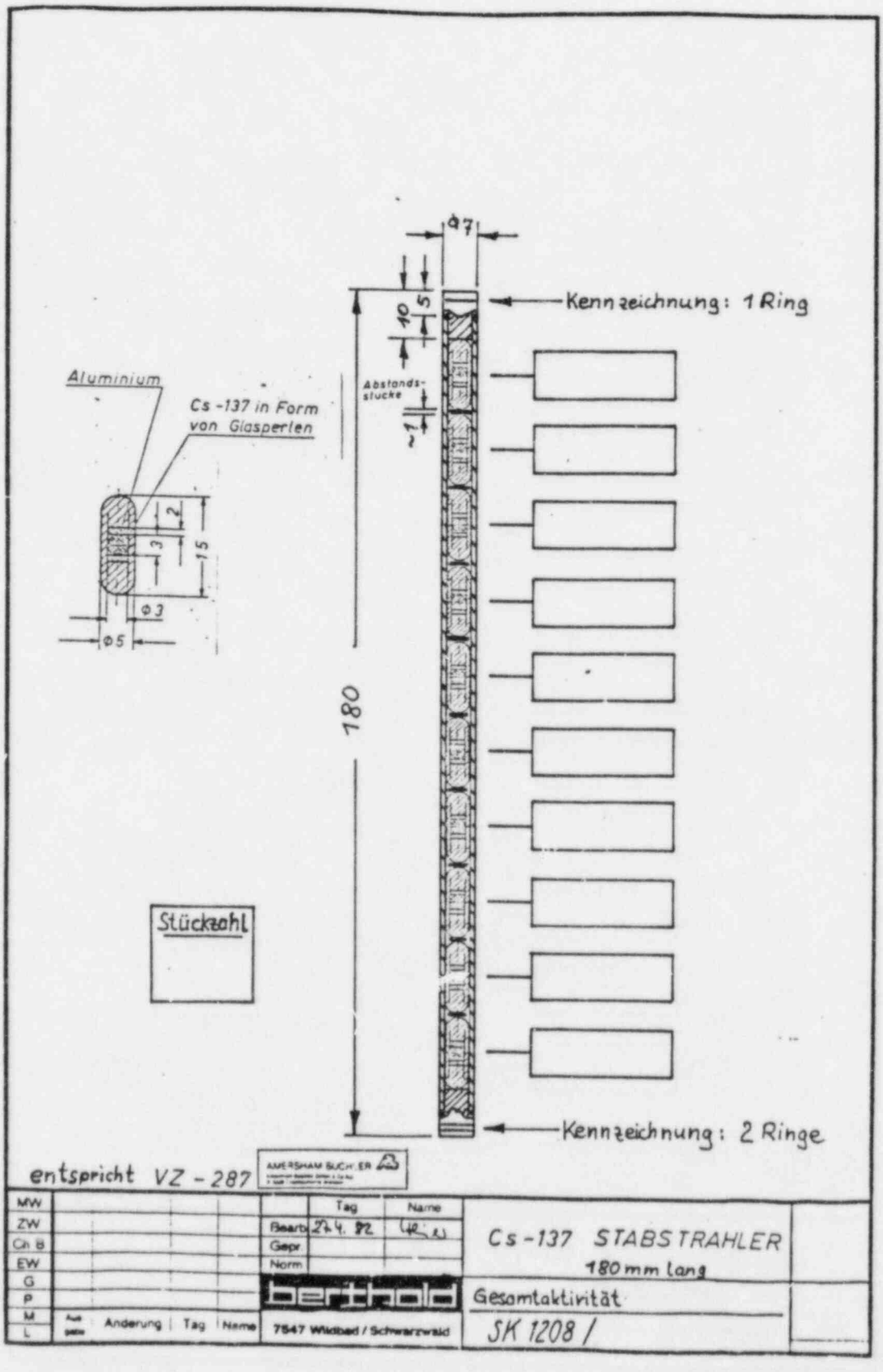
STABSTRAHLER

Cs -137 1 - 100 m Ci

Zeichnungs-Nr.: VZ - 287

AMERSHAM BUCHLER

Amersham Buchler GmbH & Co KG
D-3300 Braunschweig Wenden



entspricht VZ - 287

AMERSHAM BUCHLER

			Tag	Name
MW		Bearb.	24.4.82	(Unterschrift)
ZW		Gepr.		
Ch B		Norm		
EW				
G				
P				
M	Änderung | Tag | Name			
L				

7547 Wildbad / Schwarzwald

Cs-137 STABSTRAHLER
180 mm lang

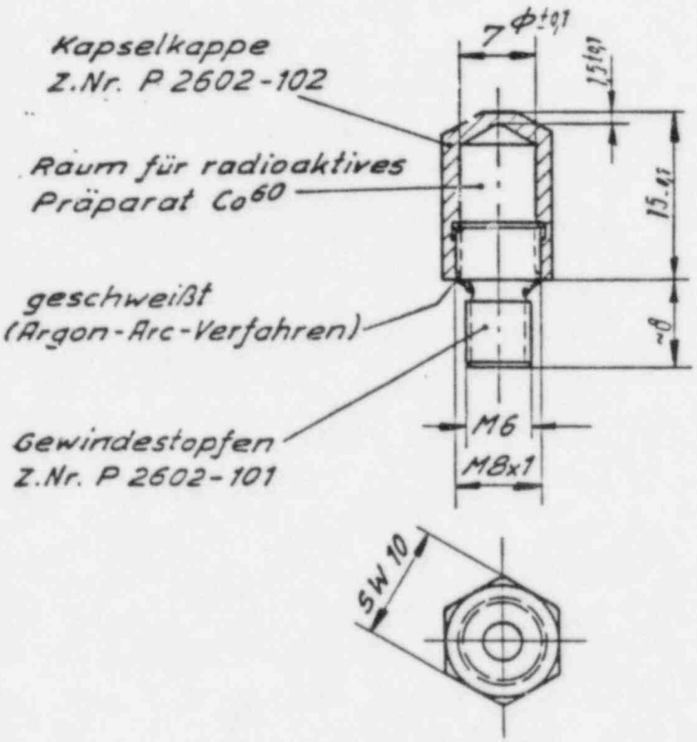
Gesamtaktivität
SK 1208 /

Anlage 1 zum Schreiben vom 11.05.1982

	MW	Cro	G	M
	ZW	EW	P	L

Probekörper Nr. 1

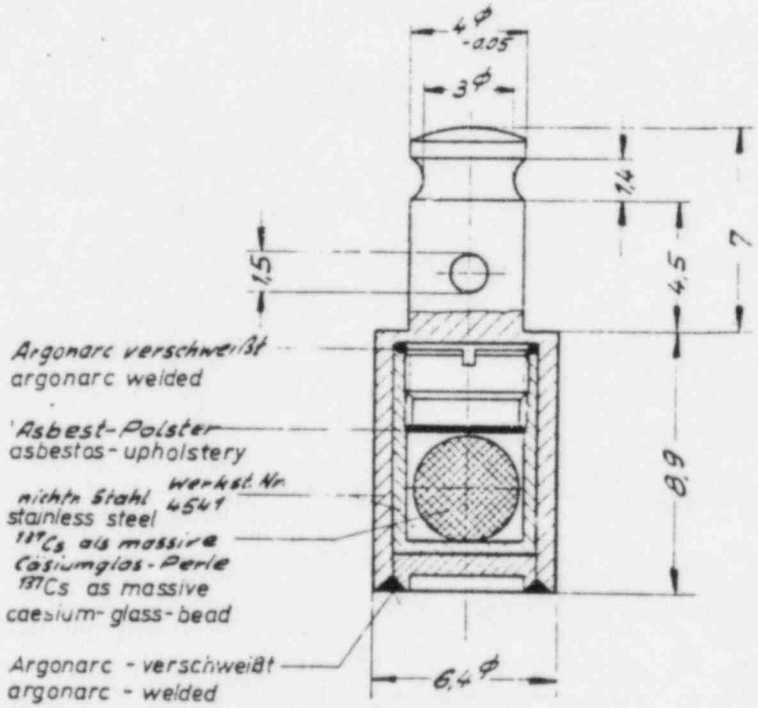
APPENDIX 4



entspricht Z.Nr. A 61208-1

	Werkstoff Nr. 1.4571 Rd. Toleranzen n. DIN 671			
	Sonderbearb. 6 kt Toleranzen n. DIN 7168			
	Maße ohne Toleranzangabe DIN 7168 m			
	Diese Maße werden besonders geprüft	Paßmaß	Abmaße	verw. bei
2 die Anschlüsse R 1/8"	Laboratorium Prof. Dr. Berthold Wildbad / Schwarzwald		Tag	Name
Ausgabe / Änderung / Tag / Name		gez.	1.3.61	Fauler
		gepr.		
Maßstab 2:1	Strahlerkapsel für ^{60}Co		Zeichn.-Nr. P 2602 – 100	

APPENDIX 5



Beschreibung der Hülle:
Bauartbeschreibung: doppelt umschlossen
Material: Innen- und Außenkapsel Edelstahl W.Nr.4541
Wanddicke: Innenkapsel: 0,5 mm
Außenkapsel: 0,65 mm
Art der Abdichtung: Argonarc-verschweißt

Entspricht Buchler u. Co-Ausführ. VZ-0079 bzw. IN0.79/rs

Laboratorium Prof. Dr. Berthold
Wildbad im Schwarzwald

Bearbeitung

Änderung | Tag | Name

Werkstoff

Maße ohne Toleranzangabe

Diese Maße werden besonders geprüft

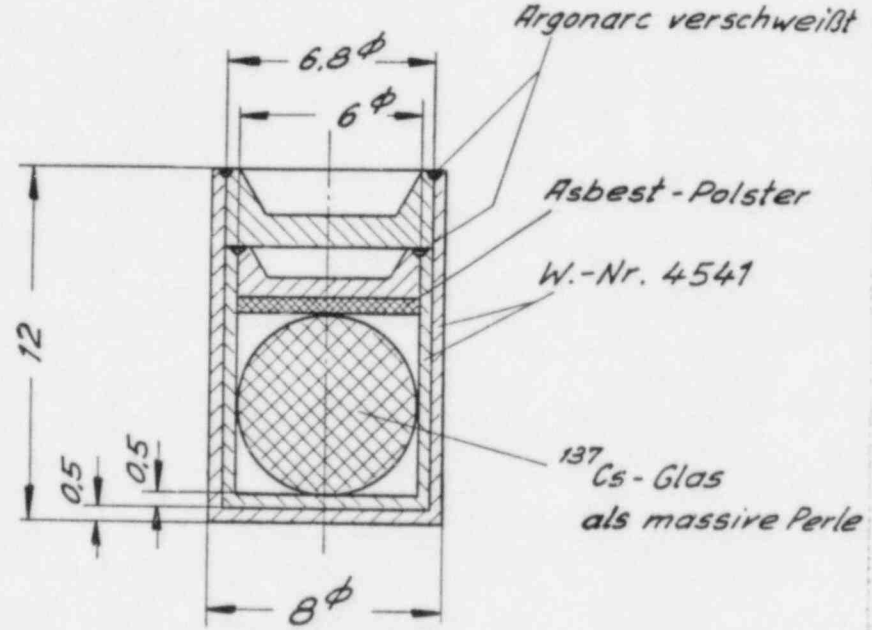
Tag Name
2.7.65

Maßstab 5:1

Industrial - Point source to 500 mCi
137Cs-Industrie-Punktstrahler bis 500 mCi

Zeichnung Nr. P 2623 - 100

	MW	Gäb	G	M
	ZW	EW	P	L



Entspricht Buchler-Ausführung IND 92/Cs Bzw. VZ 0092

Ausgabe	Änderung	Tag	Name

Werkstoff

Sonderbearb.

Maße ohne Toleranzangabe

Diese Maße werden besonders geprüft

Paßmaß	Abmaße	verw. bei

Laboratorium
Prof. Dr. Berthold
Wildbad / Schwarzwald

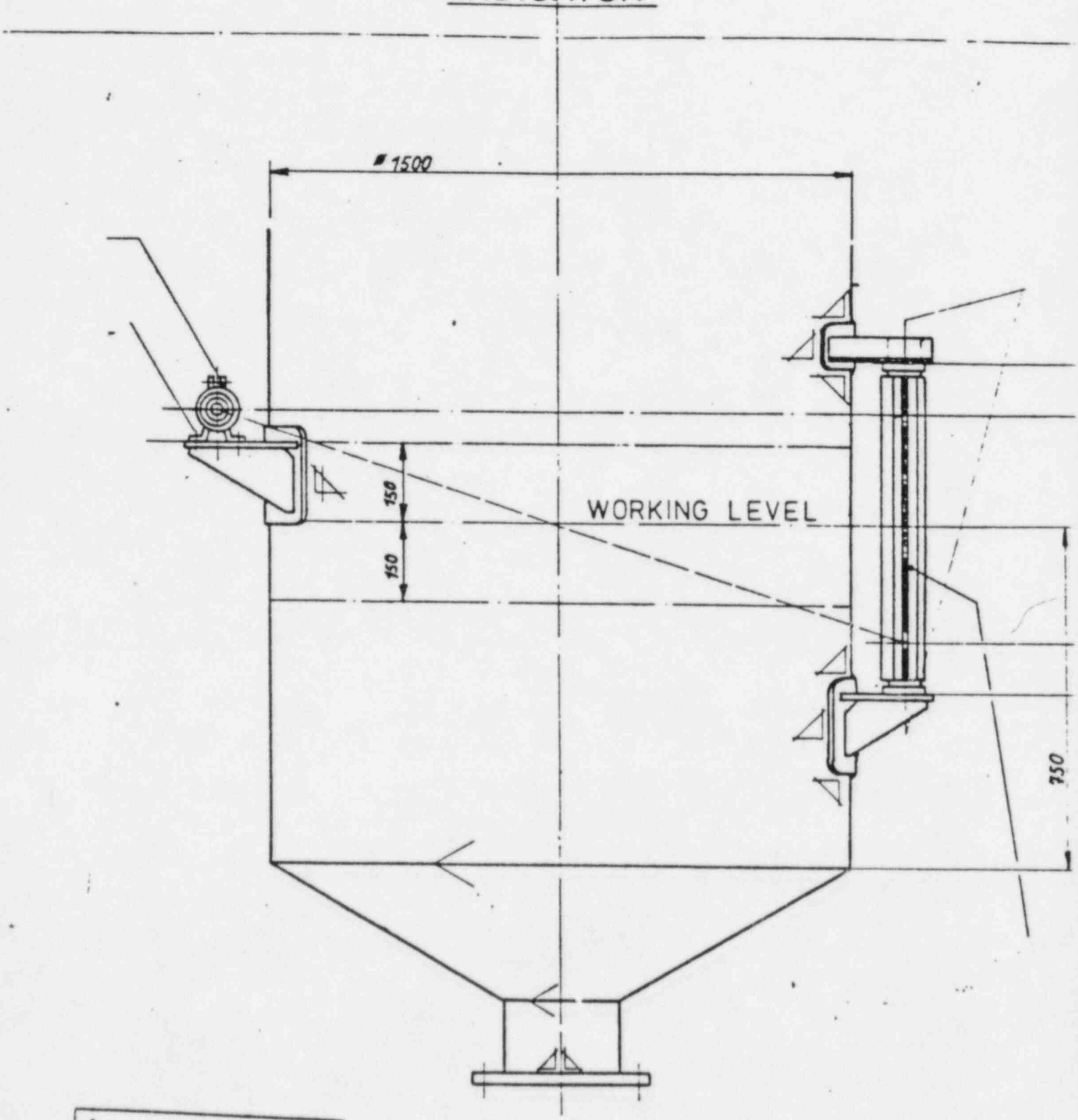
	Tag	Name
gez.	20.5.74	
gepr.		

Maßstab 5:1

^{137}Cs - Industrie - Strahler 1-3 Ci

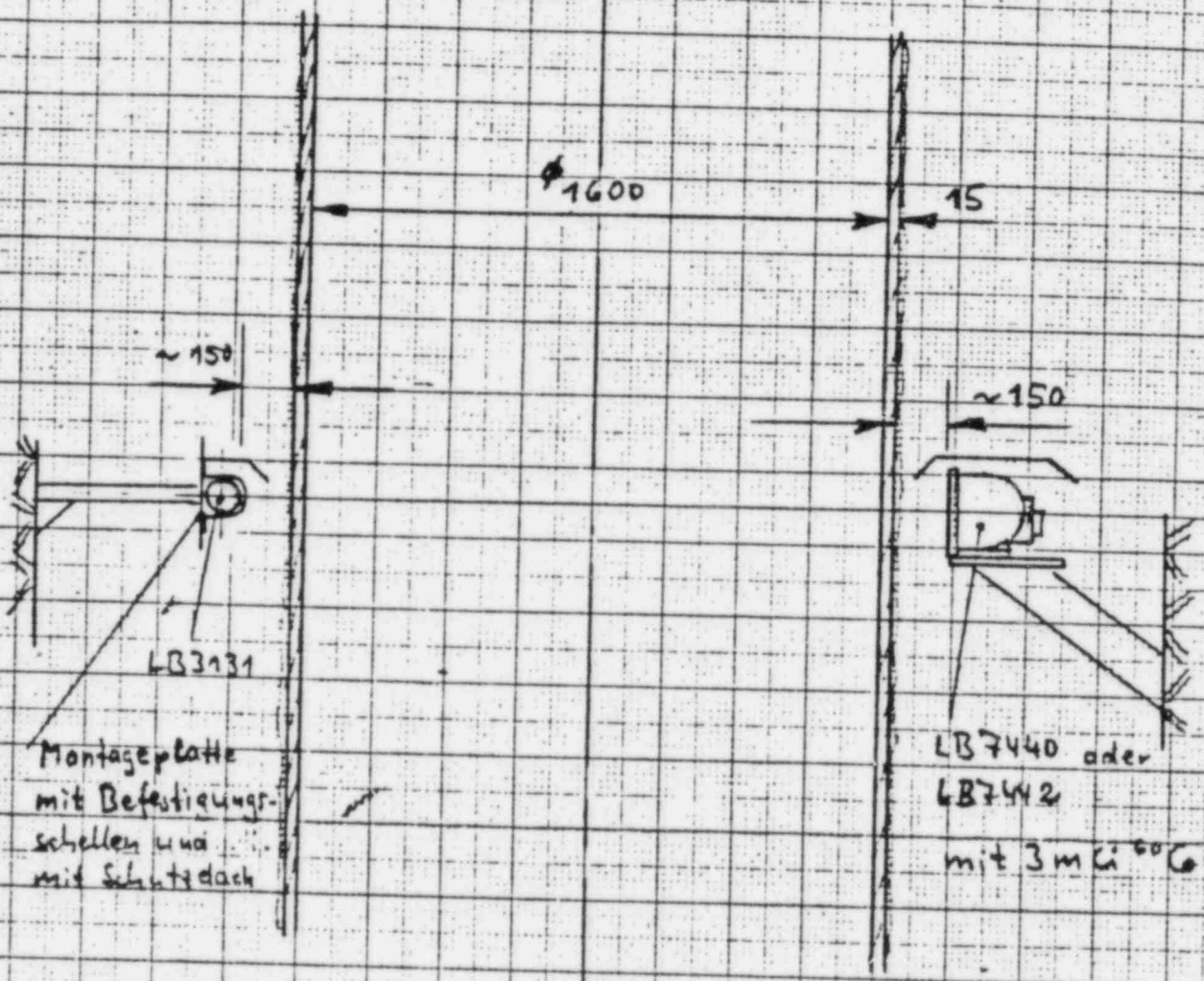
Zeichn.-Nr. 2645.100-000

RADIOACTIVE LEVEL INDICATOR



berthold
Labor Prof. Dr. Berthold
7547 Wildbad 1 (Schwarzwald)
Calmbacher Str. 22 — Postfach 160
Telefon (0 70 81) 39 81 — Telex 07 240 19

M 1:20



Anordnung an einem
Kupolofen ohne Ausmauerung

berthold
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7547 Wildbad 1 (Schwarzwald)
Calmbacher Str. 22 – Postfach 660
Telefon (0 70 81) 2881 – Telex 0734013

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INSTRUCTIONS FOR RADIOLOGICAL PROTECTION

C O N T E N T S

INSTRUCTIONS FOR RADIOLOGICAL PROTECTION

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

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

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

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

1. Types and Properties of Radio-active Radiation

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

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

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

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

2. Dosimetric Evidence

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

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

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

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

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

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

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

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

3. Important Terms

3.1 Activity

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

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

3.2 Dose

3.2.1 Energy dose

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

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

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

3.2.2 Dose equivalent

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

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

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

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

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

The following quality factors apply to different types of radiation:

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

*) 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 be informed and instructed accordingly.

Main items of information:

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

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

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

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

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

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

6. Permissible Radiation Doses

6.1 Occupationally not exposed persons

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

6.2 Occupationally exposed persons in the category B

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

6.3 Occupationally exposed persons in the category A

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

7. Radiation Protection Areas

7.1 Barred areas

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

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

7.2 Control areas

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

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

7.3 Monitoring areas

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

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

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

8. Physical Radiation Protection Control

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

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

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

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

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

9. Further Regulations

9.1 Storage and custody

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

9.2 Checking of sealed radio-active substances

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

9.3 Transmission of radio-active substances

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

9.4 Recording and reporting

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

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

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

9.5 Misappropriation of radio-active substances

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

9.6 Penalties

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

10. Shielding

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

The shielding effect in the case of gamma radiation depends, as a first approximation, on the specific 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.

TECHNICAL DATA SHEET

FOR RADIOACTIVE SUBSTANCES

BERTHOLD Commission No.:

Applicant:

1. Description of the radioactive substance:

1.1	Isotope:	Co-60
1.2	Chemical condition:	Co
1.3	Physical condition:	solid, wire
1.4	Design:	rod source, capsuled
1.5	Manufacturer and supplier:	Labor Prof. Dr. Berthold Wildbad/Schwarzwald
1.6	Quantity and activity:	each MBq (mCi)

2. Description of the capsule:

2.1	Dimensions:	7 mm Ø, mm total length (parts)
2.2	Material:	stainless steel, shop no. 1.4541 or 1.4571
2.3	Wall thickness:	1 mm
2.4	Sealing:	Argon-Arc-welding
2.5	Design:	according to drawing P 2608-100 and P 2608-101
2.6	Strain:	ISO/C 65444 according to DIN 25426 "special form" - permit D/0037/S of the BAM
2.7	Certificate:	According to the PTB-certificate 23590.63 VI B/RA of Oct. 17,1963 repeated seal tests are not necessary if the source is not exposed to mechanical strain, to corrosive substances or temperatures exceeding 400°C.

3. Description of the shielding: (only for transport)

The source is installed in a lead shielding with drilled hole and an end cover held in place by screws.

Data for the shielding:

3.1	Design:	according to drawing	
3.2	Exterior diameter:	approx.	mm
3.3	Total length:	approx.	mm
3.4	Total weight:	approx.	kg
3.5	Effective shielding thickness	approx.	mm Pb

4. Doserates (except in direction of useful beam):

4.1	In 1 m distance from the unshielded radioactive source:	approx.	µSv/h (	mrem/h)
4.2	In 1 m distance from the shielded radioactive source:	approx.	µSv/h (	mrem/h)
4.3	In 25 cm distance from the surface of the shielding	approx.	µSv/h (	mrem/h)

5. Description of the intended applications:

The source is situated in an immersion pipe within the vessel which is in accordance with the drawings of the applicant. The wall thickness of the immersion pipe used, the wall thickness of the vessel and the external insulation layer act as a shielding.

The dose rate at the detector position is:

approx. µSv/h (mrem/h)

6. Whereabouts of radioactive sources which are no longer in use:

Return to the responsible national collection depot for radioactive waste to the supplier.

Date:

Enclosures:

Drawing No. P 2608-100

Drawing No. P 2608-101

Drawing No.

PTB-certificate 23590.63 VI B/RA

TECHNICAL DATA SHEET

FOR RADIOACTIVE SUBSTANCES

BERTHOLD Commission No.:

Applicant:

1. Description of the radioactive substance:

1.1	Isotope:	Cs-137
1.2	Chemical condition:	Cs
1.3	Physical condition:	solid, ceramic or glass
1.4	Design:	Point source, capsuled
1.5	Manufacturer and supplier:	Labor Prof. Dr. Berthold Wildbad/Schwarzwald
1.6	Quantity and activity:	each MBq (mCi)

2. Description of the capsule:

2.1	Dimensions:	6,4 mm Ø, 15,9 mm total length
2.2	Material:	stainless steel, shop no. 1.4541
2.3	Wall thickness:	interior capsule 0,5 mm; exterior capsule 0,65 mm
2.4	Sealing:	Argon-Arc-welding
2.5	Design:	according to drawing P 2623-100
2.6	Strain:	ISO/C 64344 according to DIN 25426
2.7	special information:	The described capsule is encapsulated in a further protective capsule according to drawing no P 2601.101. This capsule is also argon-arc welded.

3. Description of the shielding:

The source is installed in a lead shielding with a tight casting casing: The useful beam can be shut off by means of a turnable shutter. The shutter can be locked and secured with a padlock in the position "OPEN" and "CLOSED". The construction of the shielding guarantees an especially firm and safe installation of the source.

LABORATORIUM PROF. DR. BERTHOLD
D-7547 WILDBAD 1 · Germany F.R. · Phone 07081/3981 · Telex 0724019

Data for the shielding:

3.1	Design:	according to drawing		
3.2	Exterior diameter:	approx.	mm	
3.3	Total length:	approx.	mm	
3.4	Total weight:	approx.	kg	
3.5	Effective shielding thickness	approx.	mm Pb	

4. Doserates (except in direction of useful beam):

4.1	In 1 m distance from the unshielded radioactive source:	approx.	µSv/h (	mrem/h)
4.2	In 1 m distance from the shielded radioactive source:	approx.	µSv/h (	mrem/h)
4.3	In 25 cm distance from the surface of the shielding	approx.	µSv/h (	mrem/h)

5. Description of the intended applications:

The source is part of a radioactive level gaging system

6. Whereabouts of radioactive sources which are no longer in use:

Return to the responsible national collection depot for radioactive waste to the supplier.

Date:

Enclosures:

Drawing No. 2623-100

Drawing No.

Drawing No. P 2601-101

TECHNICAL DATA SHEET
FOR RADIOACTIVE SUBSTANCES

BERTHOLD Commission No.:

Applicant:

1. Description of the radioactive substance:

1.1	Isotope:	Co-60
1.2	Chemical condition:	Co
1.3	Physical condition:	solid, wire
1.4	Design:	point source, capsuled
1.5	Manufacturer and supplier:	Labor Prof. Dr. Berthold Wildbad/Schwarzwald
1.6	Quantity and activity:	each MBq (mCi)

2. Description of the capsule:

2.1	Dimensions:	Hexagon SW 10, approx. 23 mm total length
2.2	Material:	stainless steel, shop no. 1.4541 or 1.4571
2.3	Wall thickness:	at least 1,5 mm
2.4	Sealing:	Argon-Arc-welding
2.5	Design:	according to drawing P 2602-100
2.6	Strain:	ISO/C 65444 according to DIN 25426 "special form" - permit D/0038/S of the BAM
2.7	Certificate:	According to the PTB-certificate 6.3-38491/73 of January 16, 1974, repeated seal tests are not necessary if the source is not exposed to temperatures exceeding 400°C.

3. Description of the shielding:

The source is installed in a lead shielding with a tight casting casing. The useful beam can be shut off by means of a turnable shutter. The shutter can be locked and secured with a padlock in the position "OPEN" and "CLOSED". The construction of the shielding guarantees an especially firm and safe installation of the source.

LABORATORIUM PROF. DR. BERTHOLD
D-7547 WILDBAD 1 · Germany F.R. · Phone 07081/3981 · Telex 0724019
RADIATION MEASURING INSTRUMENTS FOR INDUSTRY, SCIENCE AND MEDICINE

Data for the shielding:

3.1	Design:	according to drawing	
3.2	Exterior diameter:	approx.	mm
3.3	Total length:	approx.	mm
3.4	Total weight:	approx.	kg
3.5	Effective shielding thickness	approx.	mm Pb

4. Doserates (except in direction of useful beam):

4.1	In 1 m distance from the unshielded radioactive source:	approx.	µSv/h (	mrem/h)
4.2	In 1 m distance from the shielded radioactive source:	approx.	µSv/h (	mrem/h)
4.3	In 25 cm distance from the surface of the shielding	approx.	µSv/h (	mrem/h)

5. Description of the intended applications:

The source is part of a radioactive level gaging control system

6. Whereabouts of radioactive sources which are no longer in use:

Return to the responsible national collection depot for radioactive waste to the supplier.

Date:

Enclosures:

Drawing No. P 2602-100

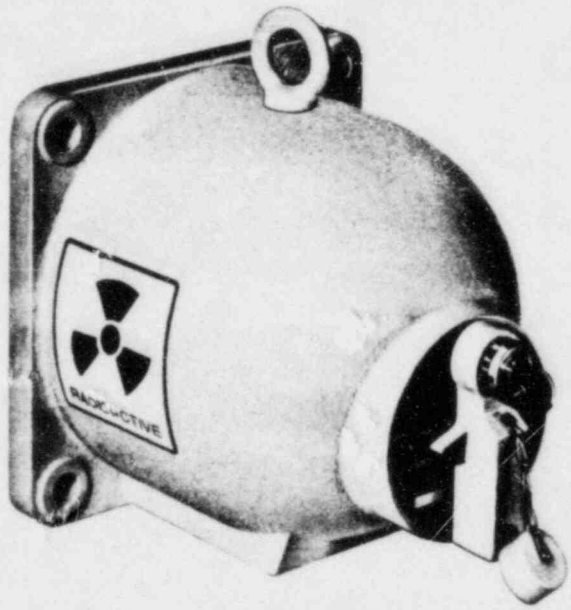
Drawing No.

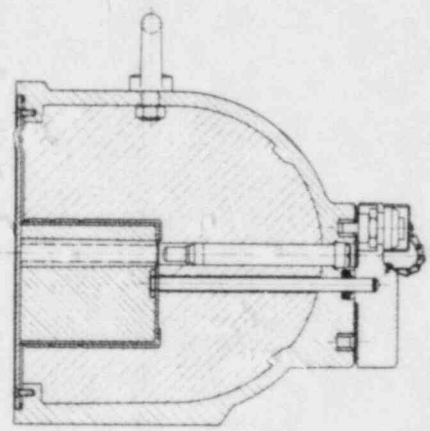
PTB-certificate 6.3-38491/73

72-2-0378

Berthold
Abschirmbehälter/Shielding container
LB 7440, LB 7442, LB 7444

in Gußgehäuse mit verschließbarem Strahlenaustrittskanal
in casting cabinet with lockable radiation channel





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Beschreibung

Der Abschirmbehälter besteht aus einem mit Blei gefüllten stabilen Gußgehäuse (GG 18). Zum Verschließen des Strahlenaustrittskanals ist eine drehbare Blende eingebaut. Die Bedienung erfolgt von der Rückseite her über einen Knebel, welcher sowohl in offener als auch in geschlossener Stellung durch ein eingebautes Schloß gesichert wird. Der Strahler ist so eingebaut, daß er ebenfalls durch das Schloß gegen unbefugte Entnahme geschützt ist.

Zur Montage besitzt der Abschirmbehälter einen angegossenen Flansch und zusätzlich einen Befestigungsfuß mit Gewindebohrungen.

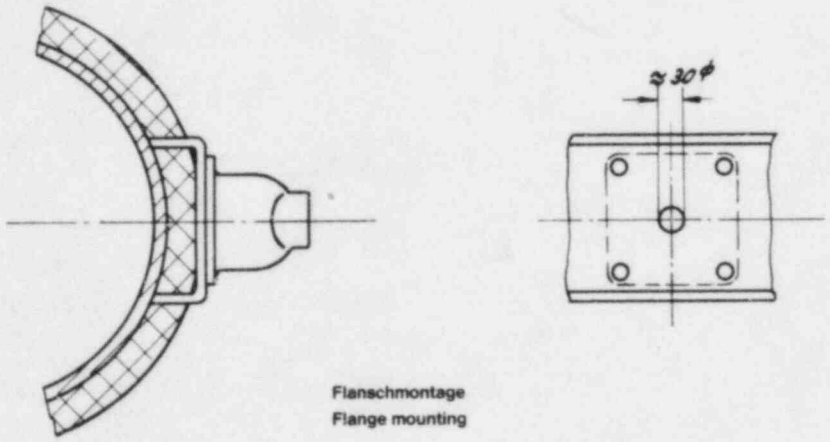
Description

The shielding container is consisting of a stable casting cabinet (GG 18) filled with lead. For closing the radiation output channel a rotatory mask is built-in. Operation is made from behind by a toggle, which is secured by a built-in lock in opened as well as in closed position. The source is mounted in a way, that unauthorized taking off is also prohibited by the lock.

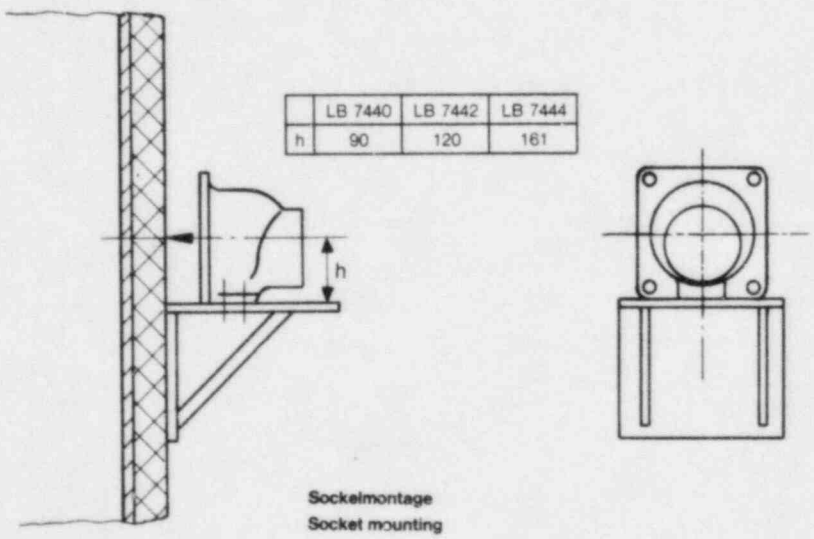
For mounting purposes, the shielding container has an integrally cast flange and a fixing socket with tapped holes.

Montagevorschläge

Mounting proposals



Flanschmontage
Flange mounting



	LB 7440	LB 7442	LB 7444
h	90	120	161

Sockelmontage
Socket mounting

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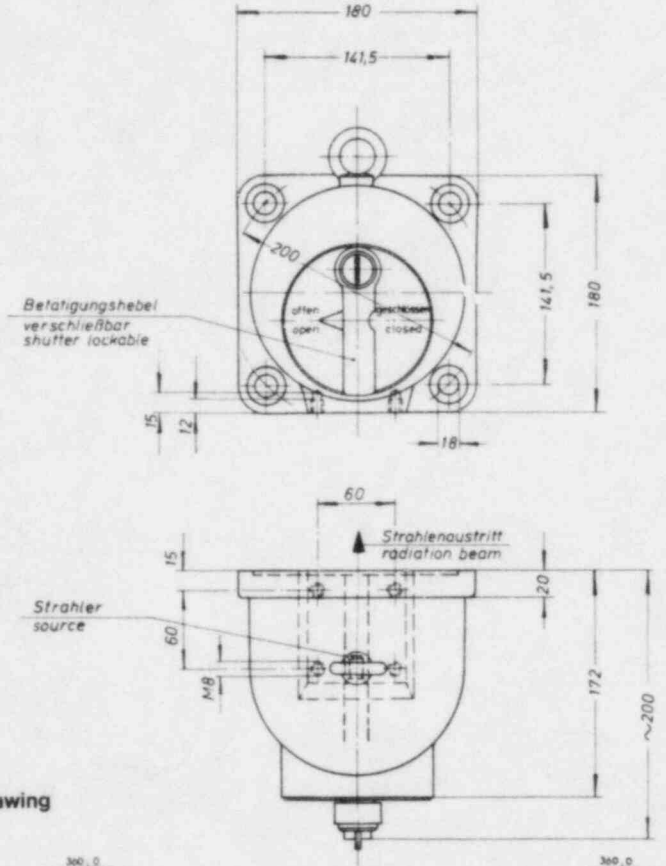
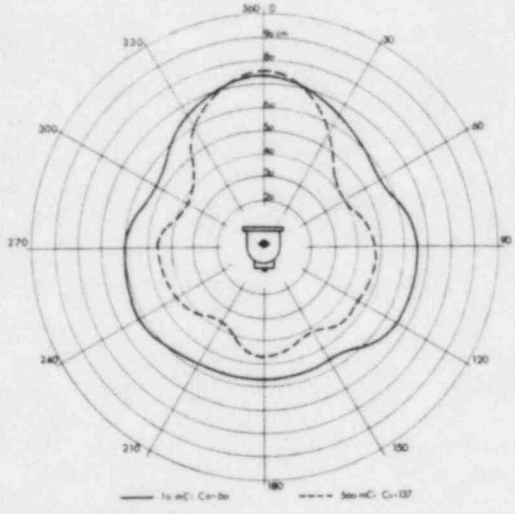
LB 7440

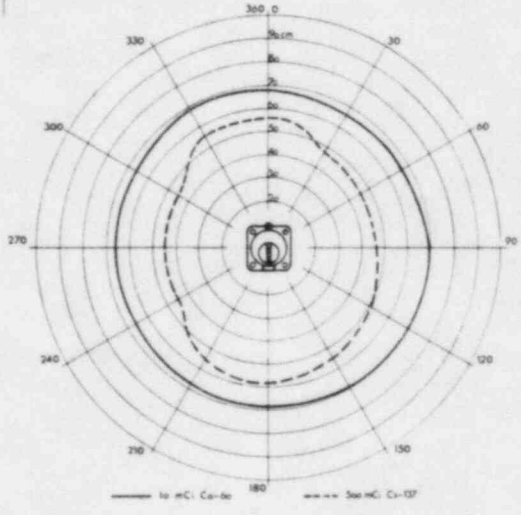


Maßbild
Dimension drawing



Isodosenkurven

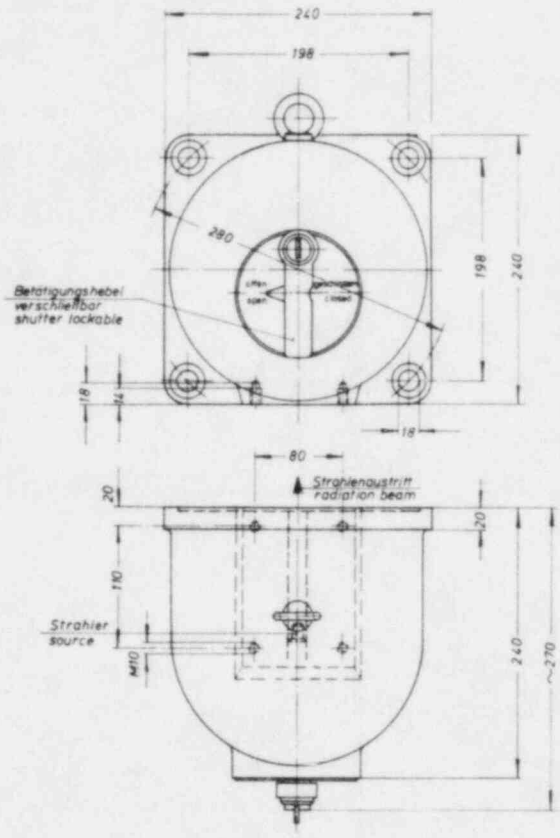
für 0,75 mrem/h (gemessen mit TOL/E) bei geschlossenem Strahlenaustrittskanal. Abstandsangaben in cm von der Oberfläche des Abschirmbehälters.



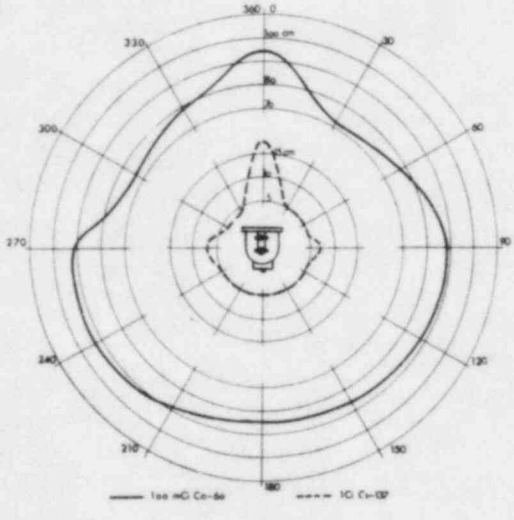
Isodose curves

for 0,75 mrem/h (measured with TOL/E) with closed radiation output channel. Distance dates in cm of the surface of the shielding container.

LB 7442

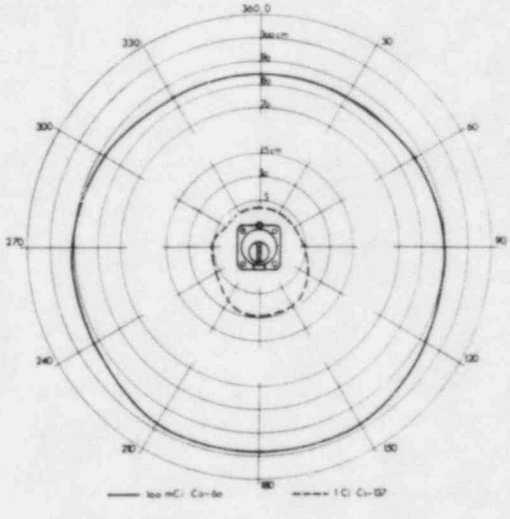


Maßbild
Dimension drawing



Isodosenkurven

für 0,75 mrem/h (gemessen mit TOL/E) bei geschlossenem Strahlenaustrittskanal. Abstandsangaben in cm von der Oberfläche des Abschirmbehälters.



Isodose curves

for 0,75 mrem/h (measured with TOL/E) with closed radiation output channel. Distance dates in cm of the surface of the shielding container.

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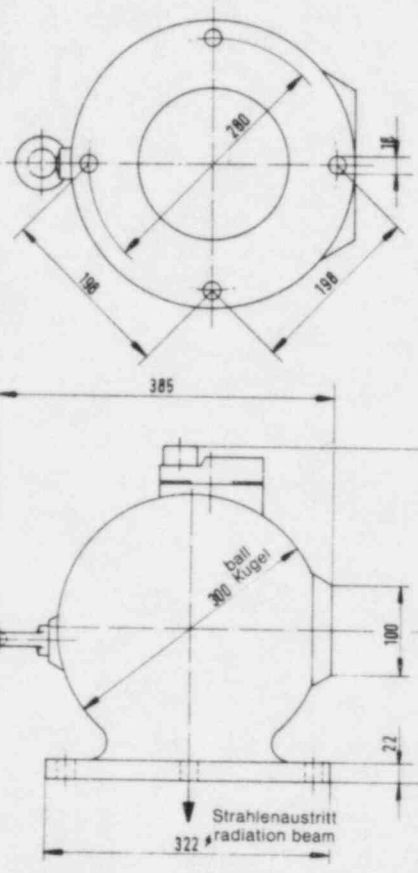
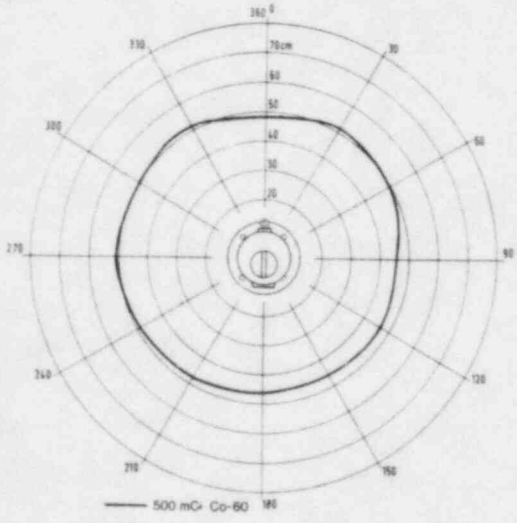
LB 7444

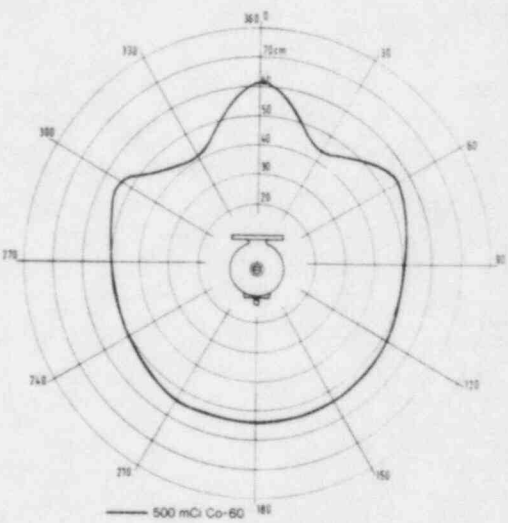


Maßbild
Dimension drawing



Isodosenkurven

für 0,75 mrem/h (gemessen mit TOL/E) bei geschlossenem Strahlenaustrittskanal. Abstandsangaben in cm von der Oberfläche des Abschirmbehälters.



Isodose curves

for 0.75 mrem/h (measured with TOL/E) with closed radiation output channel. Distance dates in cm of the surface of the shielding container.

LABORATORIUM PROF. DR. BERTHOLD, D-7547 Wildbad 1, Calmbacher Str. 22, Postfach 160, Tel (07081)3981, Telex 724019

Technische Daten/Technical dates

Typ/model	LB 7440	LB 7442	LB 7444
Zeichnung/drawing	PB 2199-100	PB 2197-100	21135.100-000 M
Flansch/flange (mm)	ca./approx. 180 x 180	ca./approx. 240 x 240	ca./approx. 322 ∅
Flansch-Anschlußmaße nach DIN 2501 Flange connection dimensions to DIN 2501	NW 125 ND 6 (4 Schraubenlöcher/ 4 screw holes)	NW 200 ND 6 (4 Schraubenlöcher/ 4 screw holes)	NW 200 ND 6 (4 Schraubenlöcher/ 4 screw holes)
Durchmesser/diameter (mm)	ca./approx. 160	ca./approx. 220	ca./approx. 300
Länge/length (mm)	ca./approx. 200	ca./approx. 270	ca./approx. 375
Gewicht/weight (kg)	ca./approx. 31	ca./approx. 81	ca./approx. 170
Abschirmdicke (mm Blei) Shielding thickness (mm lead)	ca./approx. 67	ca./approx. 97	ca./approx. 132
Winkel des Nutzstrahlenbündels Angel of the radiation beam	ca./approx. 10°	ca./approx. 6°	ca./approx. 6°
Schwächungsfaktor Weakening factor			
für/for Co-60	ca./approx. 30	ca./approx. 180	ca./approx. 1800
für/for Cs-137	ca./approx. 700	ca./approx. 16000	
Dosisleistung D in 1 m Abstand von der Oberfläche des Abschirmbehälters (mrem/h) Dose rate D in 1 m distance of the surface of the shielding container			
für/for Co-60	$D = 0.04\ A^*$	$D = 6.3 \cdot 10^{-3}\ A^*$	$D = 5.5 \cdot 10^{-4}\ A^*$
für/for Cs-137	$D = 5 \cdot 10^{-4}\ A^*$	$D = 2 \cdot 10^{-5}\ A^*$	
Dosisleistung Do an der Oberfläche des Abschirmbehälters Dose rate Do at the surface of the shielding container (mrem/h)			
für/for Co-60	$Do = 6\ A^*$	$Do = 0.53\ A^*$	$Do = 0.03\ A^*$
für/for Cs-137	$Do = 0.06\ A^*$	$Do = 1.6 \cdot 10^{-3}\ A^*$	
Radius r des Kontrollbereichs Radius r of the control range (0,75 mrem/h) (cm)			
für/for Co-60	$r = 25\sqrt{A^*}$	$r = 10\sqrt{A^*}$	$r = 3.2\sqrt{A^*}$
für/for Cs-137	$r = 2.7\sqrt{A^*}$	$r = 0.55\sqrt{A^*}$	
Betriebstemperatur Operation temperature	max. 200° C (ca./approx. 475 K)		

A* = Aktivität in mCi/activity in mCi

Technische Änderungen vorbehalten
Technical changes without prior notice

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*ATTACHMENT # 5
*ITEM # 16 - TRAINING IN RADIATION PROTECTION BY ALFRED McCABE

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

*ITEM #17 - EXPERIENCE

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

Instrumentation: Liquid Scintillation Counters
Gamma Counters
Proportional Counters

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

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

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

*ATTACHMENT # 5

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

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

b - Packard Instruments, Inc.

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

*ITEM # 17 - EXPERIENCE

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

APPLICATION FOR SERVICING OPERATION

APPLICANT

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

Application Date - April 16, 1984

1 Servicing Operations

a) Specific device:

Berthold level control systems

b) Operations to be performed:

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

ii) Make an area radiation survey, if requested.

iii) Provide wipe test, if required.

c) Step by step procedure:

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

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

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

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

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

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

  Co-60 maximum source strength 200 mCi
  whole body exposure 18 mrem

  Cs-137 maximum source strength 1000 mCi
  whole body exposure 24 mrem

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

d) Names of individuals:

James A. Welsh - Industrial Product Manager

e) Trainer's qualifications:

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

f) No operations will require radiation surveys.

2 Leak Testing of Sealed Sources

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

3 Radiation Survey Instruments

We propose using the following instruments:

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

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

INSTRUCTIONS FOR RADIOLOGICAL PROTECTION

C O N T E N T S

INSTRUCTIONS FOR RADIOLOGICAL PROTECTION

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

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

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

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

1. Types and Properties of Radio-active Radiation

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

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

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

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

2. Dosimetric Evidence

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

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

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

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

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

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

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

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

3. Important Terms

3.1 Activity

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

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

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 be informed and instructed accordingly.

Main items of information:

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

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

5.8 Considerations must be given too and mea ures taken for situations arising from accide ts or catastrophes (such as fire, explosion).

5.9 Radio-active substances must be protecte from misappropriation and unauthorized person . This applies in particular to radio-active so rces temporarily not in use which must be sto ed in protected rooms or containers.

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

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

6. Permissible Radiation Doses

6.1 Occupationally not exposed persons

Persons and, more particularly, members o the plant which are not occupationally expos d to radiation must not exceed an annual dose of 0.5 rem if they work in a monitoring area adj cent t the control area (para 51 as well as encl sures and X of the Strahlenschutzverordnung).

6.2 Occupationally exposed persons in the category B

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

6.3 Occupationally exposed persons in the category A

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

7. Radiation Protection Areas

7.1 Barred areas

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

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

7.2 Control areas

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

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

EMPLOYMENT RESUME

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

MAY 1983 --- Present
Berthold Instruments, Inc.
136 Bradford Avenue
Pittsburgh, PA 15205

Technical Representative

1981 --- APRIL 1983

Pharmatopes, Inc.
3402 Butler Street
Pittsburgh, PA 15201

Sales Representative

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

1974 --- 1981

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

Cheif Nuclear Medicine Technologist

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

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

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

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

1979 --- 1980

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

Cheif N.M. Technologist

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

1978 --- 1979

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

Biomedical Repair Technician
Electronic construction of prototype devices

Area Service Rep. for:

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

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

Forma, Inc.
Incubation and environmental chambers

1969 --- 1973

United States Navy

Hospital Corps School
Great Lakes, Ill.

Great Lakes Naval Hospital
Great Lakes, Ill.

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

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

Honorably Discharged (HM2, E5)

1967 --- 1969

Washington Hospital School of X-Ray Technology
Washington, PA

Two year on the job training in X-ray technology

Received Registry

High School

Canon-McMillan Senior High School
Canonsburg, PA

Acedemic Course
Graduated: 1967

Others:

Cleveland Institute of Electronics
Radiotelephone License and Electronics

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

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.

Department

berthold

Nuclear Instrumentation

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

January 21, 1985

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

ATTN: JACK DAVIS
CONTROL # 02478 AND 02479

Dear Sir:

Jack, please find attached the license package for Possession and Distribution. I incorporated all the deletions and additions requested into one package to simplify matters. This package along with my letter of January 11, 1985, which provided additional information and clarification should make Berthold's file up to date.

I may have been redundant in certain areas, but I hope overall that this simplifies our application.

Regards,

James A. Welsh

JAW:mls

Enclosure

Possession & Distribution Package

~~SSI-QD-19531~~

"OFFICIAL RECORD COPY"

ML10

02479

24 JAN 1985

Distribution request

NRC Form 313 I (12-81) 10 CFR 30 — U.S. NUCLEAR REGULATORY COMMISSION

APPLICATION FOR BYPRODUCT MATERIAL LICENSE
INDUSTRIAL

1. APPLICATION FOR: (Check and/or complete as appropriate)

X a. NEW LICENSE

b. AMENDMENT TO: LICENSE NUMBER

c. RENEWAL OF: LICENSE NUMBER

See attached instructions for details.

Completed applications are filed in duplicate with the Division of Fuel Cycle and Material Safety, Office of Nuclear Material Safety, and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC 20555 or applications may be filed in person at the Commission's office at 1717 H Street, NW, Washington, D. C. or 7915 Eastern Avenue, Silver Spring, Maryland.

2. APPLICANT'S NAME (Institution, firm, person, etc.)

BERTHOLD INSTRUMENTS, INC.

TELEPHONE NUMBER: AREA CODE – NUMBER EXTENSION

(412) 922-2635

3. NAME AND TITLE OF PERSON TO BE CONTACTED REGARDING THIS APPLICATION

JAMES A. WELSH, PRODUCT MANAGER

TELEPHONE NUMBER: AREA CODE – NUMBER EXTENSION

(412) 922-2635

4. APPLICANT'S MAILING ADDRESS (Include Zip Code) (Address to which NRC correspondence, notices, bulletins, etc., should be sent.)

136 BRADFORD AVENUE
PITTSBURGH, PA 15205

5. STREET ADDRESS WHERE LICENSED MATERIAL WILL BE USED (Include Zip Code)

136 BRADFORD AVENUE
PITTSBURGH, PA 15205

(IF MORE SPACE IS NEEDED FOR ANY ITEM, USE ADDITIONAL PROPERLY KEYED PAGES.)

6. INDIVIDUAL(S) WHO WILL USE OR DIRECTLY SUPERVISE THE USE OF LICENSED MATERIAL (See Items 16 and 17 for required training and experience of each individual named below)

	FULL NAME	TITLE
a.		
b.		
c.		

7. RADIATION PROTECTION OFFICER

JAMES A. WELSH

Attach a resume of person's training and experience as outlined in Items 16 and 17 and describe his responsibilities under Item 15.

8. LICENSED MATERIAL

LINE NO.	A ELEMENT AND MASS NUMBER	B CHEMICAL AND/OR PHYSICAL FORM	C NAME OF MANUFACTURER AND MODEL NUMBER (Of Sealed Source)	D MAXIMUM NUMBER OF MILLICURIES AND/OR SEALED SOURCES AND MAXIMUM ACTIVITY PER SOURCE WHICH WILL BE POSSESSED AT ANY ONE TIME
	Refer to attachment #1 item 8 (a) thru (d)			
(1)	COBALT-60	SEALED ROD SOURCE	BERTHOLD-GERMANY P-2608-100 & 101	50 mCi ea.
(2)	COBALT-60	SEALED POINT SOURCE	BERTHOLD-GERMANY P-2602-100	200 mCi ea.
(3)	CESIUM-137	SEALED ROD SOURCE	AMERSHAM BUCHLER UZ-287 & SK-1208	500 mCi ea.
(4)	CESIUM-137	SEALED POINT SOURCE	AMERSHAM BUCHLER P-2623-100	1000 mCi ea.

	E DESCRIBE USE OF LICENSED MATERIAL
(1)	TO BE USED IN INDUSTRIAL DEVICES TO MONITOR AND MEASURE.
(2)	TANK LEVELS, DENSITY MEASUREMENT, BELT WEIGHING, MOISTURE MEASUREMENTS AND ASH CONTENT DETERMINATION.
(3)	
(4)	

9. STORAGE OF SEALED SOURCES

LINE NO.	CONTAINER AND/OR DEVICE IN WHICH EACH SEALED SOURCE WILL BE STORED OR USED. A.	NAME OF MANUFACTURER B.	MODEL NUMBER C.
(1)	Refer to attachment #1 item 9.		
(2)	~~N/A~~		
(3)			
(4)			

10. RADIATION DETECTION INSTRUMENTS

LINE NO.	TYPE OF INSTRUMENT A	MANUFACTURER'S NAME B	MODEL NUMBER C	NUMBER AVAILABLE D	RADIATION DETECTED (alpha, beta, gamma, neutron) E	SENSITIVITY RANGE (milliroentgens/hour or counts/minute) F
(1)						
(2)		N/A				
(3)						
(4)						

11. CALIBRATION OF INSTRUMENTS LISTED IN ITEM 10

☐ a. CALIBRATED BY SERVICE COMPANY

NAME, ADDRESS, AND FREQUENCY

☐ b. CALIBRATED BY APPLICANT

Attach a separate sheet describing method, frequency and standards used for calibrating instruments.

12. PERSONNEL MONITORING DEVICES

TYPE (Check and/or complete as appropriate.) A	SUPPLIER (Service Company) B	EXCHANGE FREQUENCY C
☐ (1) FILM BADGE ☐ (2) THERMOLUMINESCENCE DOSIMETER (TLD) ☐ (3) OTHER (Specify): _____	N/A	☐ MONTHLY ☐ QUARTERLY ☐ OTHER (Specify): _____

13. FACILITIES AND EQUIPMENT (Check were appropriate and attach annotated sketch(es) and description(s).

☐ a. LABORATORY FACILITIES, PLANT FACILITIES, FUME HOODS (Include filtration, if any), ETC.

☐ b. STORAGE FACILITIES, CONTAINERS, SPECIAL SHIELDING (fixed and/or temporary), ETC.

☐ c. REMOTE HANDLING TOOLS OR EQUIPMENT, ETC.

☐ d. RESPIRATORY PROTECTIVE EQUIPMENT, ETC. N/A

14. WASTE DISPOSAL

a. NAME OF COMMERCIAL WASTE DISPOSAL SERVICE EMPLOYED

b. IF COMMERCIAL WASTE DISPOSAL SERVICE IS NOT EMPLOYED, SUBMIT A DETAILED DESCRIPTION OF METHODS WHICH WILL BE USED FOR DISPOSING OF RADIOACTIVE WASTES AND ESTIMATES OF THE TYPE AND AMOUNT OF ACTIVITY INVOLVED. IF THE APPLICATION IS FOR SEALED SOURCES AND DEVICES AND THEY WILL BE RETURNED TO THE MANUFACTURER, SO STATE.

N/A

INFORMATION REQUIRED FOR ITEMS 15, 16 AND 17

Describe in detail the information required for Items 15, 16 and 17. Begin each item on a separate page and key to the application as follows:

15. RADIATION PROTECTION PROGRAM. Describe the radiation protection program as appropriate for the material to be used including the duties and responsibilities of the Radiation Protection Officer, control measures, bioassay procedures *(if needed)*, day-to-day general safety instruction to be followed, etc. If the application is for sealed source's also submit leak testing procedures, or if leak testing will be performed using a leak test kit, specify manufacturer and model number of the leak test kit.

16. FORMAL TRAINING IN RADIATION SAFETY. Attach a resume for each individual named in Items 6 and 7. Describe individual's formal training in the following areas where applicable. Include the name of person or institution providing the training, duration of training, when training was received, etc.

    a. Principles and practices of radiation protection.

    b. Radioactivity measurement standardization and monitoring techniques and instruments.

    c. Mathematics and calculations basic to the use and measurement of radioactivity.

    d. Biological effects of radiation.

17. EXPERIENCE. Attach a resume for each individual named in Items 6 and 7. Describe individual's work experience with radiation, including where experience was obtained. Work experience or on-the-job training should be commensurate with the proposed use. Include list of radioisotopes and maximum activity of each used.

18. CERTIFICATE

(This item must be completed by applicant)

The applicant and any official executing this certificate on behalf of the applicant named in Item 2, certify that this application is prepared in conformity with Title 10, Code of Federal Regulations, Part 30, and that all information contained herein, including any supplements attached hereto, is true and correct to the best of our knowledge and belief.

WARNING.--18 U.S.C., Section 1001; Act of June 25, 1948; 62 Stat. 749; makes it a criminal offense to make a willfully false statement or representation to any department or agency of the United States as to any matter within its jurisdiction.

a. LICENSE FEE REQUIRED *(See Section 170.31, 10 CFR 170)*	b. CERTIFYING OFFICIAL *(Signature)*
$ 950.00	c. NAME *(Type or print)* ALFRED J. McCABE
(1) LICENSE FEE CATEGORY: 3 G	d. TITLE EXEC. VICE-PRES.
(2) LICENSE FEE ENCLOSED: $ 950.00	e. DATE MAY 24, 1984

*ATTACHMENT # 1
*ITEM # 8 - LICENSED MATERIAL

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 Be	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.

*ITEM # 9 - STORAGE OF SEALED SOURCES.

A. Returned Berthold sealed source.

Will be stored behind lead brick caves to await disposal.

B. Source awaiting distribution.

These sources will be stored in its own shielded housing approved for safety.

C. Sources used for instrument checking.

These sources will be of exempt quantity but aggregate quantities will be stored behind lead brick shields.

: # 9)

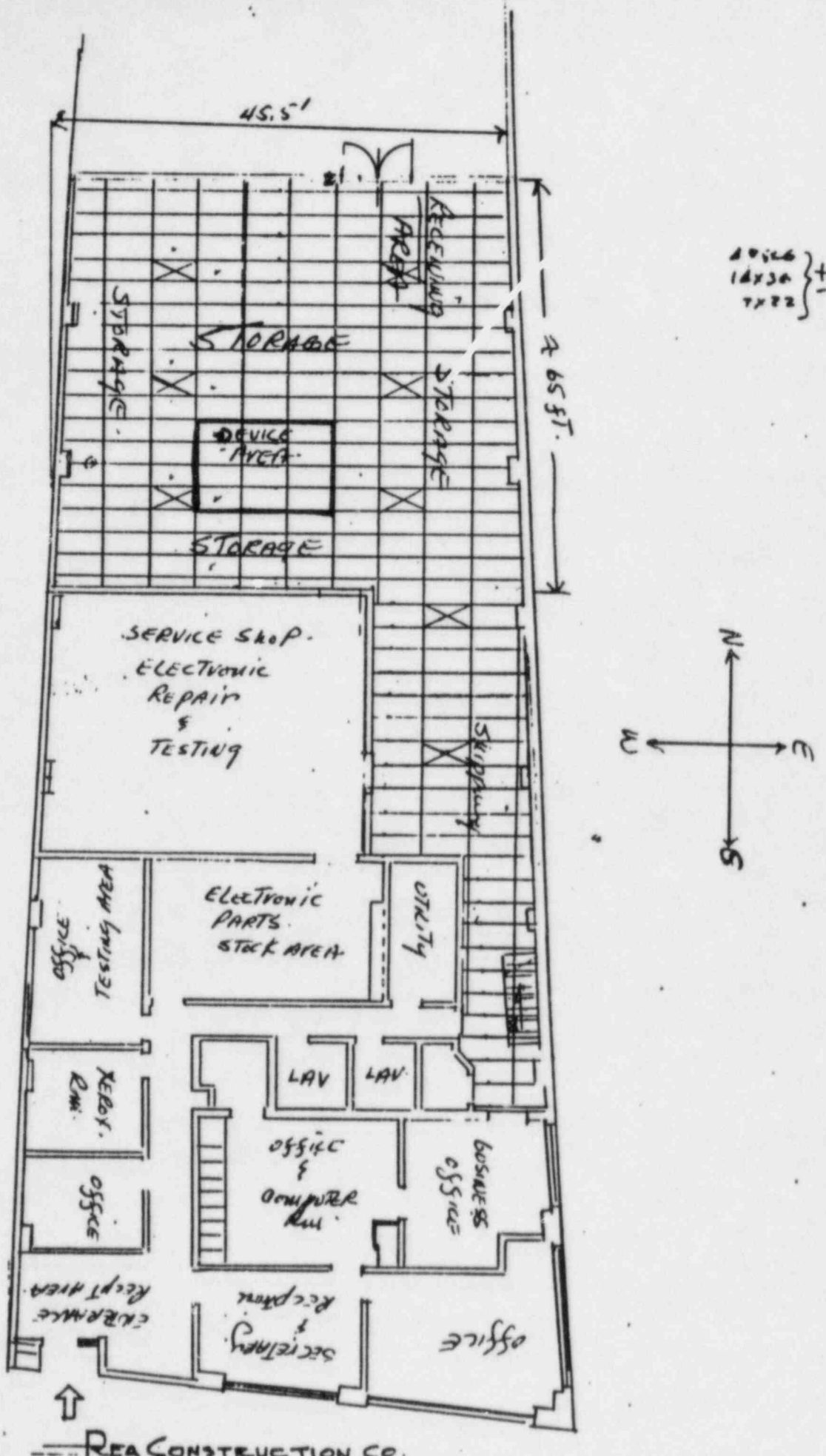
1)	Rod source housing shield for sources 2608-100/101 and VZ287.	Berthold	21157.001
2)	Housing for Source P2611-100.	Berthold	19166-002
3)	Shield storage for housing 19166-002.	Berthold	21121-002
4)	Point Source shield housing for sources P-2602-100, P-2623-100, and 2645.100-000.	Berthold	P82199.002
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

attachment #2

13a



REA CONSTRUCTION CO.
136 BRADFORD AVE.
GRAFTON PA.

=APPROX. OFFICE LAYOUT

Att. #3.

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.