23 March 1984

Mr. Steven L. Baggett
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Baggett:

Pursuant to the course of action agreed upon during our phone conversation of 16 February 1984, we are forwarding the information requested by you for the licensing of the coal-slurry sensors. In addition, we are providing information on the seven items requested by James W. Patterson; copy of the letter enclosed. These radiation safety and radiation handling data are related to an application for an amendment to License No. 37-1712-11. The license and amendment are to authorize use of custom radiation gauging devices manufactured by Science Applications, Inc.

The body of this communication is devoted to background information on the function of the devices, the construction and pressure-safety margin, and the past experience with the system. Attachment 1 covers the seven (7) items that Mr. Patterson asked us to address. Also enclosed are earlier communications with (then) DOE covering the earlier descriptive material related to radiation safety and licensing, and later communications between NRC, Pittsburgh Research Center, and SAI: I have taken the liberty of updating the data of the October 1, 1981 letter and attachments to cover the reduced radiation fields for the 6" and 18" sensors due to proportional reductions in source strengths, and to include radiation-field data for the 10" and 12" sensors as well.

The generic name for the device is, "Coal Slurry Concentration Sensor." It consists of a neutron sensor, a gamma-ray sensor, and a conductivity gauge. The neutron gauge provides a sensitive, yet independent measure of the water content and the coal content in the slurry, by virtue of the hydrogen content: Pittsburgh Seam Bituminous coal has about 35% by weight, of the hydrogen content of water. It is relatively insensitive to rock content. The gamma-ray probe, on the other hand, has nearly the same sensitivity per unit areal mass to water, coal and rocks. The conductivity gauge strictly measures water content (or, by subtraction, total solids volume). Thus, with three simultaneous equations that relate the outputs of the three sensors to coal, rock, and water content, one solves for the coal, rock and water concentrations by means of a microprocessor and prints out the concentrations every 1-2 seconds. These data are used in studying coal/rocks/water haulage to the surface of deep underground mines by the hydraulic transport method.

Only the conductivity gauge is in direct contact with the slurry. However, it is constructed of standard steel pipe, rubber lined internally, that is rated way above the normal operating pressures and well above the rupture-disk blowout pressure of the 6" line and the 18" line where each is installed.

All four concentration sensors (one each for the 6", the 10", the 12" and the 18" diameter haulage line) utilize a clamp-on type of neutron gauge and gamma-ray gauge mounted on a section of steel haulage pipe that is rated way above the normal operating pressures of the rest of each line, and well above the safety-disk rupture pressure. The 6" and 18" sensors are presently mounted on the vertical pipe section of the Bureau of Mines Hydraulic Transport Research Facility (HTRF). Both the gauge and vertical haulage pipe are secured to the scaffolding at frequent intervals along the pipe. The HTRF is completely enclosed, including the vertical section with scaffolding, so that entry to the area where the gauges are present is controlled.

The regions where the neutron and gamma-ray sensors are mounted are mostly well out of reach from the walkways. Nevertheless, roped-off exclusion areas are employed with posted signs reading, "Danger, Radiation Area," at the periphery, where the radiation field strength drops below 2 mrem/hr.

The operating crew are well trained in working with the sensors, and simply stay beyond the roped-off areas until the local health physicist (or authorized SAI personnel) removes the sources and places them in their shipping and storage casks. Here, again, a roped off area is used for radiation storage. The whole operation is in a controlled area, inside a locked building.

During operation, the sources are installed, a padlock arrangement is used to secure them inside their respective shields, and the area is roped-off with "Danger - Radiation Area" signs attached to the ropes.

Both neutron and gamma-ray gauge housings are of welded aluminum plate construction. The gamma-ray sources are shielded with enough lead to reduce the radiation field well below 2 mr/hr at one foot from the surface of the gamma-ray gauge housing. The neutron sources are shielded by about one inch of lead and 12" of polyethylene for the 10", 12" and 18" lines, and 6" of polyethylene for the 6" sensor. Due to limitations of space, weight and handling ability, the neutron source shielding was designed to reduce the radiation field to about 2 mrem/hr at 2' from the gauge housing. The neutron sources are therefore roped-off at about 2' from the housing and posted with appropriate "CAUTION - RADIOACTIVE MATERIAL" signs.

We hope that the above description will provide the kind of background information that you requested about the sensors, their sturdiness, and the related radiation-safety considerations. The enclosed October 1, 1981 letter to Richard Wang, with attachments concerning the radiation-safety data, will hopefully provide the remaining information needed for processing the radiation-licensing request. And, of course, the response to the

seven (7) items addressed in the letter of James W. Patterson (also enclosed) is also included. Please let me know, at your earliest convenience, of anything I might have overlooked or of anything needing further description.

Sincerely,

SCIENCE APPLICATIONS, INC.

Victor V. Verbinski

Dr. Victor V. Verbinski
Principal Investigator
Coal Slurry Concentration Sensor Program
(Sponsored by Bureau of Mines, Department of Interior, Mr. Richard C. Wang, Technical Project Monitor)

VVV:smr
Enclosures

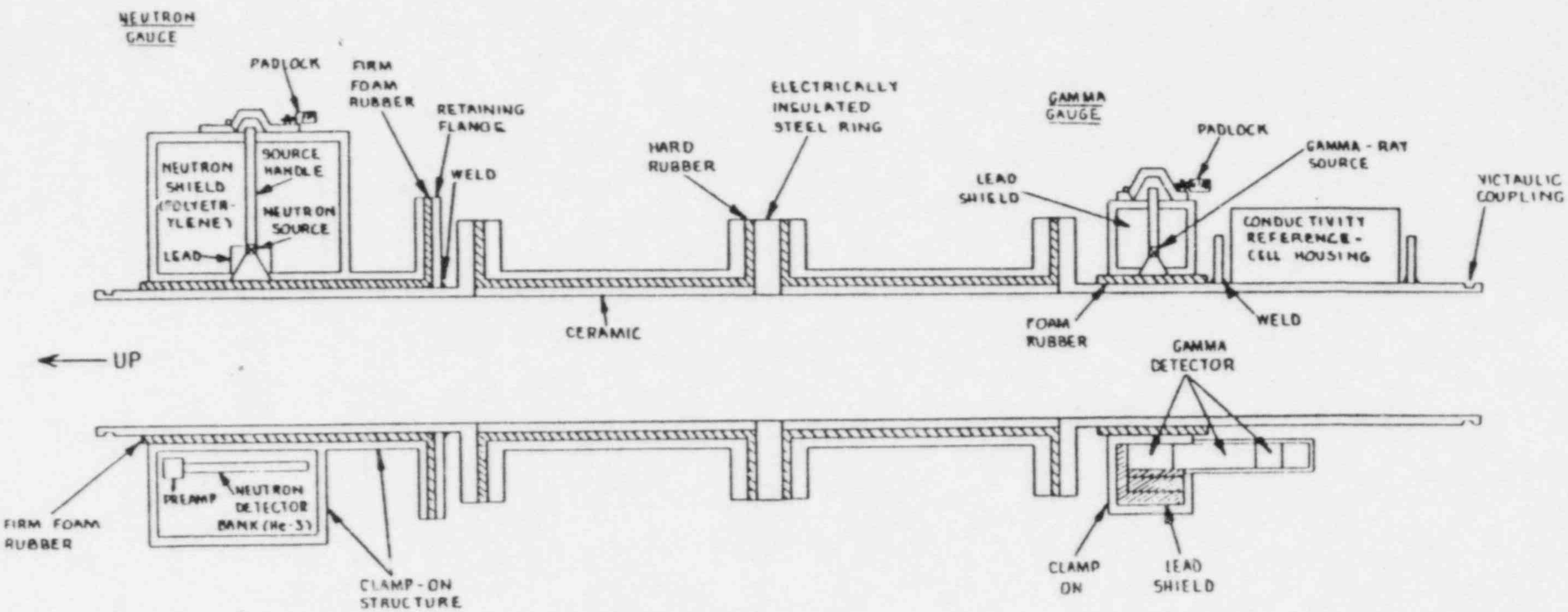


Figure 1. Coal Slurry Concentration Sensor.

October 1, 1981

Mr. Richard C. Wang
U.S. Department of Energy
Pittsburgh Mining & Technology Center
P.O. Box 10940
Pittsburgh, PA 15236

Dear Mr. Wang:

This is to forward the data needed for licensing of the radiation sources utilized in the 6", 10", 12" and 18" coal slurry concentration sensors. The sources and maximum source strengths for the 6" sensor are as follows:

Neutron:	3 ea.	Cf-252	1 μg (0.537 mCi)
Gamma:	3 ea.	Cs-137	1 mCi

This corresponds to a total of 3 μg (1.61 mCi) for Cf-252 and 3 mCi for Cs-137.

For the 10" and 12" sensors, the source strengths are as follows:

Neutron:	2 ea.	2 μg (1.074 mCi)
	1 ea.	5 μg (2.685 mCi)
Gamma:	2 ea.	3 mCi
	1 ea.	5 mCi

For the 18" sensor, the corresponding sources are as follows:

Neutron:	2 ea.	Cf-252	5 μg (2.685 mCi)
	1 ea.	Cf-252	10 μg (5.37 mCi)
Gamma:	2 ea.	Cs-137	5 mCi
	1 ea.	Cs-137	10 mCi

This corresponds to a total of 20 μg (10.74 mCi) for Cf-252 and 20 mCi for Cs-137.

A description of the neutron sources and source encapsulation is presented in Attachment 1. The corresponding gamma source data can be found in Attachment 2. The sources are manufactured/encapsulated by Amersham Corp. They are rugged industrial sources and are doubly encapsulated in heliarc-welded stainless steel capsules. The Cf-252 neutron source encapsulation is the X.1 capsule (see Attachment 1, Figure 26) in all cases. The Cs-137 gamms ray capsule is the X.8 capsule of page 55, Attachment 2.

A radiation field mapping was conducted for the 6", 10", 12" and 18" sensors, and the results are presented in Attachments 3 and 4 respectively. The radiation fields for the 6" gamma gauge are the order of 0.2 mRem/hr at 3 feet. For the 6" neutron gauge, the fields are the order of 1.5 mRem/hr at 2 feet and will require a rope or fence exclusion barrier at 2 feet from the gauge.

The radiation fields for the 18" gamma ray gauge are also quite low at 2 feet. They are significantly higher for the neutron gauge, being close to the field strengths observed for the 6" neutron gauge. A rope or fence exclusion barrier will be required for the 18" neutron gauge at about 2 feet.

No sources will be present in any of the sensors during installation. They will be inserted via the source-holders shown in Attachments 5 and 6, and will be secured in place via combination locks for the 6" and via padlocks for the 18", the 10" and 12" sensors.

The sources will be shipped in separate DOT-approved shipping containers. They will be installed and removed only by radiation-gadged personnel who are cleared to handle sealed radiation sources. After installations, the radiation gauges will be properly identified as such with glue-on radiation labels, and the exclusion area will be roped off or fenced in (at the discretion of the local Radiation Safety Officer).

In the event of any major mishaps with the neutron and gamma ray gauges, radiation-qualified and badged personnel will attend to removing the sources and putting them safely away in the shipping containers. These containers, when loaded with the sources, will be kept in a limited-access area and appropriately locked and/or roped off with the proper radiation labels and placards in clear sight at the safe exclusion boundaries as well as on the shipping containers themselves.

We hope that these data will facilitate early administration of a safe operating procedure with radiation sources, and an early approval of any licensing amendment that may be necessary.

Please let us know at your earliest convenience if there is any additional information we can supply to help in bringing the radiation-handling/licensing task to an early and satisfactory conclusion.

Sincerely,

SCIENCE APPLICATIONS, INC.

Victor V. Verbinski

Victor V. Verbinski
Principal Investigator

VVV:smr
Attachments

Spontaneous fission neutron sources

Californium-252

Nuclear data

Californium-252 decays by α-emission and spontaneous fission emitting neutrons

Half-life (α-decay):	2.73 years
Half-life (spontaneous fission):	85.5 years
Half-life (effective):	2.65 years
Neutron emission:	2.3×10^9n/sec per mg
Average neutron energy:	~2MeV
Equilibrium γ-exposure rate (from unshielded source):	1.6×10^2mR/h at 1m per mg
Neutron dose rate:	~2.3rem/h at 1m per mg
Specific activity:	~536mCi/mg

Composition

Californium-252 as oxide (normally for sources up to 20μg) or as a palladium cermet in the form of wire or pellet for 50μg and over.

Encapsulation

The radioactive material is doubly-encapsulated in welded stainless steel capsules (see fig. 26) as listed in the adjoining table.

Sources containing 100μg and over can also be supplied in various other capsules; details on request.

Quality control

Wipe test A
Bubble test D
Immersion test L (for sources under 50μg)

Neutron emission measured against standards using BF_3/wax moderator system.

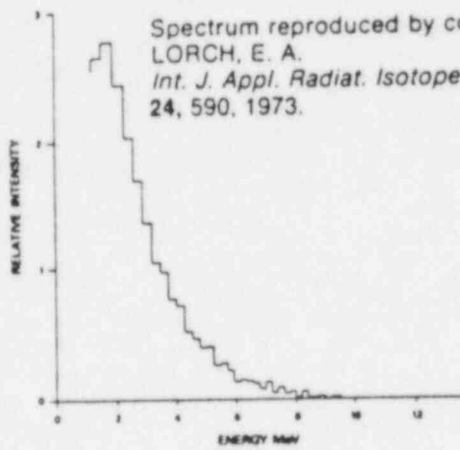
The test report includes a statement of the neutron emission.

^{252}Cf content*	^{252}Cf activity	emission n/sec	capsule	code
0.01μg	5μCi	2.3×10^4	X.1	CVN.101
0.1μg	54μCi	2.3×10^5	X.1	CVN.1
0.5μg	268μCi	1.15×10^6	X.1	CVN.2
1μg	536μCi	2.3×10^6	X.1	CVN.3
2μg	1.07mCi	4.6×10^6	X.1	CVN.4
5μg	2.7mCi	1.15×10^7	X.1	CVN.5
10μg	5.4mCi	2.3×10^7	X.1	CVN.6
20μg	10.7mCi	4.6×10^7	X.1	CVN.7
50μg	27mCi	1.15×10^8	X.1	CVN.10
100μg	54mCi	2.3×10^8	X.1	CVN.11
200μg	107mCi	4.6×10^8	X.1	CVN.12
500μg	268mCi	1.15×10^9	X.33	CVN.330
1mg	536mCi	2.3×10^9	X.33	CVN.331
2mg	1.07Ci	4.6×10^9	X.35	CVN.352
3mg	1.61Ci	6.9×10^9	X.35	CVN.353

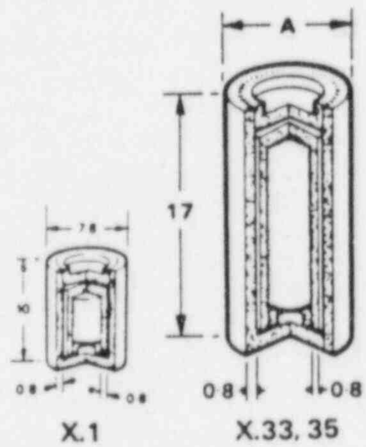
*tolerance −10, +20%

Neutron spectrum

Source made and measured at Amersham using a stilbene crystal and pulse shape discrimination.



Spectrum reproduced by courtesy of:
LORCH, E. A.
Int. J. Appl. Radiat. Isotopes,
24, 590, 1973.



capsule	diam. 'A' mm
X.33	7.8
X.35	9.5

Fig. 26 Dimensions in mm

Prototype testing

capsule	IAEA special form	ANSI classification
X.1	SFC.7	C64544
X.33	SFC.174	C64545
X.35	SFC.175	C64545

Availability:
Up to 2μg —D6
5–50μg —D5
100μg and over—D*

Cesium-137 sources

Sources up to 3 curies contain the radionuclide as a bead of cesium glass; the higher activity sources contain compressed pellets of cesium chloride.

Encapsulation is in welded stainless steel. Sources up to 300mCi are supplied with single or double encapsulation; higher activity sources are doubly encapsulated.

Quality control
Wipe test A
Bubble test D
Immersion test M (for capsules X.7, 8, 9, 19)
Helium leak test H (for capsules X.60/1–66/1)

A Test Report is supplied with each source or batch of sources, stating the measured equivalent activity for sources up to 3Ci; for higher activity sources, the nominal content is stated, together with the exposure rate measured according to the procedure in ICRU Report 18.

Prototype testing:

capsule type	IAEA Special form	ANSI Classification
X.7	SFC.23	C64444
X.8	SFC.24	C64444
X.9	SFC.25	C64444
X.19	SFC.117	C64444
X.60/1		E63534
X.60/2		E63534
X.61/1		E63534
X.62/1		E63534
X.63/1		E63534
X.64/1		E63534
X.65/1		E63534
X.66/1		E63534

nominal equivalent activity*	single encapsulation type X.7 source code	double encapsulation type	double encapsulation source code
1mCi	CDC.701	X.8	CDC.801
3mCi	CDC.703	X.8	CDC.803
5mCi	CDC.704	X.8	CDC.804
10mCi	CDC.705	X.8	CDC.805
20mCi	CDC.706	X.8	CDC.806
30mCi	CDC.707	X.8	CDC.807
50mCi	CDC.708	X.8	CDC.808
100mCi	CDC.709	X.8	CDC.809
200mCi	CDC.710	X.8	CDC.810
300mCi	CDC.711	X.8	CDC.811
500mCi		X.19	CDC.190
1Ci		X.19	CDC.191
2Ci		X.19	CDC.192
3Ci		X.9	CDC.93

*tolerance −0, +25%
for definition of equivalent activity, see page 00.

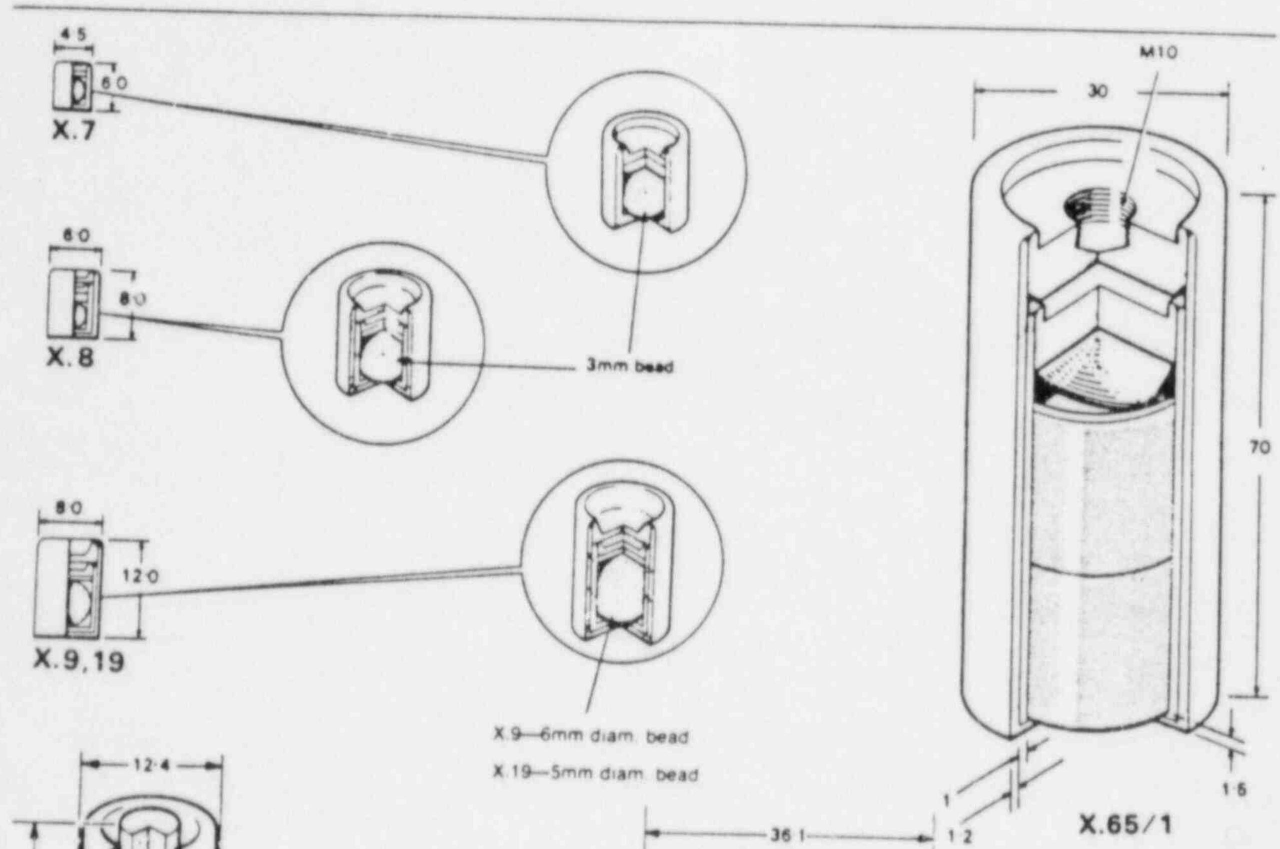
nominal content†	type	source code
5Ci	X.60/2	CDC.6024
10Ci	X.60/2	CDC.6025
30Ci	X.60/1	CDC.601
55Ci	X.61/1	CDC.611
120Ci	X.62/1	CDC.621
230Ci	X.63/1	CDC.631
450Ci	X.64/1	CDC.641
1500Ci	X.65/1	CDC.651
2700Ci	X.66/1	CDC.661

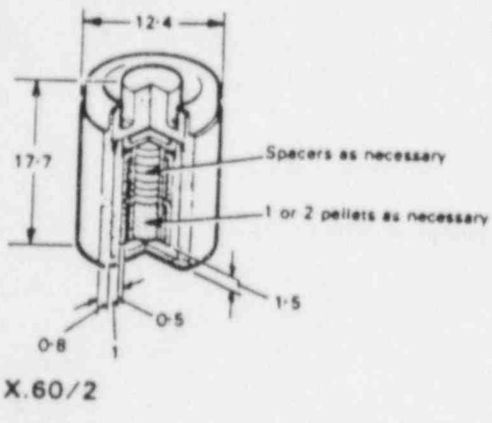
†dependent on specific activity of the caesium chloride; content normally within −0, +25% of stated nominal.

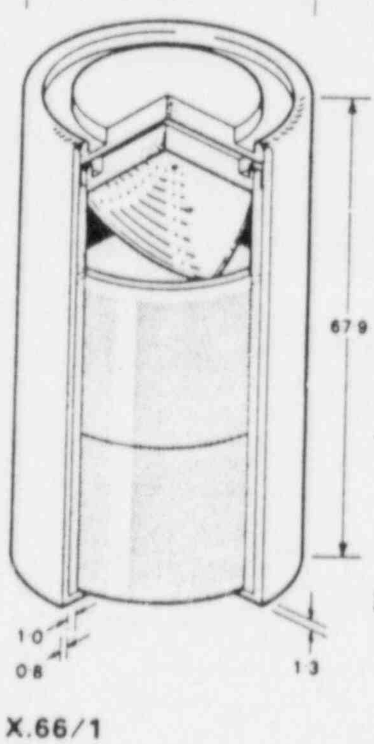
Availability
Sources up to 55Ci: D4
Sources over 55Ci: D*

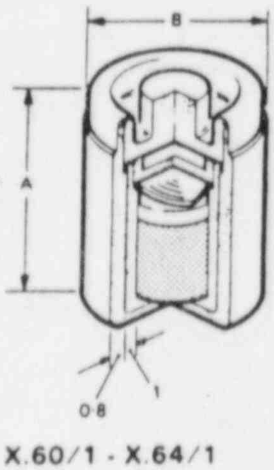
Cesium-137 sources, 3mCi–3Ci, can be supplied calibrated with measured radiation output (code H.50).
Calibration accuracy: ±5% overall uncertainty.

Cesium-137 source capsules







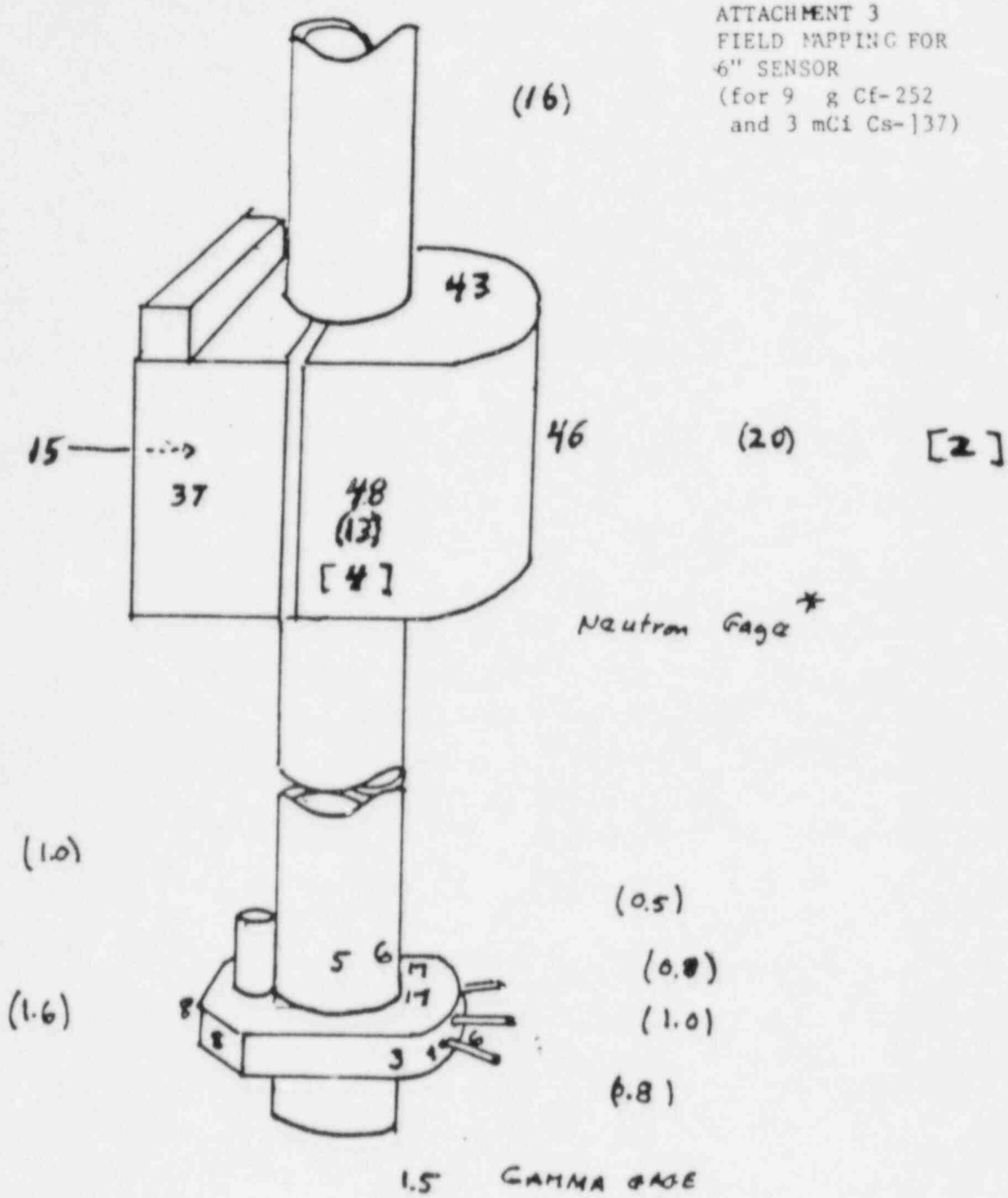


Capsule dimensions

capsule	height 'A' mm	diameter 'B' mm
X.60/1	17.7	12.4
X.61/1	20.2	14.6
X.62/1	22.7	17.4
X.63/1	26.2	21.2
X.64/1	28.2	27.0

Dimensions in mm

ATTACHMENT 3
FIELD MAPPING FOR
6" SENSOR
(for 9 g Cf-252
and 3 mCi Cs-137)



TOTAL DOSE RATES AROUND 6" COAL Slurry Concentration Gage

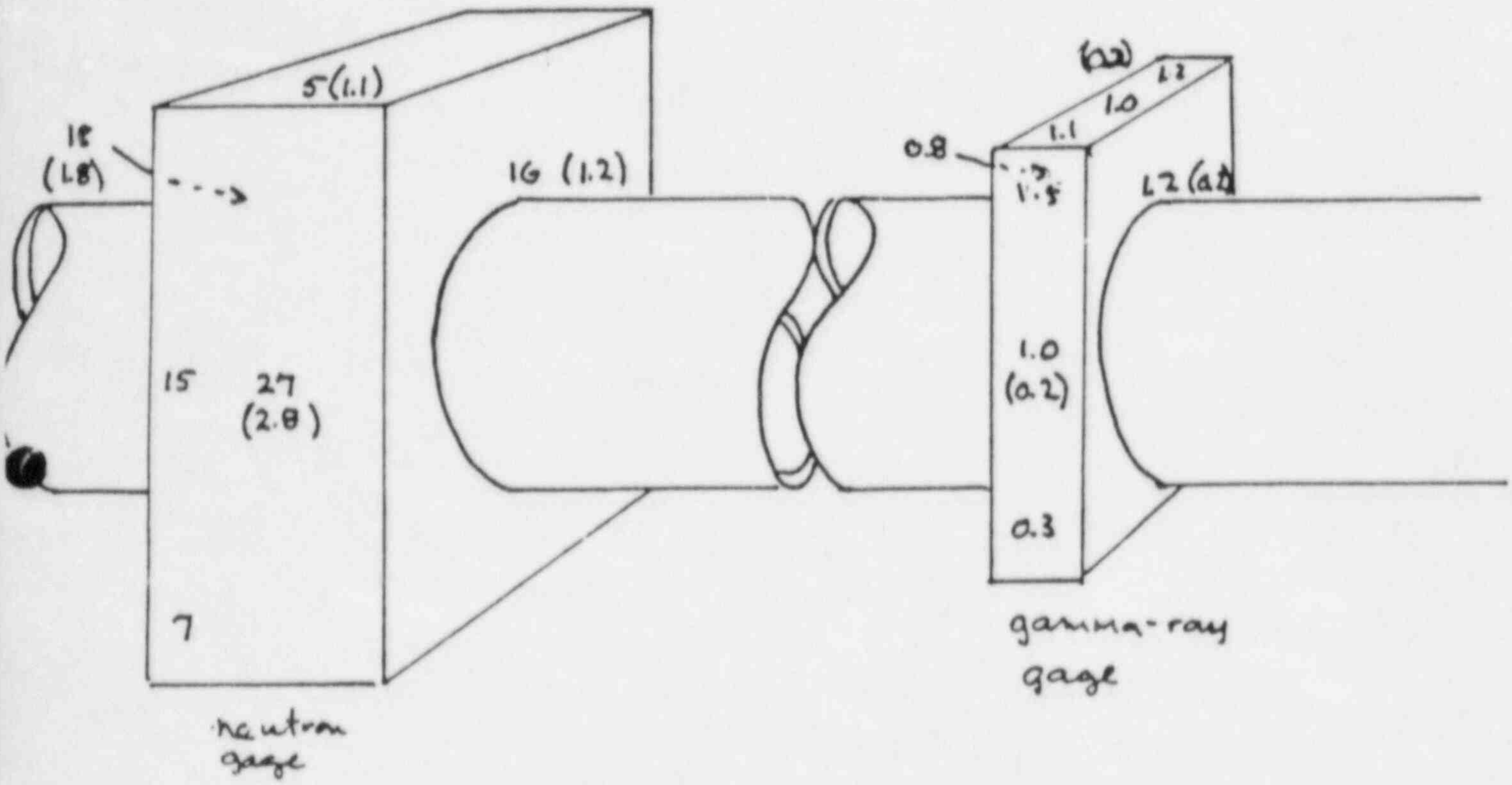
Numbers represent total dose rate (mRem/h at surface

( ) measurements at 1ft

[ ] measurements at 3ft

* Neutron dose rates measured with 1.6 µg source and scaled to 9 µg source

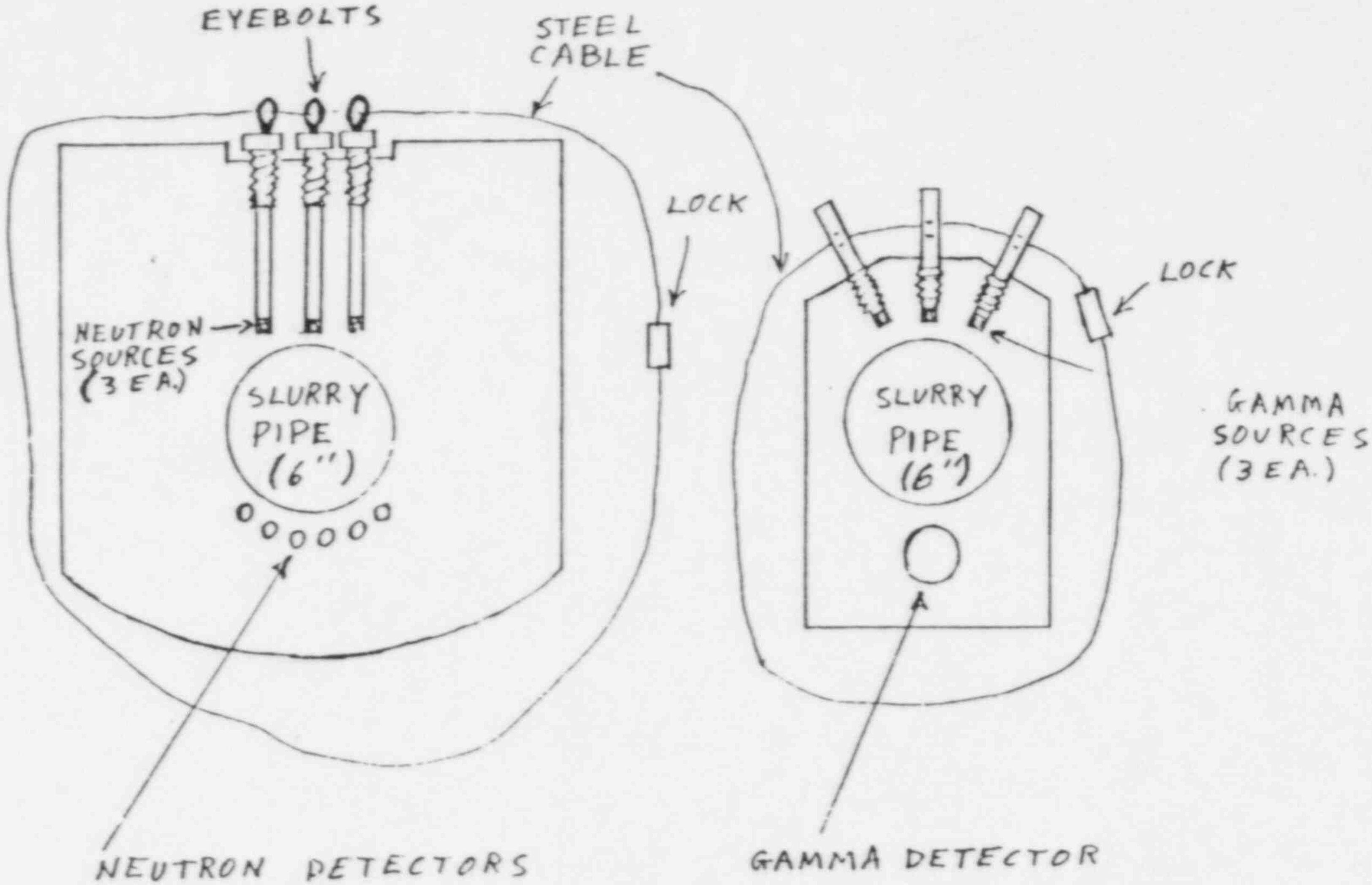
ATTACHMENT 4
FIELD MAPPING FOR 18"
SENSOR
(40 μg Cf-252 and
60 mCi Cs-137)



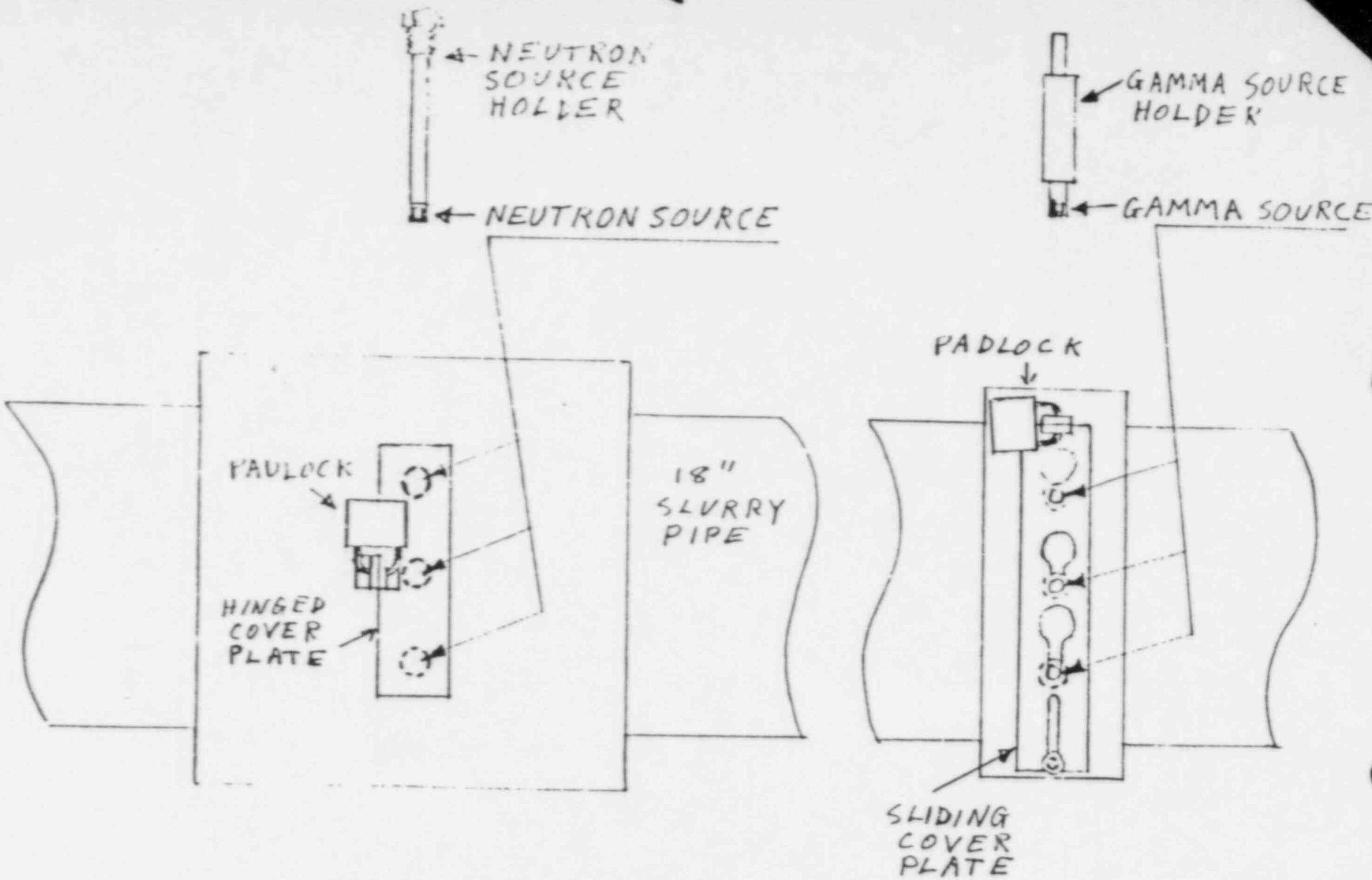
<u>TOTAL DOSE RATES</u> 18" Coal Slurry
Concentration Gage

numbers indicate dose rate mRem/hr

( ) indicates measurement at 3 ft
from surface



ATTACHMENT 5: SOURCE LOCKING MECHANISM FOR 6" SENSOR



ATTACHMENT 6: SOURCE LOCKING MECHANISM FOR 18" SENSOR

ATTACHMENT 1

RESPONSE TO THE SEVEN ITEMS ADDRESSED BY JAMES W. PATTERSON

1. List of the isotopes, number of sources, and the total activity.

   Please see October 1, 1981 letter to Mr. Richard C. Wang, with attachments.

2. Frequency of leak tests.

   The recommended frequence for source wipes (for alphas, Cf-252, and betas, Cs-137) is 6 months. This is the frequency of routine source wiping when the sources are in possession of SAI (i.e., when the gauges are being fabricated and awaiting shipment, when they are returned to SAI from the various locations where they may be used, etc.) This is the period between source wipes that has been recommended to Bureau of Mines.

3. Description of sealed sources, source holders, source shielding and method of inserting and retaining sources in shields, and of padlocking mechanism and procedures.

   Please refer to above letter (to Mr. Baggett), and letter to Mr. Wang with attachments.

4. Information to be fixed to the devices, and location of label.

   This label includes the name of the manufacturer (Science Applications, Inc.), name of device, type of isotope (Cs-137 and Cf-252), the number and strength of each source type, the date of the last source wipe, and the standard label for radiation sources (which contains the words "CAUTION - RADIOACTIVE MATERIAL.")

5. "Indicate the duration of time and what tests were performed on the device at each test site." "The testing, engineering analysis, or historical data should demonstrate that the device will maintain containment integrity during specified conditions of use."

   As for historical data, the 6" and 18" sensors have been installed and used at the Hydrotransport Research Facility (HTRF) of the Pittsburgh Mining Technology Center (PMTC) since 1982 with no incident related to radiation safety, containment integrity. One sensor (the 12" sensor, used on a 12" hydraulic haulage line) has recently been tested at the Saskatoon Research Council (SRC) facility in Saskatoon, Saskatchewan, Canada. At both the HTRF and SRC facility, the haulage pipe was relatively free of vibration and the system was therefore in no danger of "breakage."

   The piece of piping on which the instrumentation is mounted (the "Spoolpiece") is Schedule 80 pipe, and the rest of HTRF and SRC facility utilizes Schedule 40 pipe. Therefore, the "spoolpiece" is

rated for a much higher pressure and the rest of the pipeline is much more likely to rupture first.

At the HTRF, the piping is attached to the scaffolding at frequent intervals and is therefore restrained from falling by the points of attachment and by the rigidity of the pipe (i.e., if it were to completely break in two, which is not likely for a mild steel, the stiffness of the pipe would keep it from falling or bending over above the lower attachment point).

The sensor has the sources completely removed when it is being installed, taken down, shipped, or when not in use. Thus, the containment integrity applies only to the situation wherein it is mounted as part of the haulage line.

As such, the neutron and gamma-ray gauges are each in a separate housing, and the housing is mounted on the pipe by a clamp-on arrangement with firm foam rubber (about ½" thick) between pipe and housing. For vertical mounting, an added sleeve is attached to the heavy neutron housing. It is also mounted on the pipe via a firm foam rubber seating. At the far end of the sleeve is a flat plate that's welded to the pipe and attached to the "sleeve" again with a firm foam rubber seating. This plate keeps the gauge, with heavy polyethylene shield, from slipping down the instrumentation spoolpiece. The gamma-ray gauge is mounted with a firm foam rubber seating, and is kept from sliding down the pipe by a flange welded on to the pipe.

Both neutron and gamma-ray gauges are of welded aluminum plate construction and able to withstand considerable shock and vibration during shipment, installation, and use. The shock and vibration during use is about an order of magnitude lower than what it had withstood during shipping and installation, with sources removed, of course. Therefore, the historical data on shipping, installation and past use in the HTRF and SRC facility demonstrate that the device has (and will) maintain containment integrity.

In the design of the gauge, a task of evaluating the normal temperature pressure, vibration and shock was carried out and the sensor system was designed to withstand these with a safety factor of about 10.

6. Safety Analysis. See Attachment 2 of this communication.

7. Radiological Safety and Operating Instructions. See Attachment 3 of this communication.

ATTACHMENT 2

SAFETY ANALYSIS

1. Safety Considerations during Shipment, Installation, Removal, Storage.

   No sources are to be installed during these activities. This is so stated in the radiological safety and operating instructions.

2. Safety Considerations during Use.

   The Coal Slurry Concentration Sensor utilizes an "instrumentation spoolpiece" that consists of three different pieces bolted together by means of flanges welded to the pipe, and fastened to the remaining piping of the test facility by means of the victaulic couplers that are used throughout the Hydrotransport Research Facility (HTRF) haulage pipe length (see Figure 1). The pipe grooves for the victaulic couplers are standard. The weldments of the pipe to the above mentioned flanges have been carried out in a standard, approved manner and the weldments have passed a full radiographic inspection. The pipe for the spoolpiece is Schedule 80, whereas the test loop is made of Schedule 40 piping, which has a much lower (factor of two) pressure rating. The instrumentation spoolpiece is therefore not likelv to rupture before the Schedule 40 pipe; nor is it likely to rupture before the rupture disk goes, since it is pressure-rated above the rupture-disk rating (about 425 psi for the 6" pipe).

   The outside of the radiation gauge is made of aluminum plating in a welded structure, and has a strength much greater than that required for normal operation. The observed vibration amplitude and frequency for the piping system, even during the haulage of very coarse coal and rock particles (up to several inches) was far below the design rating of about 0.250" and 0-200 Hz, by virtue of the 0.500" firm foam rubber lining between the spoolpiece piping and each of the radiation gauges.

   Each gauge has a proportionately large "seating area" of the firm foam rubber shock absorbing material, designed by load tests to compress no more than 0.125" during full horizontal loading. For vertical loading, such as in the present configuration at the HTRF, each gauge rests on a circular support plate held onto the pipe by means of a split pipe section contacting the pipe via more of the above mentioned firm foam rubber material and held in place by bolts pulling the two halves of the sleeves together. There is adequate redundancy in the sleeve-bolting, such that if any one bolt were to fail, the foam rubber seating material would make it stand out and be very noticeable without the gauge being able to slip vertically. In addition, a maximum amount of slippage of only a few inches is possible before the "sleeve" comes to rest on a flange welded to the pipe: For the heavy neutron-gauge shield, this flange is one of the oversize pipe flanges (Schedule 80) while for the much smaller, lighter gamma-ray gauge, this flange is one with which a NEMA enclosure (housing part of the conductivity gauge) is supported on the instrumentation spoolpiece.

As mentioned above, there is a large margin of safety in the design of the neutron and gamma-ray shields and shield housings, what with the very low amplitude pipe vibrations observed under the worst operating conditions, the shock insulation of the gauges, and the redundantly strong aluminum-plate housing of the gauges. The "quiet" nature of the pipe was also observed when one of the sensors was recently tested in Canada (in March of 1984).

Turning now to wear and abrasion, it is clear that the Schedule 80 pipe will wear much longer than the Schedule 40 pipe from which the test of the system is constructed. In addition, if and when the latter should wear out what with the little use that it gets, even at peak-load periods, the Schedule 80 instrumentation spoolpiece will be inspected for wear and the necessary corrective measures will be taken at that time.

As for corrosions, no corrosion has been observed on the source housing, or on the source "handles" used for inserting and removing the sources. The sources themselves are doubly stainless-steel encapsulated and heliarc welded.

Impact, puncture and compressive loads. These are not likely to occur while the gauge is in use because the instrumentation "spoolpiece" is an integral part of the haulage pipe and all this is attached to the scaffolding at frequent intervals along the line. It is not likely that the system could fall. If it did fall, both the neutron and gamma-ray shielding that surround the radiation sources would absorb practically all of the shocks. This then makes it highly unlikely that the sources could become punctured.

In the case of fire, the metal housing should provide enough of a "barrier" to maintain the integrity of the shield-containment.

As for explosions, the system is in a tower made of steel with corrugated steel weather protection. Dust explosions are highly improbably because the slurry is liquid. Any slurry leakage, giving rise to coal dust entering the tower, cannot be a serious problem because of the mode of operation of the HTRF. A leak of this nature would soon be repaired and the slurry hosed away. There is a reasonable degree of "containment integrity" in the case of an explosion, because the corrugated sheet steel is most likely to go, leaving the haulage pipe with sensor standing in place. The massive neutron/gamma shielding serves as an excellent deterrent against the sources being blow loose and sent a large distance away. We are, in fact, taking advantage of this very same "mass inertia" in designing a densitometer for 5' diameter tanks of nitroglycerin (Radford Army Ammunition Plant, Virginia).

ATTACHMENT 3

RADIOLOGICAL SAFETY AND OPERATING INSTRUCTIONS

1. Introduction

The coal slurry concentration sensor is used for measuring the concentration of coal, rock (refuse) and water in a hydraulic haulage pipe, and is intended for use in deep underground mining operations. The three concentrations (coal/rock/water) are measured by three independent sensors that each sense a different property of the three components. The sensor utilizes electrical conductivity to measure the volume % of water (or the solids volume, by subtraction), a gamma gauge to measure the slurry density, and a neutron gauge that differentiates between coal, rock and water by way of their different hydrogen content.

2. Source Installation and Removal

A health physicist or other person that has been qualified to handle the sources (and who must be wearing a neutron-sensitive as well as gamma-ray sensitive radiation badge) are the only ones permitted to load and unload the sources.

Remove source-holder handle from the respective shield (see Figure 1) unscrew the end cap, insert a neutron source in each of the longer handles that go with the larger shield, and in each of the shorter handles that go with the smaller shield (see Figure 1), and screw the cap back on the end of the handle using long channel-lock pliers to hold the end cap away from the installer. (Before this, try all end caps to see that they screw on firmly. If not, put a very small amount of LOC-TITE or 5-minute epoxy on the threads to eliminate looseness.) Install source handles and screw them in all the way. Close the hasp and lock it with padlock. Place rope (orange or magenta or yellow) around neutron source to keep personnel 2' to 3' away from outside of neutron shield.

The "exclusion rope" must have hung on it, "CAUTION - RADIATION AREA - KEEP OUT."

To remove sources, reverse procedure. If LOC-TITE or epoxy holds too tight, warm end cap with mild flame (i.e., as from wooden match) to soften.

Before installing sources, make certain that each shield (neutron and gamma-ray) has affixed to it the proper label identifying the radioactive species, date of source assay, source strength at that time, the radiation symbol, the SAI (the manufacturer's) logo, and the words, "CAUTION - RADIOACTIVE MATERIAL."

3. Source Storaqe.

The sources are to be stored in a controlled (restricted) area with an orange or magenta exlusion rope at the periphery of the exclusion area. If unbadged personnel use the adjacent area, the rope must be moved out to a point where the radiation level is not greater than 2 mrem/hour. If the area is unrestricted, the rope must be beyond or at the point where the dose rate is 0.5 mrem/hour. The exclusion rope must have appropriate radiation signs on it that are clearly visible and that read, "CAUTION - RADIATION AREA."

The sources must be installed in the shipping containers and the containers closed, or they must be otherwise under full control of the health physicist (i.e., under lock and key, and with the nearest unrestricted area having a radiation field below 0.5 mrem/hour: For further details, see U.S. Nuclear Regulatory Rules and Regulations, Title 10, Chapter 1, Code of Federal Regulations - Energy, Part 20 Standards for Protection Against Radiation, paragraphs 20.101, 20.106 and 20.203 in particular.)

4. Source Wipes.

The sources are to be wiped at least once every 6 months and counted for evidence of radiation leakage; the gamma-ray sources for beta activity and the neutron sources for alpha activity.

24 August 1984

Mr. Richard C. Wang
U.S. Department of Interior
Bureau of Mines
Pittsburgh Research Center
Cochrans Mill Road
P.O. Box 18070
Pittsburgh, PA 15236

Dear Mr. Wang:

Enclosed please find a copy of Attachment (1), entitled, "Response to 6/21/84 letter of James W. Patterson (of the U.S. Regulatory Commission) to Glenn C. Pritchard (Chief, Safety Management Staff, Department of Interior)."

We hope that the answers to Mr. Patterson's questions are complete and adequate. If not, please contact me for further details.

Sincerely,

SCIENCE APPLICATIONS INTERNATIONAL CORPORATION

Victor V. Verbinski

Dr. Victor V. Verbinski

VVV:smr
Attachment

ATTACHMENT (1)

RESPONSE TO 6/21/84 LETTER

OF

JAMES W. PATTERSON (U.S. NRC)

TO

GLENN C. PRITCHARD (DEPT. OF INTERIOR)

ITEM 1

A. Californium-252 Source

A-1 1 microgram: Code (Model #) CVN.3, X.1 capsule, IAEA special form SFC.7, ANSI classification C64544.

A-2 2 microgram: Code CVN.4, X.1 capsule, IAEA special form SFC.7, ANSI classification C64544.

A-3 5 microgram: Code CVN.5, X.1 capsule, IAEA special form SFC.7, ANSI classification C64544.

A-4 10 microgram: Code CVN.6, X.1 capsule, IAEA special form SFC.7, ANSI classification C64544.

B. Cesium-137 Sources

B-1 1 millicurie: Code (Model #) CDC.801, X.8 capsule, IAEA special form SFC.24, ANSI classification C64444.

B-2 3 millicurie: Code CDC.803, X.8 capsule, IAEA special form SFC.24, ANSI classification C64444.

B-3 5 millicurie: Code CDC.804, X.8 capsule, IAEA special form SFC.24, ANSI classification C64444.

B-4 10 millicurie: Code CDC.805, X.8 capsule, IAEA special form SFC.24, ANSI classification C64444.

NOTE: 1 microgram = .535 millicurie

ITEM 2

Details of construction of the source housings are shown in Figures 1, 2, 3, and 4. The specific pipe sections (spool pieces) to which they are attached, and the location code, are shown in Figure 5.

ITEM 3

Details of construction of the source handles (rods) for the neutron and gamma-ray sources are shown in Figures 6, 7, 8 and 9. The method used to "identify the rods when loaded as to the specific californium or cesium sources that they contain" is shown in Figure 10.

ITEM 4

The earliest sensors produced were the 6" and 18" sensors. The main-conductivity-gauge pipe sections were internally lined with rubber. The 10" and 12" sensors utilized a ceramic lining, with pieces interlocked and backed by a rubber lining (between ceramic and pipe) for added electrical insulation/isolation. The advanced design, utilizing a ceramic lining, became available and known to us at the time the newer sensors were manufactured.

The lengths of the 6-inch, 10-inch, 12-inch, and 18-inch diameter pipe sections are shown in Figure 5.

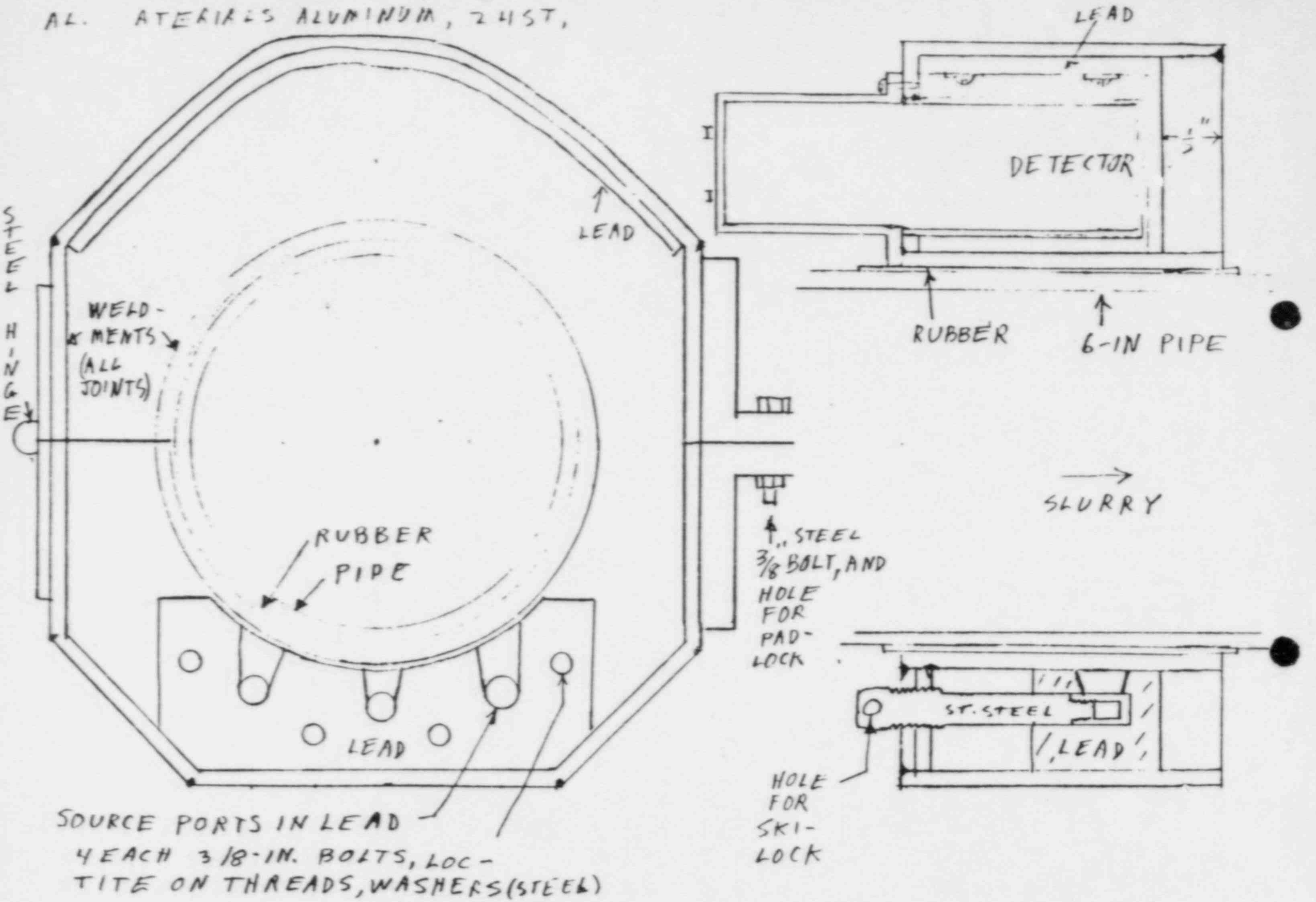


FIGURE 1 6" GAMMA GAUGE

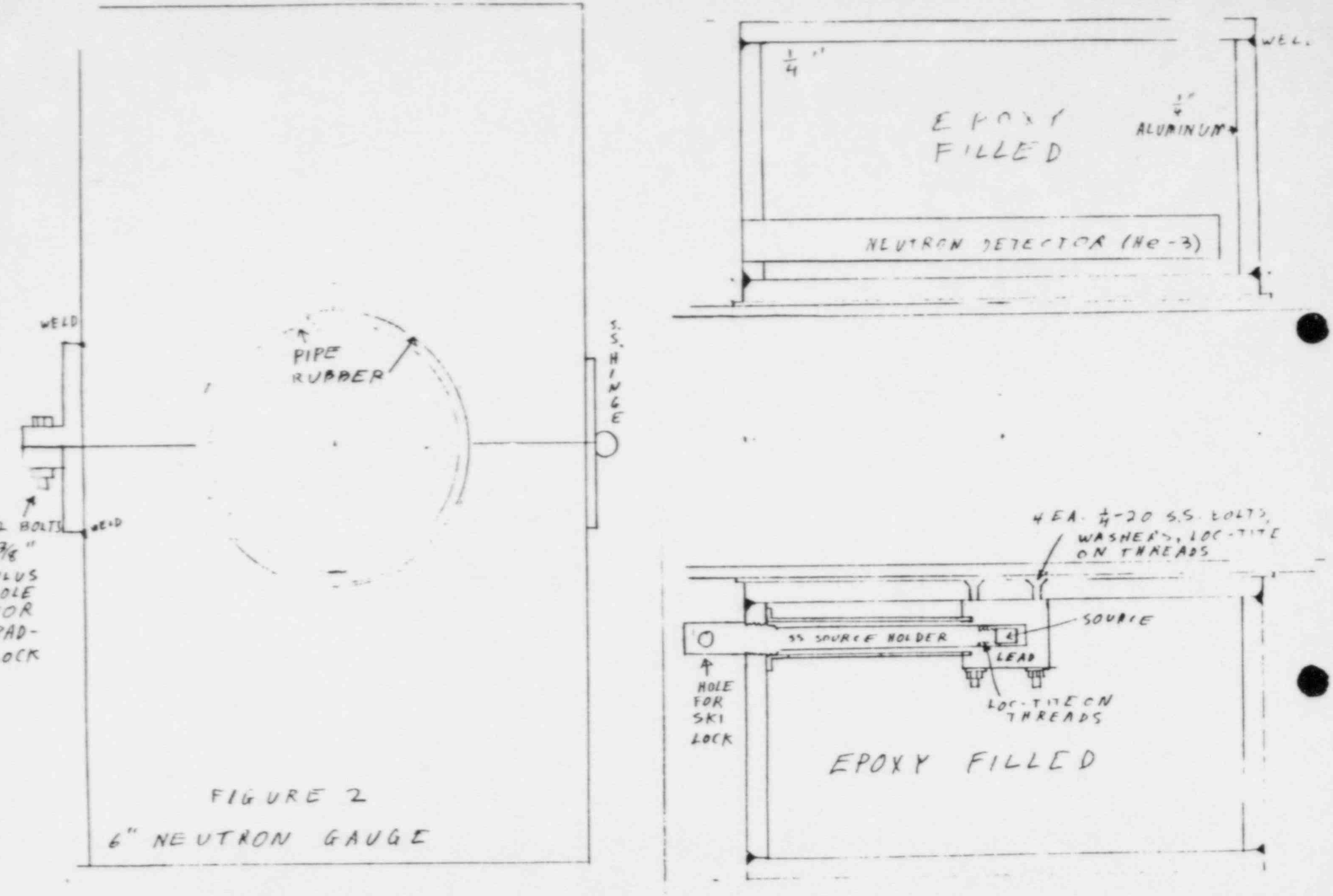


FIGURE 2

6" NEUTRON GAUGE

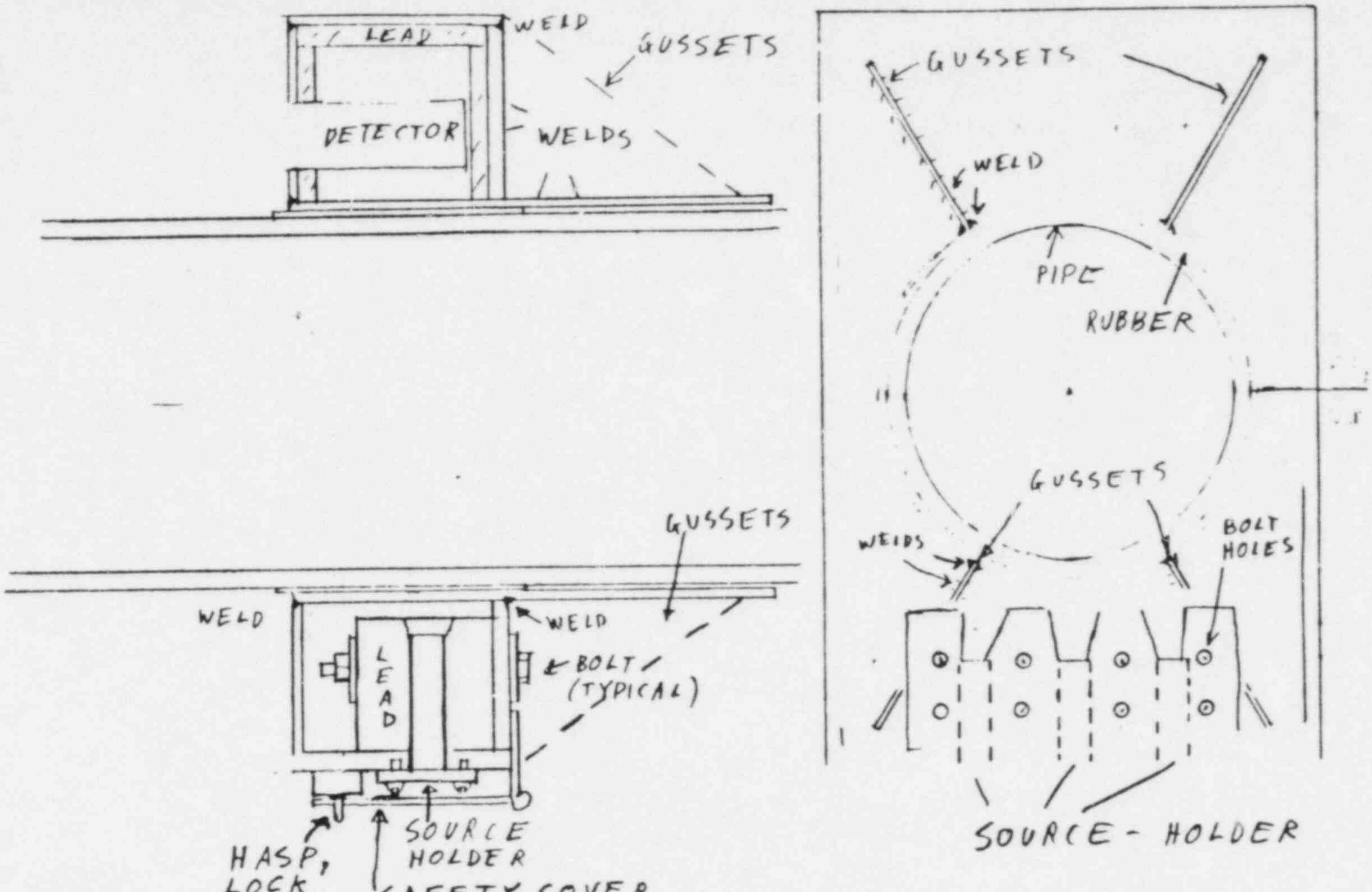


FIGURE 3. GAMMA GAUGE FOR 10", 12", 18" LINES

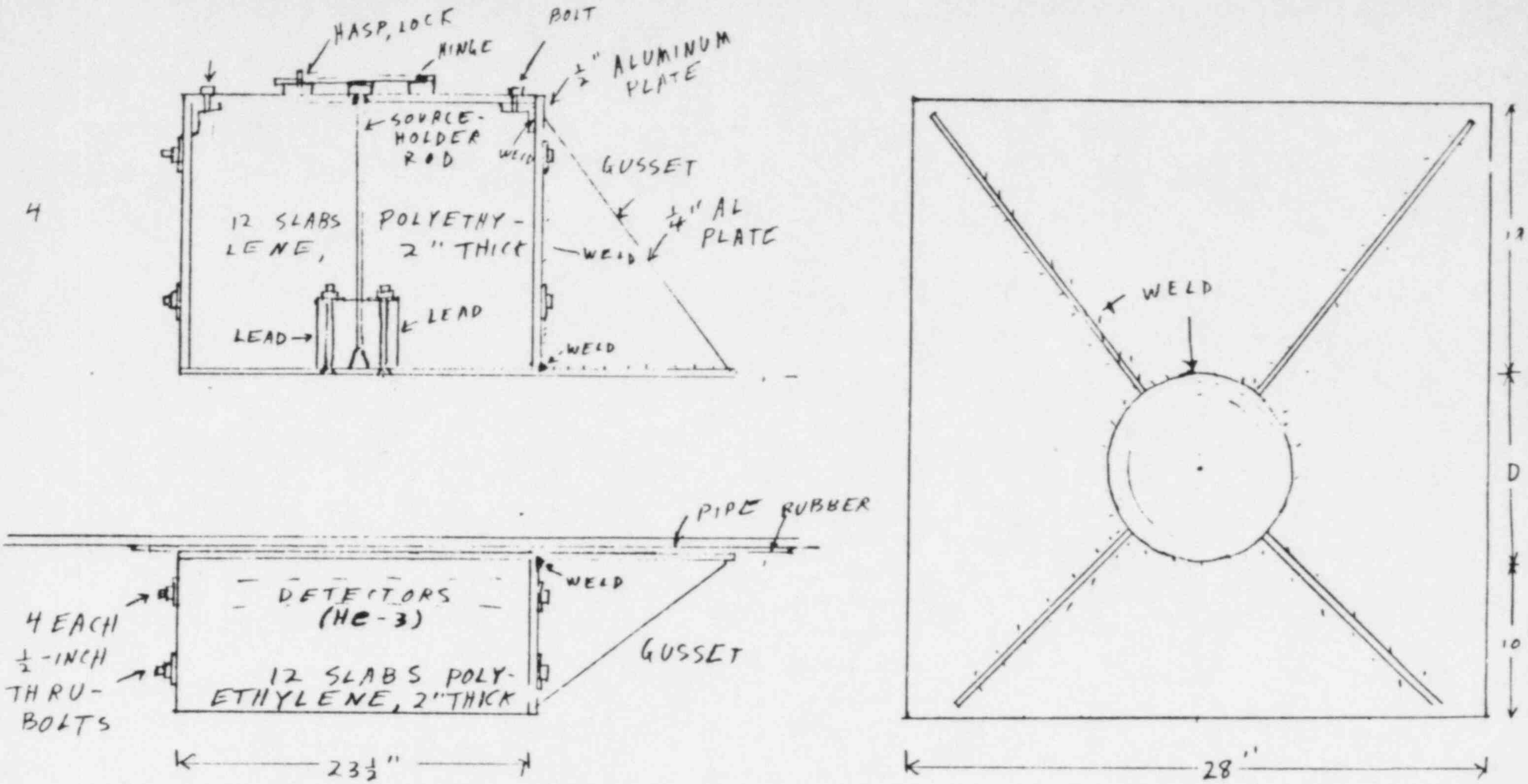


FIGURE 4 NEUTRON GAUGE FOR 10", 12", 18" LINES

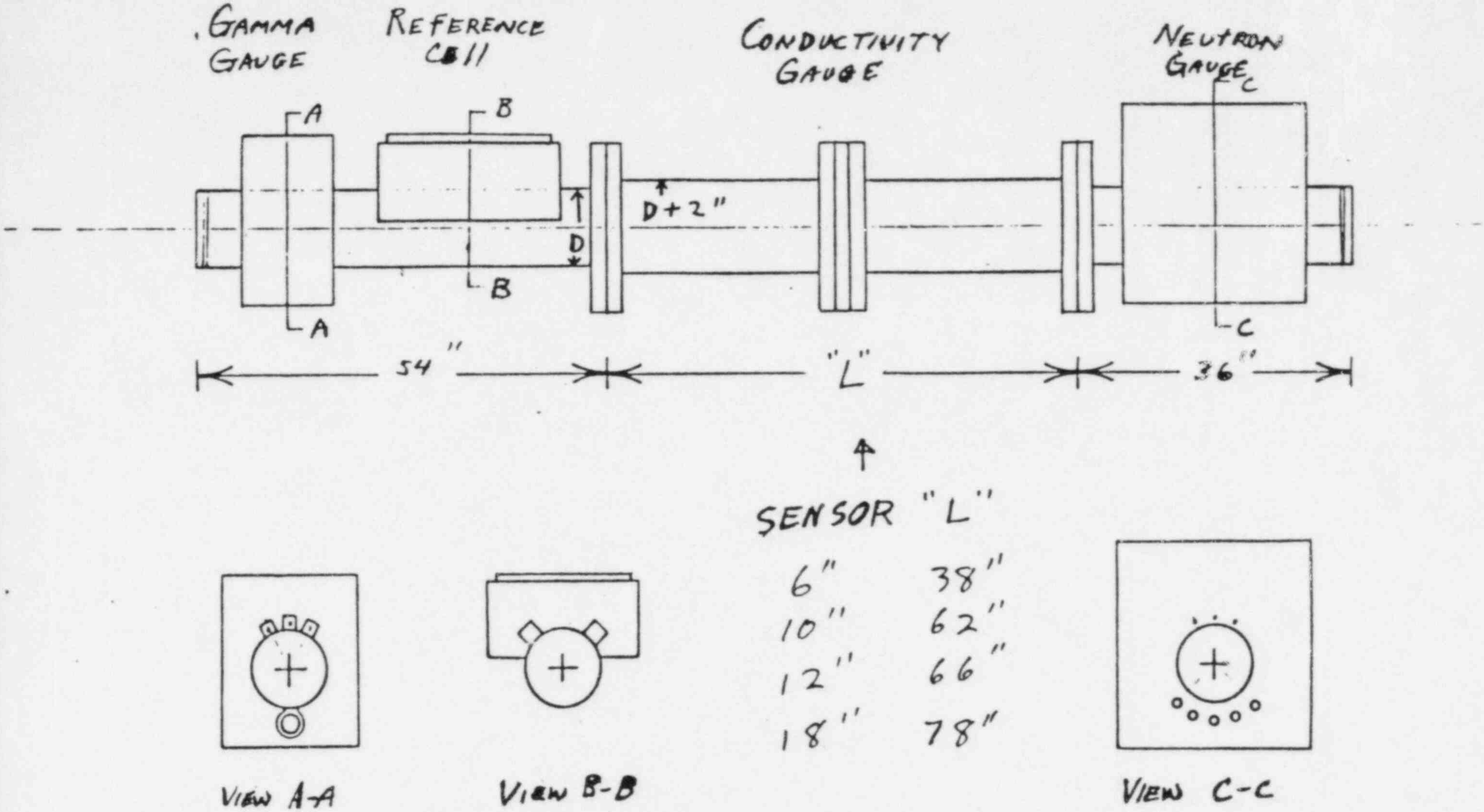


FIGURE 5. Coal/Rock/Water Concentration Sensor

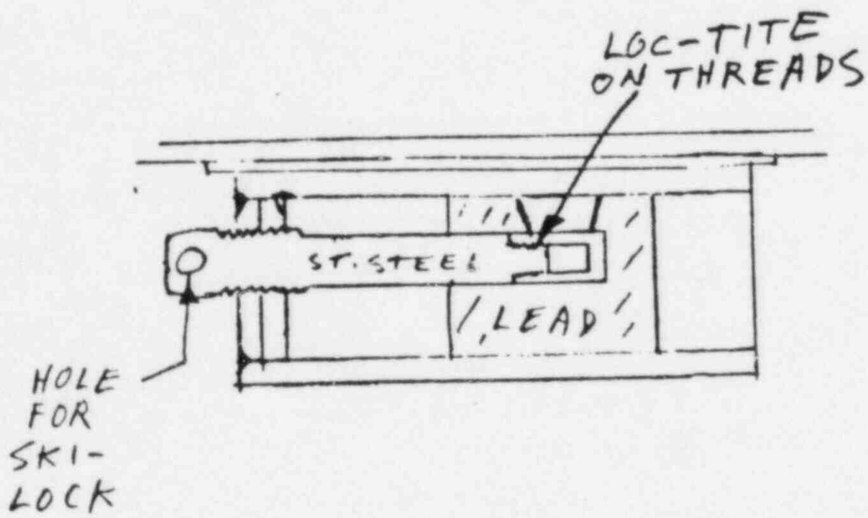


FIGURE 6. SOURCE HOLDER
FOR 6-IN GAMMA GAUGE

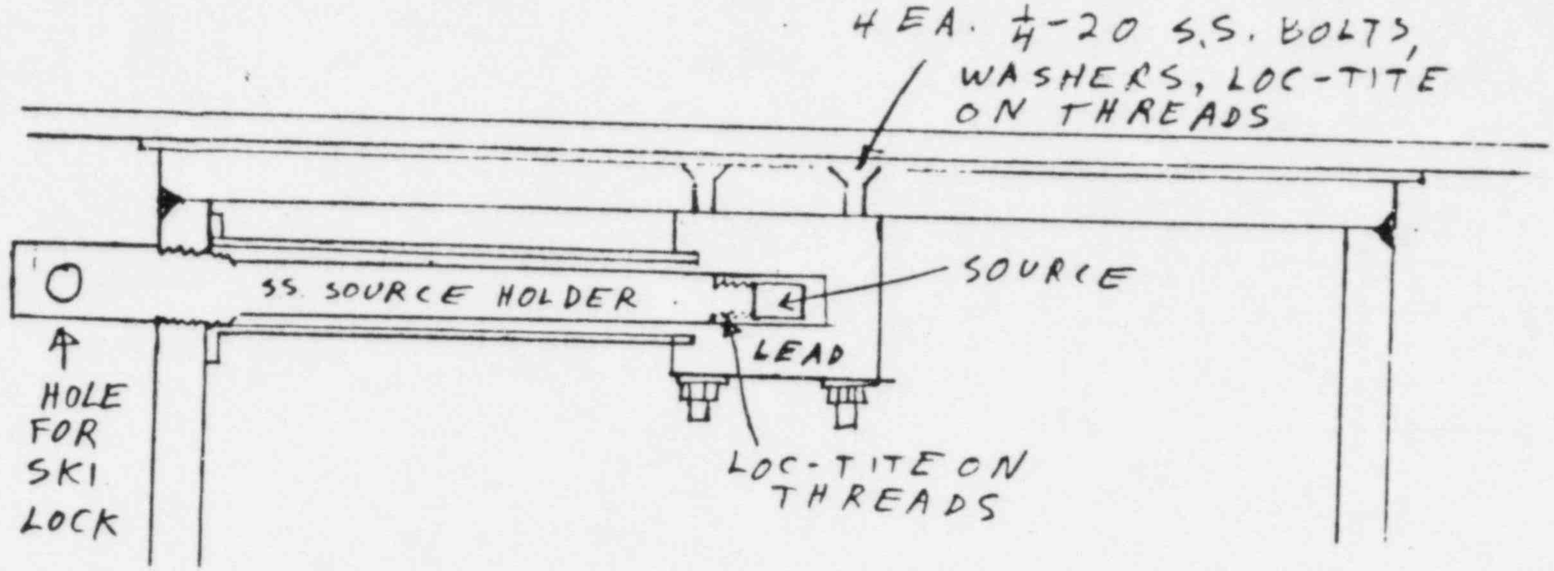


FIGURE 7 6" NEUTRON-GAUGE SOURCE HOLDER

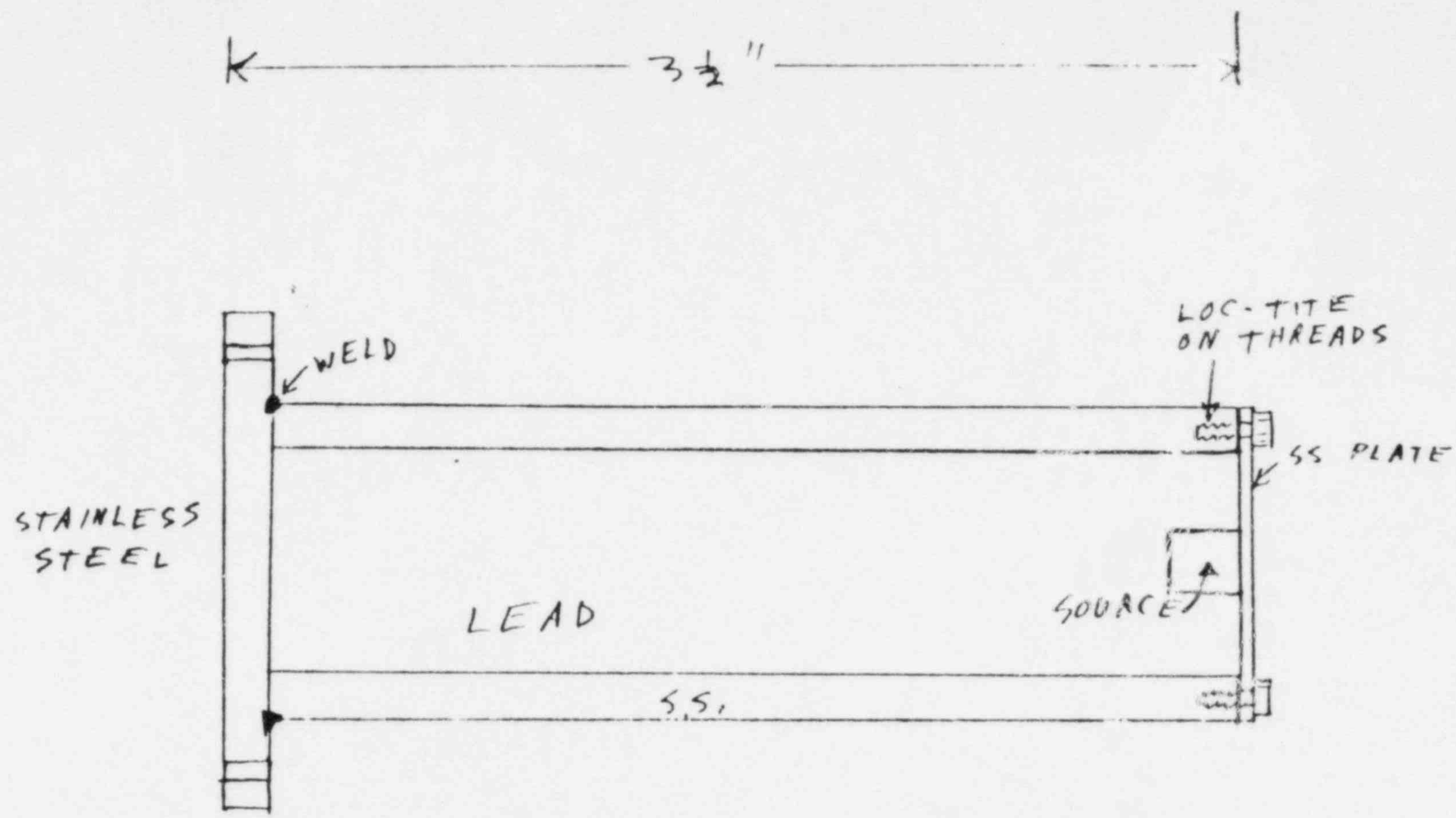
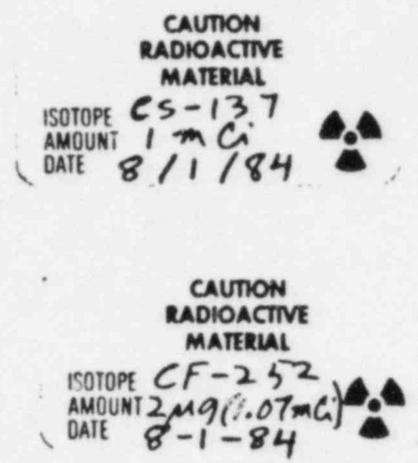


FIGURE 8. GAMMA-RAY SOURCE HOLDER FOR 10", 12", 18" LINES

FIGURE 9 NEUTRON SOURCE HOLDER
FOR 10", 12", 18" LINES



TYPICAL

FIGURE 10 LABELS ATTACHED TO TAG WIRED TO SOURCE - HOLDER RODS