DCS MS-016

MAR 8 1983

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P. Morrow

Docket No. 50-344

Mr. Bart D. Withers
Vice President Nuclear
Portland General Electric Company
121 S. W. Salmon Street
Portland, Oregon 97204

Dear Mr. Withers:
E
Enclosed is a letter from IAEA to P. Morrow (NRC) dated February 17, 1983 which contains, as an attachment, the IAEA procedures for measuring the enrichment of both fresh and irradiated fuel which you requested in order to enable you to prepare your procedures for these measurements.

The IAEA has already conducted a measurement of irradiated fuel at Rancho Seco. You may find it helpful to discuss this matter with SMUD personnel.

Sincerely,

Original signed by:

Robert A. Clark, Chief
Operating Reactors Branch #3
Division of Licensing

Enclosure:
IAEA letter dated 2-17-83
w/attachments

cc w/enclosure:
See next page

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OFFICE	ORB#3:DL	ORB#3:DL	ORB#3:DL				
SURNAME	PKreutzer	CTrammell:dd	RAClark				
DATE	3/8/83	3/8/83	3/8/83				

NRC FORM 318 (10-80) NRCM 0240 OFFICIAL RECORD COPY USGPO: 1981—335-960

cc: Michael Malmros, Resident Inspector
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Walnut Creek, California 94596

I SYSTEM DESCRIPTION

A. Detector Body

A schematic diagram of the Coincidence Collar is shown in Fig. 1. The fuel assembly is surrounded by three detector banks and the AmLi source moderator

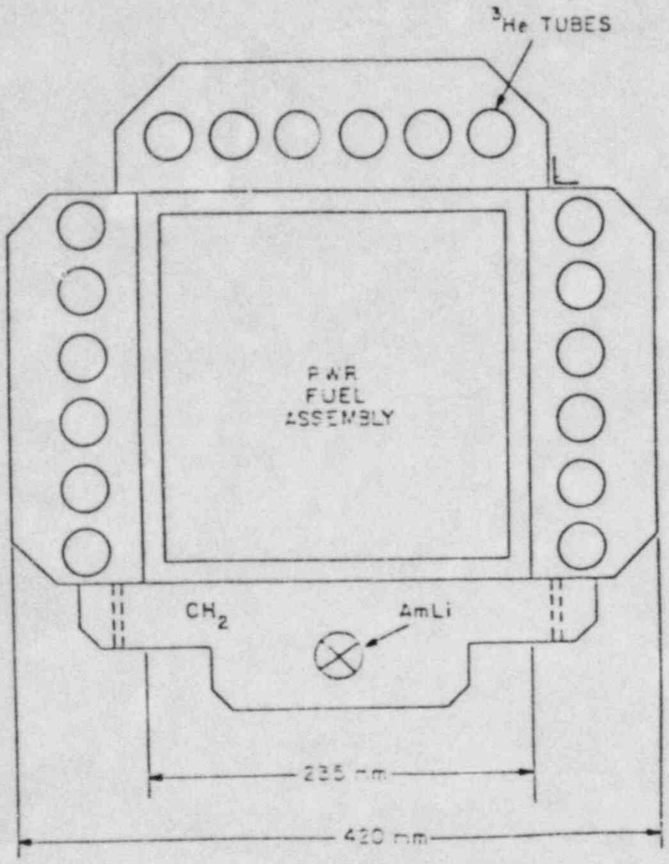


Fig. 1
Schematic diagram of Coincidence Collar showing the AmLi neutron source and the ^{3}He detector banks. The top detector bank neutron source pivots open to accommodate PWR, BWR, or HWR fuel assemblies.

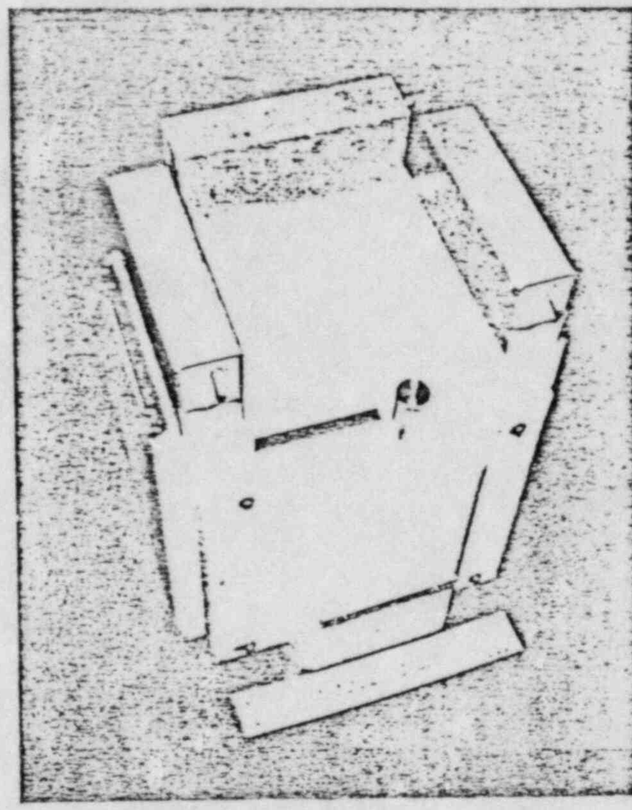


Fig. 2
Top view of Coincidence Collar showing the three CH_2 detector banks and the AmLi neutron interrogation source.

The ^{3}He detectors are embedded in high-density polyethylene. The detector unit is about 0.43 m long and the back detector section pivots on a hinge to facilitate placing the system around fuel assemblies. Figure 2 is a top view of the Coincidence Collar with the back door (^{3}He detector bank) closed in the normal configuration for counting PWR fuel assemblies. Figure 3 shows the back door open for the movement to or from a vertical fuel assembly. The three detector banks, the He tubes and junction boxes, and the neutron source moderator weigh a total of ~24 kg. This unit and its associated electronics are normally supported by a cart that is described in Sec. I-E.

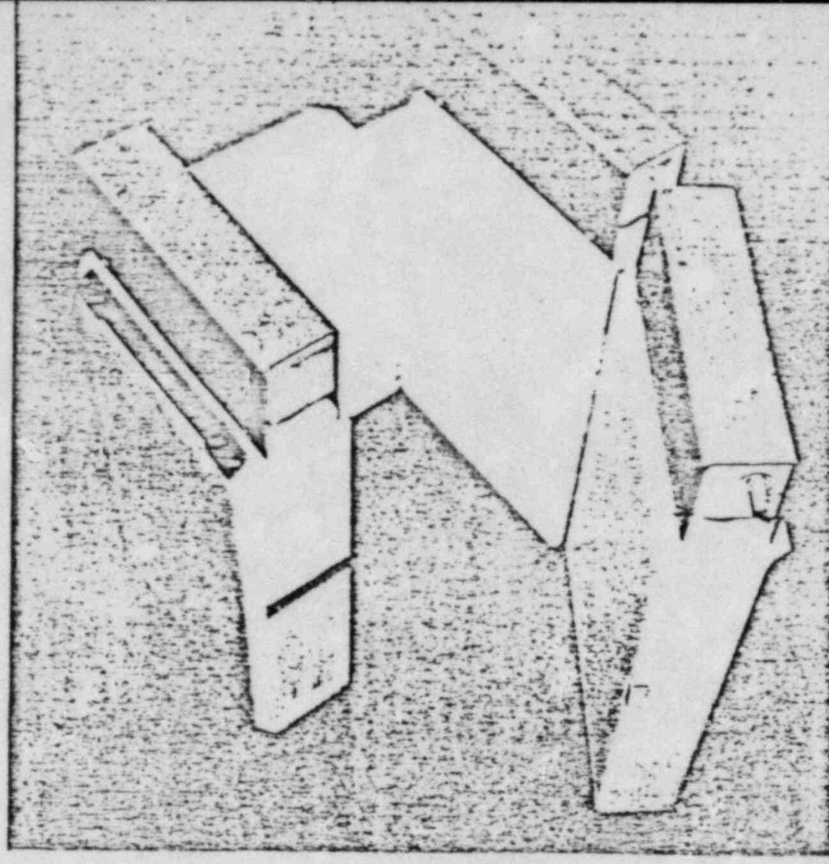


Fig. 3
Top view of Coincidence Collar with rear door open for plac-

B. Neutron Source

The Coincidence Collar uses an AmLi neutron source purchased from Monsanto Research Corporation, Dayton, Ohio. Table I lists the characteristics of the source and Fig. 5 is a photograph of one of the sources. Figure 6 is a schematic diagram of the tungsten shield, fabricated at Los Alamos, that is placed around the AmLi source to reduce the gamma-ray dose. The source gives a dose of 0.1 mR/h in air at a distance of 30 cm and less than 0.3 mR/h at the surface of the assay system. Each source is attached to a CH_2 rod as shown in Fig. 7 to facilitate handling and removal from the Coincidence Collar for the passive portion of the assay.

The AmLi sources have a long half-life (432 yr) so the original source will last for the life of the assay system. The AmLi source has a neutron yield of approximately 4.5×10^5 n/s, which is an order of magnitude less than the source used in the original Collar supplied to the IAEA. This should simplify some aspects of handling and transportation. The present Coincidence Collar was designed with a CH_2 sleeve in the source hole so that it will accommodate the larger sources that the IAEA now has for the original Collar, as well as the smaller source of the present size. The statistical performance of the unit is approximately the same for both source intensities, and either size can be used with the system. However, the calibration curve must be renormalized if the source intensity is changed.

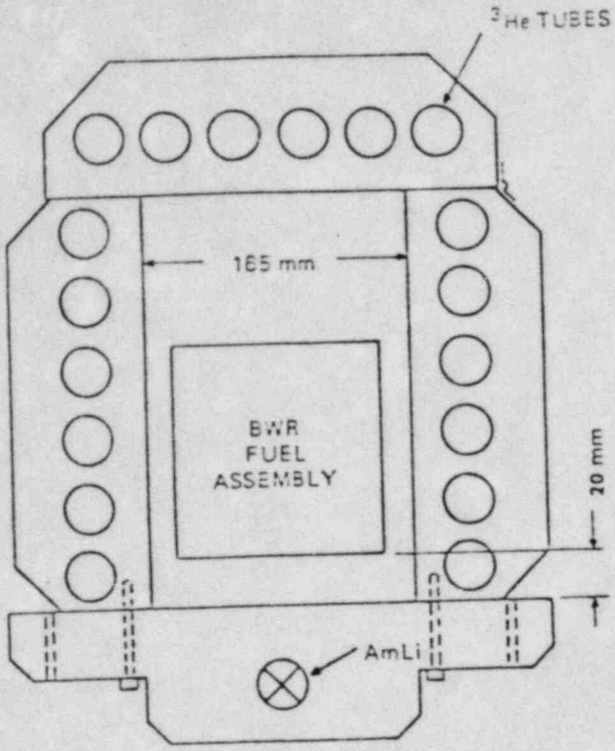


Fig. 4
Schematic diagram of Coincidence Collar with sides moved in to correspond to the BWR configuration.

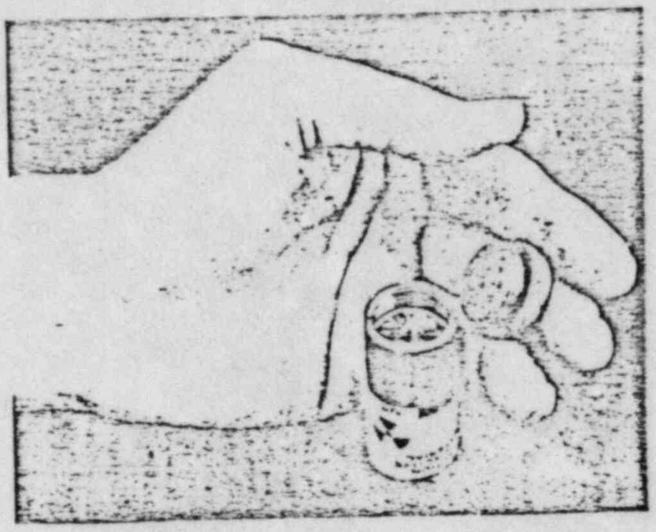


Fig. 5
Photograph of AmLi neutron source inside its tungsten container (or pipe).

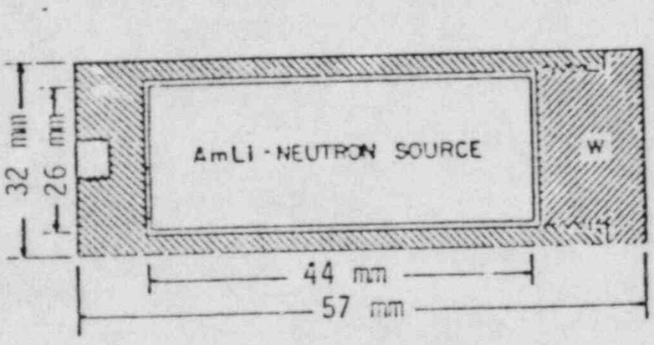


Fig. 6
Schematic diagram of tungsten holder for the AmLi neutron sources.

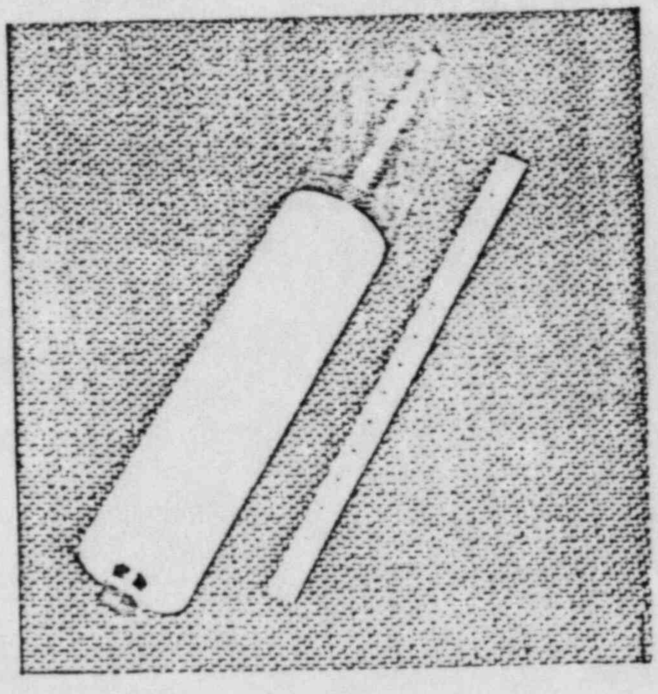


Fig. 7
AmLi neutron source and CH_2 handling rod for use in the Coincidence Collar.

TABLE I

$^{241}AmO_2$-Li NEUTRON SOURCE CHARACTERISTICS

Coincidence Collar	Source Number	Am't of ^{241}Am	Li	Emission Rate
1	MRC-AmLi-91	0.63 Ci or 0.185 g	2.3 g	4.55×10^4 n/s

Technical Information

Chemical Form: AmO_2

Isotope: Am-241

Source Container Description: MRC Model 2724-BT

Shipping Container: 10 gal drum, 6M-1026 USDOT Spec. 6m, Type B

Purchase Order Number: 5LBO-0253R-1
(Monsanto Research Corporation)

The AmLi sources were fabricated by the Monsanto Research Corporation, Dayton Laboratory, Dayton, Ohio, and are designated Model 2724-BT. The AmO_2 is contained in two 304 stainless steel cylinders with welded top plugs. The inner cylinder has an o.d. of 17.8 mm and the outer cylinder has an o.d. of 25.4 mm. The overall length is 34.8 mm. This doubly contained source is then placed in the unsealed tungsten container shown in Fig. 6. The sealed steel container (Model 2724-BT) has the IAEA Certificate of Competent Authority US/0043/S.

C. Neutron Detector Tubes

The Coincidence Collar has three identical banks of ^{3}He tubes. Each bank contains six tubes (Reuter-Stokes model RS-P4-2813-107-W) that are 2.54 cm in diameter and 33 cm long (active length). The detectors are matched to operate at the same high voltage (~1500 V) with a resolution of better than 9 percent. These detectors have been fabricated to match the ^{3}He tubes used in the IAEA's HLNCC units and they should operate satisfactorily at the same hv and discriminator settings used with the HLNCC electronics.

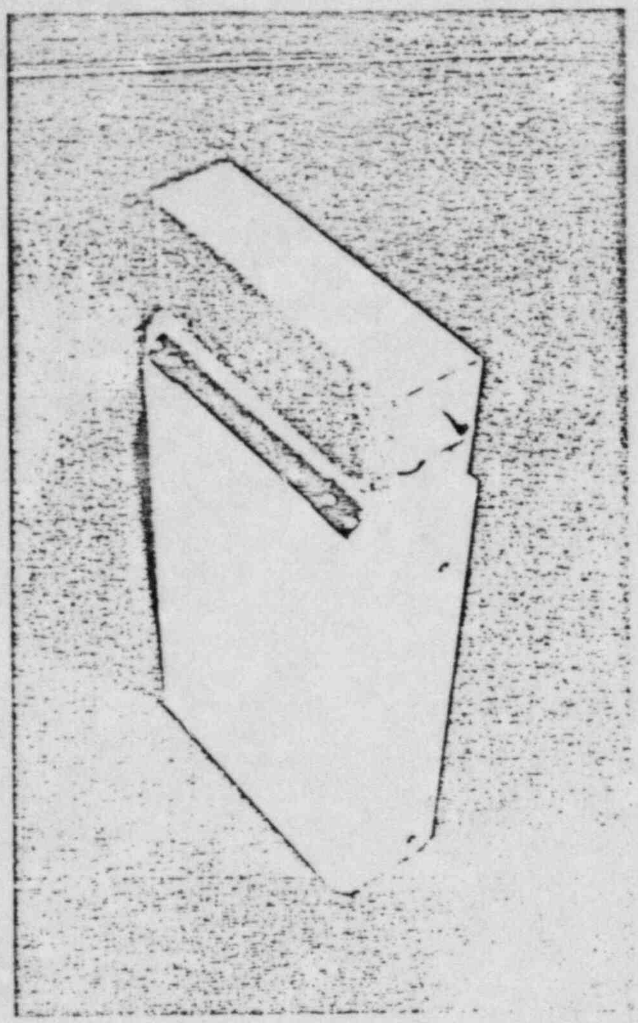


Fig. 8
Side detector bank removed from Coincidence Collar.

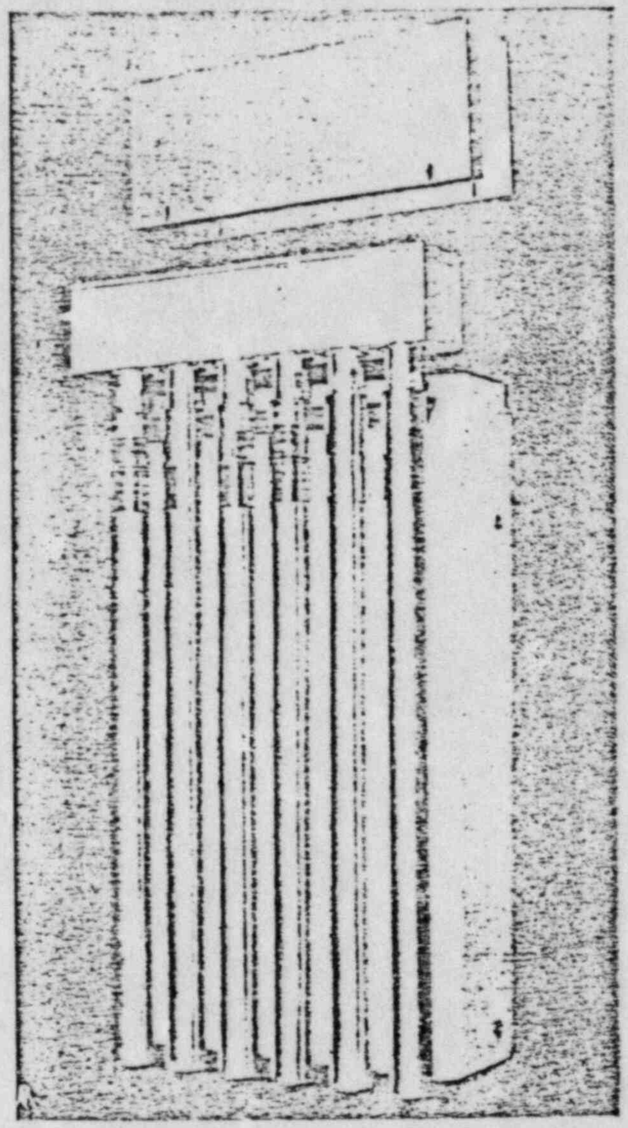


Fig. 9
Side detector bank with ^{3}He tubes removed from CH_2 moderator.

Figure 8 shows one detector bank and Fig. 9 shows the bank with the ^{3}He tubes removed. The individual detectors are interchangeable and the three detector banks are also interchangeable among the different Coincidence Collar units.

The hv junction box shown in Fig. 10 contains a desiccant to reduce the moisture content in the box to prevent hv breakdown. The lid of the junction box is sealed to the body with a silicon rubber sealer. The detectors are wired to give six tubes on each of the three lines that feed to the preamplifier box. The lid of the junction box is "stepped" to reduce electronic noise leakage into the box.

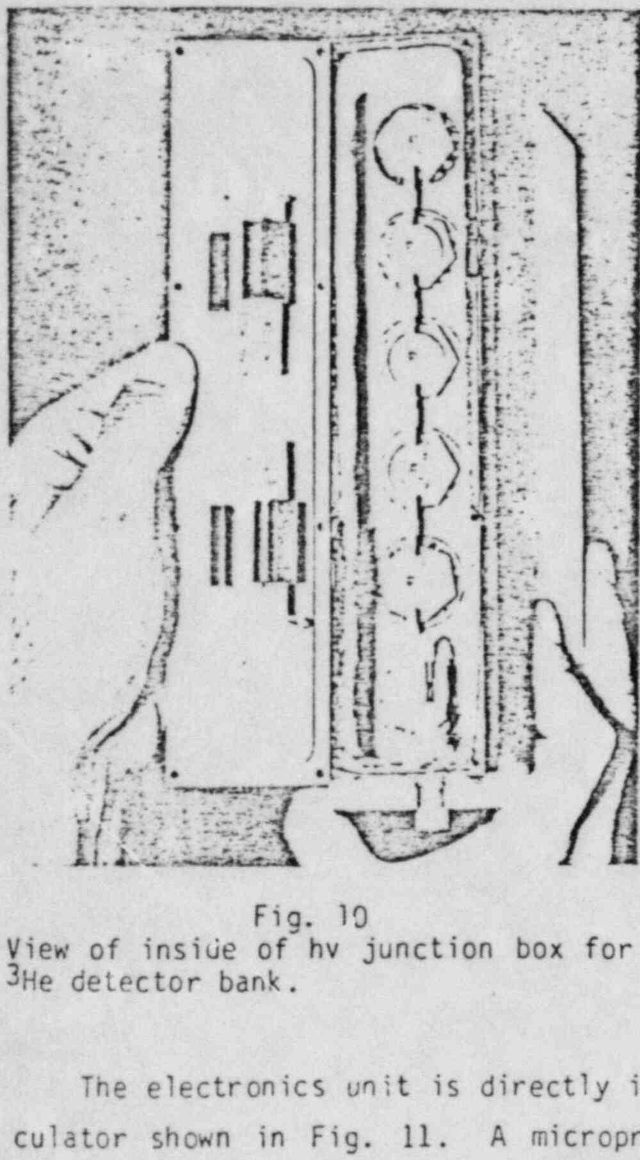


Fig. 10
View of inside of hv junction box for ^{3}He detector bank.

D. Electronics

This unit shown in Fig. 11 contains the hv and low voltage power supplies, six amplifier-discriminator lines, a microprocessor, and the shift register[5] coincidence logic.

The electronics unit is directly interfaced to the HP-97 programmable calculator shown in Fig. 11. A microprocessor in the unit reads out the run time, total counts, real coincidence plus accidental counts, and accidental counts to the HP-97. The HP-97 is then used to reduce the data using the software package selected by the operator. Details concerning the design, fabrication, and operation of the electronics system are published elsewhere.[4,5]

E. Detector Cart and Portability

A front view of the Coincidence Collar cart is shown in Fig. 12. This cart has been designed to accommodate the detector and the electronics package. The detector is attached to the cart as shown in Fig. 13, and it stays attached for the measurement and the transfer from one assembly position to the next. During shipment, the electronic package and HP-97 are lifted off the cart and are placed in a case provided for shipment and storage. For movement within a building, the electronics can remain attached to the detector and cart. The cart is made of aluminum and weighs about 8 kg.

To give the capability of verifying more than one vertical position on the fuel assembly, the cart has adjustable legs. This gives the possibility of the following distances between the floor and the bottom of the Coincidence Collar: 0, 43, 76, and 109 cm. For some applications, it might be necessary to completely remove the Coincidence Collar from the cart. An example of this would be a horizontal fuel assembly or a scanning measurement with the assembly being lowered through a hole in the floor by means of an overhead crane. The Coincidence Collar can be operated independent of the support cart.

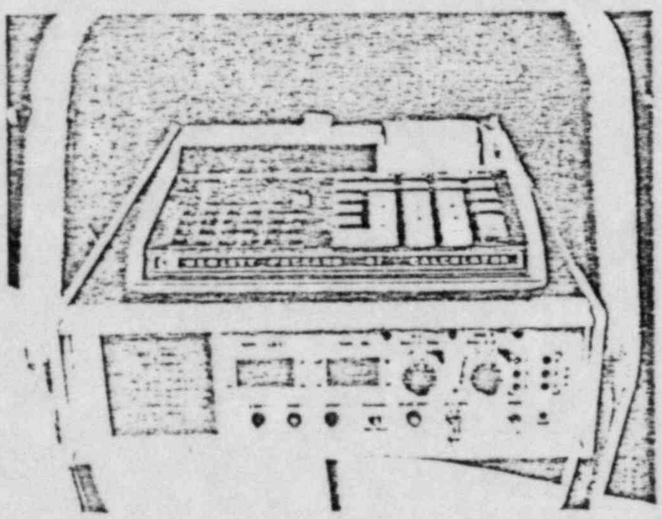


Fig. 11
Photograph of the coincidence electronics (IRT Model HEC-100) and the HP-97 programmable calculator used with the Coincidence Collar.

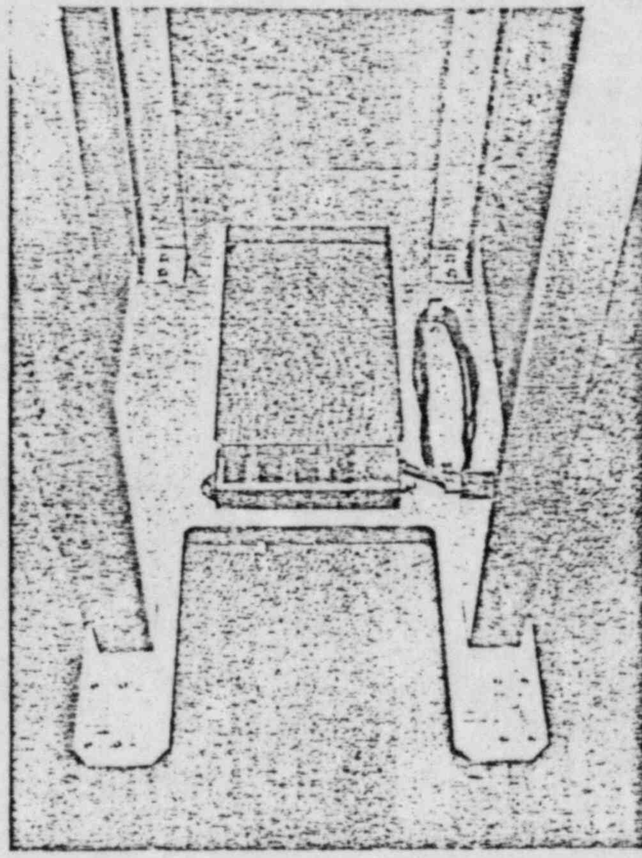


Fig. 12
View of the support cart with the top plate removed. This cart can be used to position the Coincidence Collar around reactor fuel assemblies.

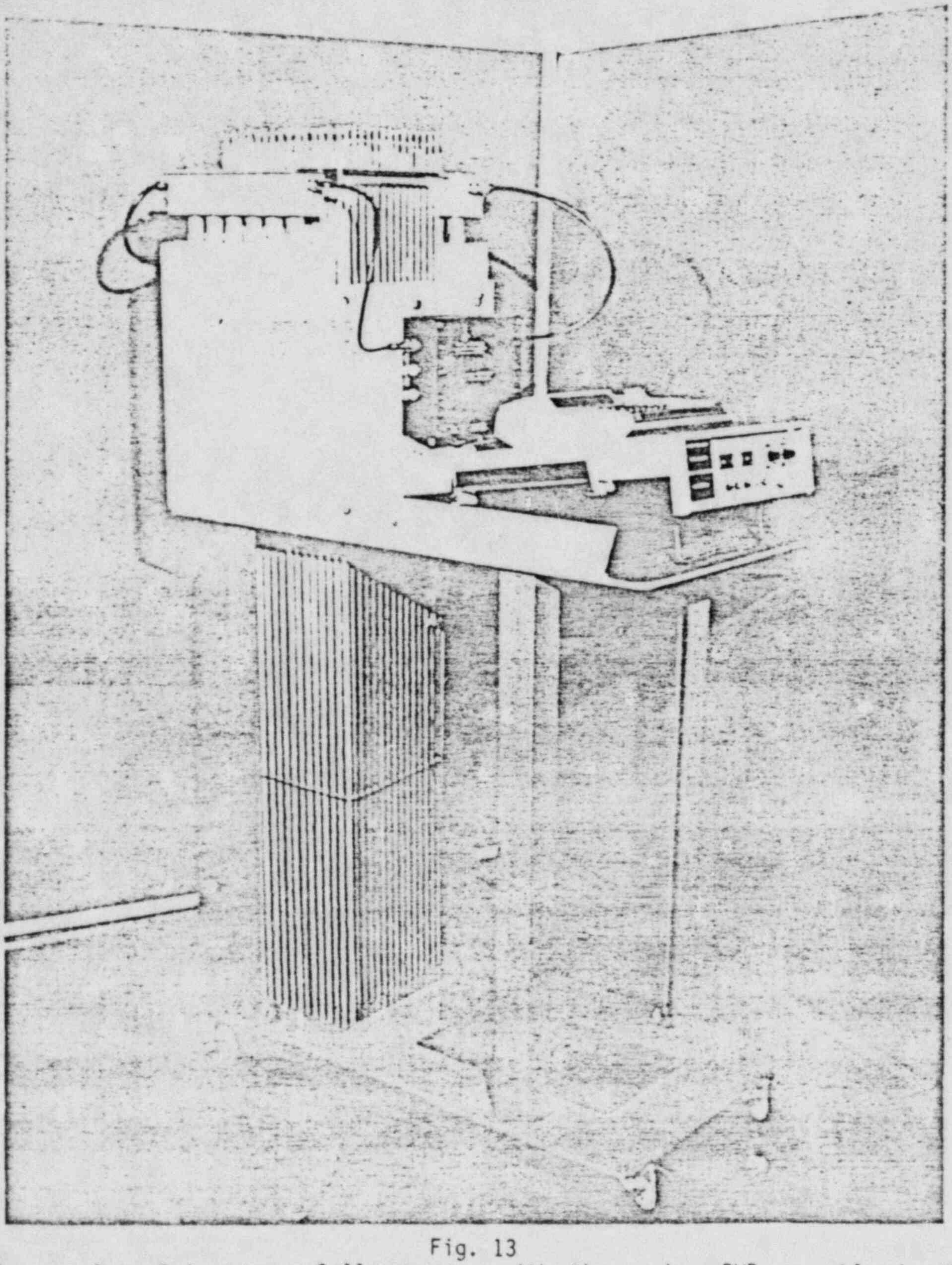


Fig. 13
The complete Coincidence Collar system with the mockup PWR assembly in the measurement position.

II. OPERATION OF ASSAY SYSTEM

A. Sample Categories

The Coincidence Collar has been designed specifically for unirradiated PWR fuel assemblies, but it also can be used for other assemblies such as BWR, heavy water reactor (CANDU), etc. Table II lists some assembly types and the corresponding configuration for the Coincidence Collar. The instrument can be applied to high enrichment uranium (HEU) fuel such as materials test reactor (MTR) assemblies, but a cadmium liner should be added to the interior of the Collar to improve neutron penetrability.

Only two size configurations have been designed into the Coincidence Collar to limit the possible positioning and calibration errors. In the full open position, the clearance hole is 235 x 235 mm. When the side detector banks are moved to the inner screw hole position, the opening is 165 x 235 mm. Each sample type and detector configuration requires a separate calibration.

TABLE II

SAMPLE CATEGORIES FOR COINCIDENCE COLLAR APPLICATION

Sample	Section Shape	Approximate Cross Section	Collar Configuration[a]
PWR Assembly	Square	216 x 216 mm	235 x 235 mm
BWR	Square	130 x 130 mm	165 x 235 mm
CANDU	Cylindrical	100 mm diam.	165 x 235 mm
WWER	Hexagonal	143 x 165 mm	165 x 235 mm
Rod Storage Tray	Rectangular	variable	165 x 235 mm
UF_6/U_3O_8 Cyl.	Cylindrical	variable	235 x 235 mm

[a]The full opening in the Collar has dimensions of 235 x 235 mm, and when the Collar is reduced to the inner screw holes, the opening is 165 x 235 mm.

B. Normal Setup

1. Detector and Cart. For normal applications, the fuel assemblies will be in a vertical storage position and the Coincidence Collar will be positioned on its cart as shown in Fig. 13. If the floor has no steps or other barriers, the unit can be rolled up to the assembly with the detector door open. When the fuel assembly is inside the detector, the door is closed and the measurement can begin. In some cases, the fuel assembly support structure will prevent this and additional steps are required. The detector door is removed easily to facilitate use in tight quarters. In general, it will be necessary to arrange adequate mechanical support with the facility operator before the measurement campaign.

In many cases, the fuel assemblies are stored in poly bags. The bag will not hinder the measurement so it can be left in place.

2. Electronic Setup. The electronic components and connections are identical to the HLNCC. Recommended settings are as follows.

a. hv = 7.5 (1500 V)
b. Discriminator = 3.0 (1.5 V)
c. Gate = 64 μs
d. Time = Desired Run Time (100-1000 s recycle).

C. Measurement Steps

The Coincidence Collar can be used in either the active (^{235}U determination) or passive (^{238}U determination) modes. When both measurements are performed, the enrichment or $^{235}U/^{238}U$ ratio is determined. In most cases, only the active measurement is necessary because the ^{235}U verification is of primary interest. When first arriving at a facility, the following steps are recommended.

1. Assemble detector and cart, and use thumb screws to attach detector to cart.
2. Check out electronics and set parameters as listed in Sec. II.B.2.

3. Take a 100-s count with no AmLi source or fuel assembly near unit. The net coincidence rate (R+A) - A, should be statistically equal to zero and the totals rate, T, should be between 10 and 600 counts/s depending on the amount of U_3O_8 in the vicinity.
4. Place the AmLi source in its normal position in the CH_2 detector (see Fig. 1) and observe (100-s run) that the net coincidence rate is statistically zero. The totals rate should be ~1800 counts/s depending on the AmLi source strength.
5. Temporarily remove the AmLi source from the unit and position the Coincidence Collar around a fuel assembly. Take a longer run (~600 s) to determine the fuel assembly coincidence background rate. This should be 10 to 15 counts/s for the net coincidence counts for PWR assemblies. This number depends primarily on the ^{238}U mass and is approximately the same for all of the fuel assemblies of the same mass. It will be subtracted from the induced coincidence counts in the data reduction.
6. Return the AmLi source to the Coincidence Collar and take the active neutron measurement. The total time available for measurement should be subdivided into several shorter intervals to check for noise pickup and data consistency using the HP-97. For example, if 15 min per assembly is available, then set the time for 300 s on the recycle mode and use the HP-97 to average the results and check for statistical consistency.

D. TIME SCHEDULE

Step 1 and 2 of the previous paragraph including the radiation protection measurments (whole body counting) and the security procedures which the inspectors must undergo, will require the whole morning of the first inspection day at the reactor plant.

Step 3	2 x 100s	= 200 s
Step 4	2 x 100s	= 200 s
Step 5	3 x 200s	= 600 s
Step 6	3 x 200s	= 600s

Approx. 30 min per assembly, number of assemblies to be measured max. 6.

E. MANPOWER

Two inspectors are needed to perform the measurements.

IRRADIATED FUEL MEASUREMENTS (2)

A. PURPOSE

Verification of operator declared values of exposure and cooling times of irradiated fuel assemblies.

INSTRUMENTATION:

1. Ion or neutron (ION-1) electronics package (Picture 1)
2. Ionization and fission chambers (Picture 2)
3. "Fork" detector head for positioning the ionization and fission chambers underwater (Picture 3)

The unit is powered by 12 D-cell batteries and is supplied with rechargeable nickel cadmium cells and or charging transformer. When using the cells supplied, the operating time per charge is greater than two 8 hr. working days, and the cells can be recharged in 12 - 16 hrs. In the event of cell or charger failure, the cells may be replaced by alkaline D cells.

B. MEASUREMENTS:

The "fork" detector head is fabricated to allow the simultaneous measurement of gamma ray and neutron signals from opposite sides of a fuel assembly. The "fork" which is fabricated of polyehtylene and can be attached to 4.45 cm diameter stainless steel pipe (0.165 cm wall thickness) for positioning and shielding the cables from the water. A pre-amplifier is mounted at the top of the pipe. The detector head can be positioned using a bracket attached to the railing of the bridge that serves as a support and filcrum. This arrangement allowes the detector head to be positioned rapidly and accurately with a minimum amount of effort. There are two measurement positions for each assembly. First, with the detector head about 20 cm above the assembly top. (Assembly being in its store position). Second with the detector head positioned around the assembly. (Assembly top pulled out about 1 m). Only one of the assemblies should be measured on scanning mode, which means that the assembly will be measured in 15 different positions along its vertical axis.

The electronics package will be located on the bridge from where the measurement operations will be performed. The average per cent difference between operator declared values for the assembly's exposures and the measured values is expected to be $<$ 5%.

C. MEASUREMENT TIME:

1. Counting time for background measurement above each assembly approx. 20 sec.
2. Counting time for measurement of assemblies ranges from 30 sec. for fuel assemblies with higher exposures ($>$ 20 GWd/tU) and shorter cooling times ($<$ 1 year), to 100 sec for fuel assemblies with lower exposures

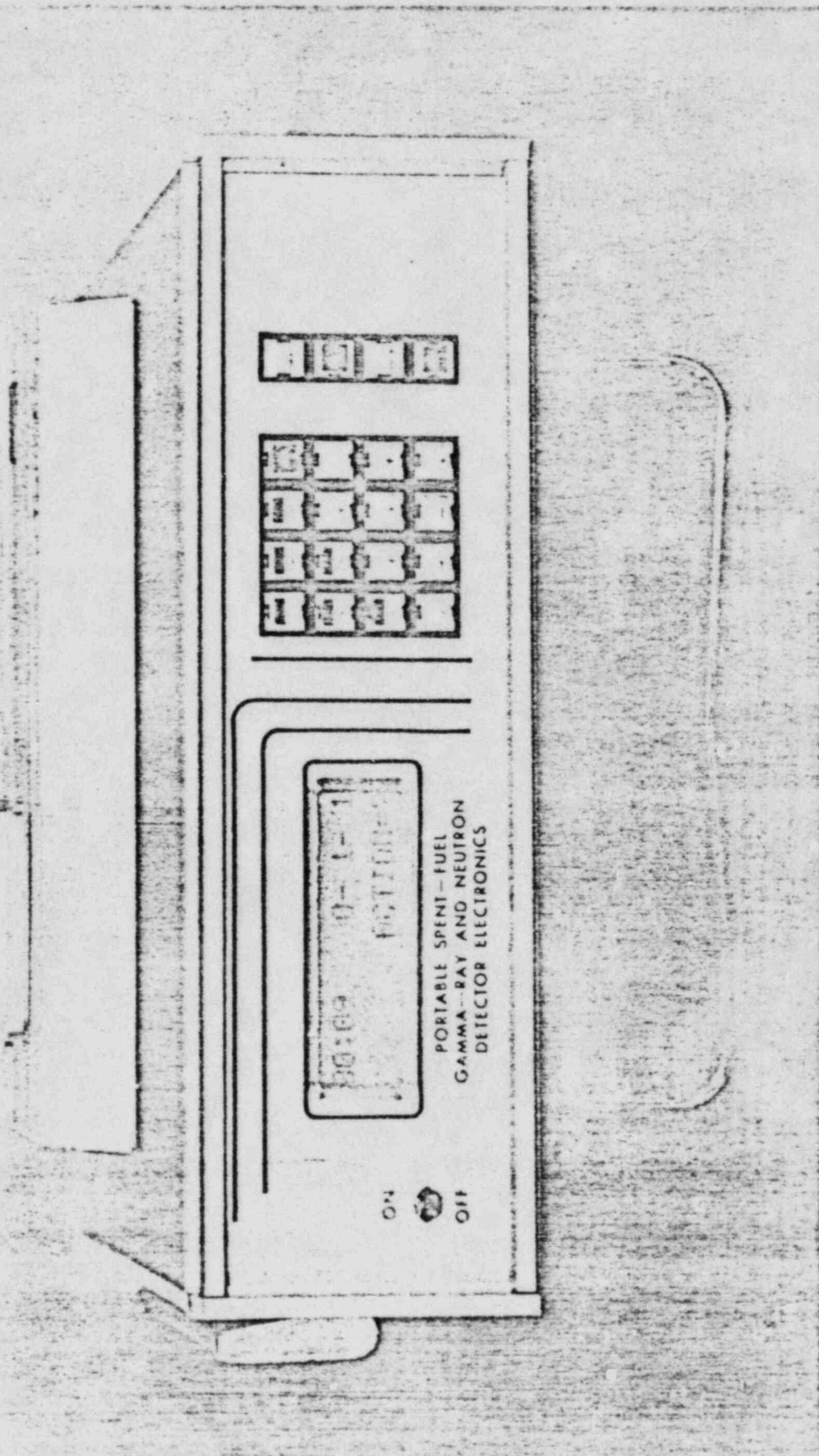
(< 15 GWd/tU) and longer cooling times (> 1 year).

3. Counting time for scanning one assembly approx. 30 min.

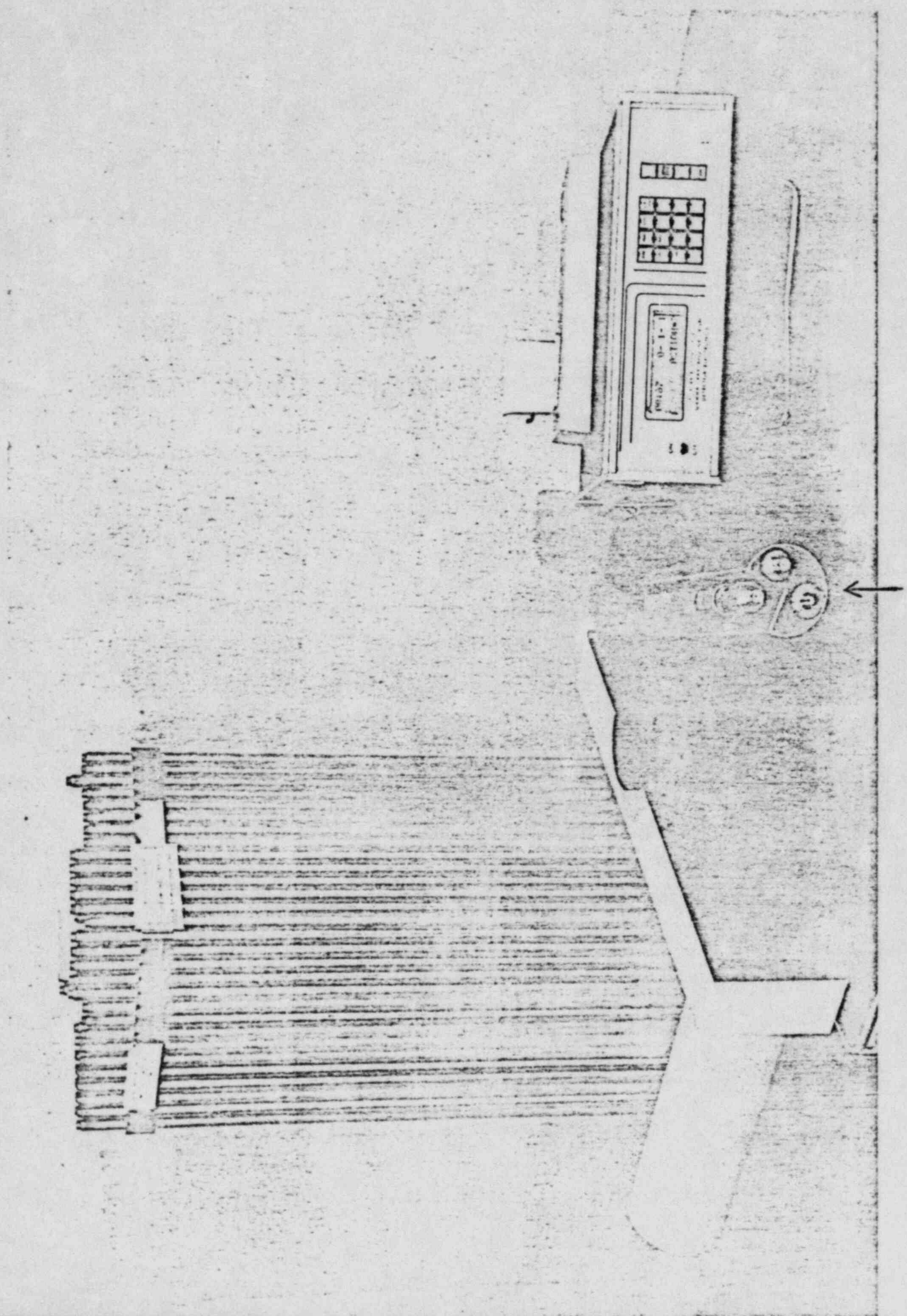
Depending on the total size of the inventory the variable sample to be verified will be around 10% of the total number of irradiated fuel assemblies. For an inventory of about 200 assemblies the time required for this variable verification, taking into account assembling and disassembling of the equipment, positioning the grapple, raising the assembly and replacing it in the storage rack will be one day.

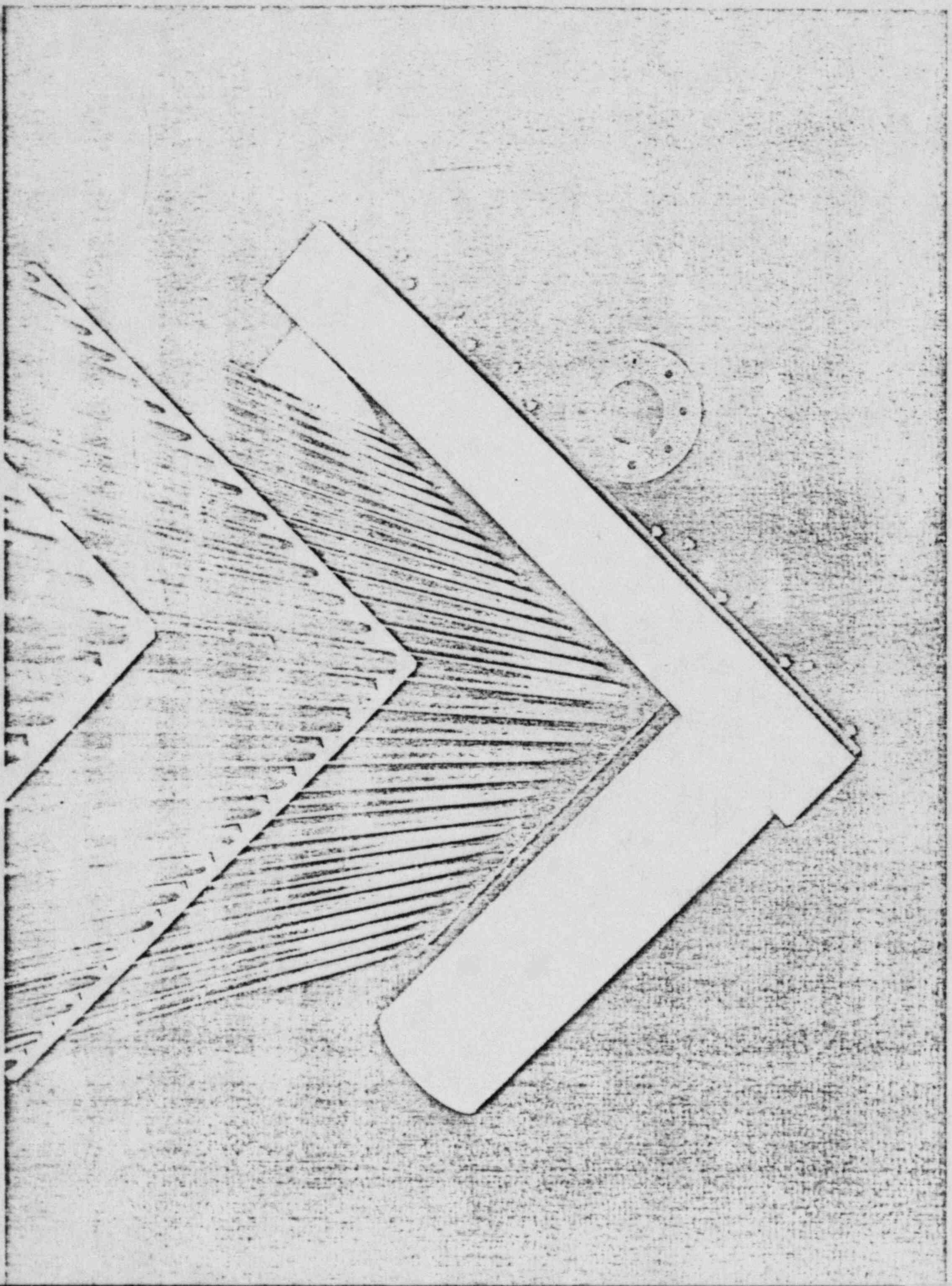
D. Manpower: Three inspectors are needed to participate in the above activity.

Picture 1


PORTABLE SPENT-FUEL
GAMMA-RAY AND NEUTRON
DETECTOR ELECTRONICS
ON
OFF

Picture 2





PICTURE 3

UNDERWATER PERISCOPE (3)

1.	Total Length (adjustable)	11.6 m
2.	Diameter	101.7 mm
3.	Weight (Instr. only)	66.56 kg
4.	Weight (with case)	105.0 kg
5.	True Field	
	Low Power	15°
	High Power	3°
6.	Exit Pupil	
	Lower Power	4 mm
	High Power	3.5 mm
7.	Resolution	
	Low Power	25 sec.
	High Power	5 sec.

For the attribute verification of the fuel inventory in the water bay the periscope needs to be hung from the bay bridge vertically into the water. By means of a strong flash light the attribute sample (about 30%) of the inventory can be identified through appropriate bridge movements.

Manpower: Two inspectors are needed to operate the underwater periscope.