CONDITIONS FOR CALIBRATING THE GO/NO- GO SYSTEM AS USED AT LEI UNANNOUNCED INPECTIONS

GEOMETRY: SOURCE AND DETECTOR ALIGNED

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1. Introduction

ABACC carried out a revision of previous work and studies as part of the efforts for improving the NDA procedures for the LEI facility in order to evaluate the chances of detecting, by transmission, a shielded cylinder in the floor. Problems and inconsistencies detected during such revision were summarized in the Annexes I and II of the letter ABACC, C-1113/ 2000from 19 June, 2000.

Measurements performed by ABACC have shown (see Report ABACC 01/2000) that the geometry used for the source and detector, the distance from the floor and also the positions inside the interconnection room affect the transmission factor. So all organizations shall agree to measure the reference value in the same conditions. In principle, it seems logic to keep the conditions that are been used: Source and detector aligned, 50cm from a thick concrete floor and not so close to the walls. The distance for the LEI facility (BRN-) is 2.10m from the source to the detector.

Furthermore, the specific location should be clearly indicated and for the LEI facility, it is convenient to carry out this activity in the so called position P1, in the interconnection room.

To avoid problems and inconsistencies, the calibration of the "Go/No-Go" device should be made in the same conditions and location where the reference value was measured for determining the minimum transmission factor. In addition, the thickness or dimensions of the polyethylene block and the thickness and dimensions of the alarm plate should be adjusted.

This adjustment will be aimed at assuring a "Go" with a transmission factor and a "No-Go" with a defined decrease of the transmission factor. It is noted that even when implementing the "Go/No-Go" software it would be necessary to have conditions for checking the equipment that would be as described above.

2. Objective

This report has the objective of presenting the values of the neutron transmission factor (and also the neutron attenuation factor) obtained in measurements performed using different thickness and sizes for the polyethylene block and for the alarm plate, aiming at obtaining the conditions to assure a 'Go" with a transmissions ratio of about 0.24 and a "No-Go" with a transmission ratio of about 0.22.

The experiments were performed at the LEI facility (Laboratório de Enriquecimento Isotópico) - ARAMAR-CTMSP, on the 25th August 2000, and were followed by the CNEN representatives Luis Mello and Fabio Cordeiro Dias, being present as observers Mrs. Dulce Daher, and Yoko Hiromoto from the CTMSP.

Before starting the experiment several measurements of the background in the interconnection room were taken in positions P3 and P5 (see the positions schematically indicated in FIGURE 1 attached).

In FIGURE 2 it can be seen the schematic representation of the source and detector at 50cm from the ground as recommended in the ABACC Annexes I and II of the letter C-1113/ 2000from 19 June, 2000.

The polyethylene plates that compose the block are fixed with bolts to the neutron source shield. The "alarm plate", used to calibrate the "Go/No-Go" system, was added to the polyethylene block and placed in the middle of the distance source-detector (1.05m from the detector).

3. Equipment, Materials and Methods

Neutron Detector type SLAB with the following specifications:

- Manufacturer: National Nuclear Corporation-NNC (the detector is ABACC's property)
- Model: SD-1A
- Composed by five ^{3}He tubes connected to a pre-amplifier Amptek type.
- The external part of the detector is covered with a cadmium plate of 1mm. In front, in the rear and laterally.

Shielding of the SLAB detector with the following characteristics:

- Manufactured in high-density polyethylene.
- Shielding laterals and rear part with the following thickness: 5cm (back, right and left) and 4cm (below and above).

Associated Acquisition data Electronics of the SLAB detector:

- Manufacturer: CANBERRA
- HV Power Supply model 3102
- Linear/Log Rate Meter Model 1481 LA
- Dual Counter Timer model 2071A
- Integral counting mode

System for discrimination of the counting level (Go-No /Go) composed by:

- Acquisition Electronic System CANBERRA to be used with the SLAB detector
- Alarming Module (sound and visual alarm) - Green –Red
- High Voltage Supply for the Alarm Module

Am-Be neutron source with the following characteristics:

- Property: ABACC
- Manufacturer: Schlumberger
- Activity: ~500mCi

- Polyethylene Blocks of variable dimensions
- Polyethylene "Alarm Plate" of several sizes with 1 inch thickness
- Metallic Supports for positioning the polyethylene block attached to the Neutron Source
- Mechanical Lifts with height variation in the interval 9 to 170 cm
- No-break (UPS).

Measurements of the background in the P3 and P5 positions were made to see the reproducibility of its value in the interconnection room.

The check of the efficiency of the detector also was made according to the working papers used by ABACC during its inspections.

Several experimental arrangements for the dimensions of the polyethylene attached to the source and the "Alarm Plate" in order to obtain the values proposed for the transmission value were experimentally tested.

The counting time adopted was 2min what was enough to have a good statistics counting.

4. Results

Table 1, presents the results of the three sets of background measurements. In the position P3, two types of measurements were made: with and without personnel around the detector. It can be clearly seen that the background is reproducible but the presence of people shielding the detector leads to a lower background in average. Another important fact noted was that the position P5 with the detector facing the inspectors entrance door has a lower background.

The most important conclusion from these results is that as just behind the wall of the interconnection room are located the feed/withdraw stations of cascades C3/C4, the background in the interconnection room is higher than the one obtained in previous measurements (when C3/C4 were not working) and can present variable values.

Table 2, presents the measurements in the position P1 of the efficiency of the detector in the vertical position, distant 210cm from the source and both detector and source at 50 cm from the floor. The values obtained for CF were 0.952, 0.946 and 0.962, which are out of the interval $0.97 < CF < 1.03$ (adopted in the working papers) indicating that a correction for the measurements must be made when using the Slab detector. (This fact practically has no influence in the measurements done for determining the transmissions ratio, that's why we have used the CF equal to 1.)

The measurements of the transmission factor have started using the 20x20x20cm polyethylene block, but in this geometry it was too far from the

value 0.24, so as can be seen in Table 3 we have increased first the thickness and then the size of the plates. With the dimension 40x40x17.5cm we succeeded in getting the transmission of 0.242. But starting to add the Alarm Plate with several dimensions we didn't succeed in obtaining a geometric situation with 0.22 as transmission factor.

A new set of measurements was performed and are in Table 4. It can be seen that a polyethylene block of 50x50x15cm attached to the source has a transmission factor of 0.2397±0.003. Several dimensions for an Alarm Plate of one inch thickness have been tested and as can be seen in the same Table 4, the alarm plate of 20x40x2.5cm results in a transmission factor of 0.2156± 0.0030.

5. Analysis of the Results and Conclusions

A) As it was verified that the transmission factor (or attenuation factor) strongly depends on the neutrons scattering in the walls and in the floor the calibration of the "Go-No/Go" system must be made always at the same position (Position P1) in the room and at a established height (50cm from the floor).

B) The values for the transmission factor proposed can be achieved using the polyethylene block of 50x50x15cm attached to the source and the Alarm Plate of 20x40x2.5cm centered with the source and detector and at the middle of the distance source to detector (210cm).

C) As all the calibration of the "Go-No/Go" system depends on these values both the block and the alarm plate should not be changed.

D) With these values the "Go-No/Go" system was calibrated and checked several times being reproducible.

E) As it was noted the background measurements are higher than previous measurements so it would be desirable to measure the background inside the cascade hall far from the feed withdrawn station.

F) As the calibration factor of the neutron source (CF) has increased and not decreased what would indicate a lost of efficiency, it is possible that the geometrical situation of the source and detector inside the interconnection room has been changed in relation to the measurements previously made.

G) The presence of other neutron sources near the calibration configuration (even outside the room) and the presence of persons near the system source detector affect the calibration of the "Go/No-Go" system.

Determination of Transmission Ratio (Detector - Vertical Position)

Local: Inside the Room Height Source Detector-50cm Distance Source Detector 120cm Counting Time : 120s		**Contings Free Source**				**Contings of Source with Polyethylene Block**				**Transmision Ratio**			**Attenuation Factor**		
SIZE AND THICKNESS POLYETHYLENE PLATE	Position	C1	σ	3 σ	E%	C1'	σ	3 σ	E%	Transmision Ratio	Error	E%	Attenuation Factor	Error	E%
0	P1	48144	219	658	0.46%										
50x50x15						11508	107	322	0.93%	**0.2390**	0.0032	1.32%	4.18	0.027	0.64%
50x50x15						11442	107	321	0.93%	**0.2377**	0.0031	1.32%	4.21	0.027	0.64%
50x50x15						11821	109	326	0.92%	**0.2455**	0.0032	1.30%	4.07	0.026	0.64%
50x50x15						11541	107	322	0.93%	**0.2397**	0.0032	1.32%	4.17	0.027	0.64%
SIZE AND THICKNESS POLYETHYLENE PLATE + ALARM PLATE	Position	C1	σ	3 σ	E%	C1'	σ	3 σ	E%	Transmision Ratio	Error	E%	Attenuation Factor	Error	E%
50x50x15+ Alarm Plate 50x50x1"	P1	48144	219	658	0.46%	8788	94	281	1.07%	0.1825	0.0028	0.0151	5.48	0.035	0.64%
50x50x15+ Alarm Plate 20x50x1"						10137	101	302	0.99%	0.2106	0.0030	0.0140	4.75	0.031	0.64%
50x50x15 + Alarm Plate 40x40x1"						9955	100	299	1.00%	0.2068	0.0029	0.0142	4.84	0.031	0.64%
50x50x15 + Alarm plate 20x45x1" (1.05m from detector)						10242	101	304	0.99%	0.2127	0.0030	0.0140	4.70	0.030	0.64%
50x50x15 + Alarm plate 20x45x1" (1.05m from detector)						10166	101	302	0.99%	0.2112	0.0030	0.0140	4.74	0.031	0.64%
50x50x15 + Alarm plate 20x40x1" (1.05m from detector)						10378	102	306	0.98%	**0.2156**	0.0030	0.0139	4.64	0.030	0.64%

TABLE 4