John A. Volpe, Ph.D., Manager
Radiation and Toxic Agents Control Section
Cabinet for Health Services
275 East Main Street
Frankfort, KY 40621-0001

OCT 24 1996

Dear Mr. Volpe:

This is response to your letter of May 22, 1996, requesting assistance in resolving the long standing issue related to the short term use of an EMR/Schlumberger, Model 758, neutron generator at Western Kentucky University.

Jim Myers, of our Office, has been in touch with you over the last several months to discuss aspects of the use of the neutron generator. A quick search of the resources on the Internet did not produce information that would be directly applicable to this situation. Most information found related to activation products produced by very large accelerators, or radioactive devices, that were used over very long time periods in the same facility. Although the EMR/Schlumberger device produces 14 MeV neutrons, it is unlikely that significant activation products would have accumulated during its very short exposure cycle. Any activation products which may have been created in the concrete while the device was in use would not appear to create a health hazard to future occupants of the room. This finding was confirmed by surveys conducted by your office which allowed the room to be subsequently released for unrestricted use. Absent new information contradicting the use of the generator, further investigation into this issue would appear to be unwarranted.

If you have any question regarding this correspondence, please contact me or Jim Myers at (301) 415-2328 or E-mail JHM@NRC.GOV.

Sincerely,

Original Signed By
RICHARD L. BANGART

Richard L. Bangart, Director
Office of State Programs

Distribution:
DIR RF (6S-142)
RLBangart
PLohaus
SDroggitis
JMyers
DCool
Kentucky File

DCD (SP06)
PDR (YES_X__ NO___)

150039

*See previous concurrence.

DOCUMENT NAME: G:\JHM\VOLPE3.JHM
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OFFICE	OSP		OSP:DD		IMNS:D		OSP:D	
NAME	JMyers:maj		PHLohaus		DCool		RLBangart	
DATE	10/01/96*		10/03/96*		10/09/96*		10/24/96	

OSP FILE CODE: SP-AG-11

45

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

October 24, 1996

John A. Volpe, Ph.D., Manager
Radiation and Toxic Agents Control Section
Cabinet for Health Services
275 East Main Street
Frankfort, KY 40621-0001

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Sincerely,

Richard L. Bangart

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Office of State Programs

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Cabinet for Health Services
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Sincerely,

Richard L. Bangart, Director
Office of State Programs

Distribution:
DIR RF (6S-142)
RLBangart
PLohaus
SDroggitis
JMyers
Kentucky File

DCD (SP06)
PDR (YES_X__ NO___)

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OFFICE	OSP	OSP:D	IMNS:D	OSP:D	
NAME	JMyers:kk	PHLohaus	DCool	RLBangart	
DATE	10/ /96	10/ /96	10/ /96	10/ /96	

OSP FILE CODE: SP-AG-11

John A. Volpe, Ph.D., Manager
Radiation and Toxic Agents Control Section
Cabinet for Health Services
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OFFICE	OSP		OSP:BC		IMNS:D		OSP:D			
NAME	JMyers:kk		PHLohaus		DCool		RLBangart			
DATE	10/ /96		10/ 3 /96		10/ /96		10/ /96			

OSP FILE CODE: SP-AG-11

(FYI) RLB2
PHL
SCO

EXECUTIVE TASK MANAGEMENT SYSTEM

<<< PRINT SCREEN UPDATE FORM >>>

TASK # - 6S142 DATE- 05/30/96 MAIL CTRL. - 1996

TASK STARTED - 05/30/96 TASK DUE - 06/13/96 TASK COMPLETED - / /

TASK DESCRIPTION - 5/22/96 LTR UNSAFE USE OF NEUTRON GENERATOR AT WESTERN KENTUCKY UNIVERSITY

REQUESTING OFF. - KY REQUESTER - J. VOLPE WITS - 0 FYP - N

PROG.- JHM PERSON - STAFF LEAD - JHM PROG. AREA -

PROJECT STATUS - OSP DUE DATE: 6/14/96

PLANNED ACC. - N
LEVEL CODE - 1

JHM

Jim: - Can you take the lead on this? We'll likely need to coordinate with R-II + NRMSS.

If so, can you provide an estimated dvc date?

Thanks
Paul 5/29

Dvc Date: 6/14/96
per JHM

CABINET FOR HEALTH SERVICES
COMMONWEALTH OF KENTUCKY
FRANKFORT 40621-0001

DEPARTMENT FOR HEALTH SERVICES

PNRB 5/29/96

May 22, 1996

PAUL H LOHAUS DEPUTY DIRECTOR
OFFICE OF STATE PROGRAMS
U S NUCLEAR REGULATORY COMMISSION
WASHINGTON D C 20555

DEAR MR. LOHAUS:

This office has conducted an investigation involving alleged unsafe use of a neutron generator at Western Kentucky University. It could not be determined, based on interviews conducted with individuals involved, that the generator was used at any time other than during a shielding evaluation. There appear to be no witnesses to document use of the generator at any time other than the single instance when the users of the generator admit to conducting a test to determine shielding adequacy.

The individual who brought this situation to our attention still has concerns regarding how many times the generator may have been used, and any resultant potential exposures to other individuals. He believes it is necessary to obtain a core sample of the concrete beneath the location of the generator for neutron activation analysis to verify whether the generator was in fact, used on multiple occasions. The gentleman has agreed that if the Nuclear Regulatory Commission indicates this would not be practical or necessary, he will feel that the investigation is concluded. If the analysis is deemed to be necessary, the University would be instructed to obtain the sample and submit it to a third party, selected by this office, for analysis.

The generator which was used is a EMR/Schlumberger, Model 758, with a 7-10 curie tritium source, in a sealed envelope. A copy of the Sealed Source and Device Registry Sheet is enclosed for your convenience. The generator is capable of producing fourteen (14) MeV neutrons.

Please inform this office if you consider the neutron activation analysis to be indicated in this situation. If additional information is needed, please contact Radiation Control staff at (502) 564-3700.

Sincerely,

John A. Volpe, Ph.D., Manager
Radiation and Toxic Agents
Section

9607090053
1p.

REGISTRY OF RADIOACTIVE SEALED SOURCES AND DEVICES
SAFETY EVALUATION OF DEVICE

NO.: NR-316-D-101-S DATE: July 14, 1992 PAGE 1 OF 7

DEVICE TYPE: Neutron Generator

MODELS: 758, 761, 762

MANUFACTURER/DISTRIBUTOR:

Technology

EMR Photoelectric
A Division of Schlumberger
Corporation
P.O. Box 44
Princeton, NJ 08542-0044

ISOTOPE:

Hydrogen-3 (Tritium)

MAXIMUM ACTIVITY:

10.0 Curies

LEAK TEST FREQUENCY: Not Required

PRINCIPAL USES: (F) Well Logging

CUSTOM DEVICE: _____ YES ___X___ NO

9607090061

9pp.

REGISTRY OF RADIOACTIVE SEALED SOURCES AND DEVICES
SAFETY EVALUATION OF DEVICE

NO.: NR-316-D-101-S DATE: July 14, 1992

DEVICE TYPE: Neutron Generator

DESCRIPTION:

The EMR Photoelectric Models 758, 761, and 762 neutron generators are small, high-voltage accelerators used to generate high energy neutrons (14.2 MeV, 1.42 Joules) from a deuterium-tritium fusion reaction. Neutrons emitted from the generator interact with the nuclei of surrounding material (ex. earth in well-logging applications). The results of these interactions can be detected and related to the properties of the surrounding material.

The devices are comprised of a hermetically sealed envelope made of ceramic and metal. Deuterium and tritium are adsorbed in two places inside the envelope: a thin metal film coating the face of a copper target post and in another thin metal film coating a coiled tungsten filament. The target and filament are located at opposite ends of the envelope. Neutron generation may only take place when a high voltage charge is applied to the generator. On activation, the current causes the tungsten filament to heat up releasing the deuterium and tritium into gaseous form inside the sealed envelope. The applied voltage causes a flow of ionized particles toward the copper target which, upon impact, cause neutron production through a deuterium-tritium fusion reaction.

The generator envelopes for all three models are constructed similarly from high density metallized alumina ceramic, Kovar (a trade name for a Fe/Ni/Co alloy used for sealing to ceramics), and OFHC copper. Model 758 also contains a small section of stainless steel. The metallized ceramic to metal joining is done by a brazing practice using a Cu-Ag eutectic braze material. All metal-metal joining is accomplished by a tig weld, and the final envelope seal is done with a cold-weld pinch-off which is then protected by a thin metal overlay which is soldered in place.

Wall thicknesses vary according to the material used. The metals range from approximately 0.020" to 0.030" (0.51 to 0.76 mm) thick, while the ceramics are all approximately 0.10" (2.54 mm) thick. The main structural difference between these models is that the 758 uses stainless steel for its midsection while the 761 and 762 use Kovar. Another difference of note is physical size. The 758 is approximately 5.5" (14 cm) in length by 1" (2.54 cm) in diameter, the 761 is approximately 4.7" (12 cm) in length by 1" (2.54 cm) in diameter, and the 762 is approximately 5" (14 cm) in length by 2" (5.1 cm) in diameter.

REGISTRY OF RADIOACTIVE SEALED SOURCES AND DEVICES
SAFETY EVALUATION OF DEVICE

NO.: NR-316-D-101-S DATE: July 14, 1992

DEVICE TYPE: Neutron Generator

DESCRIPTION: (Cont'd)

The neutron generators are designed to be placed inside of a metal high voltage assembly. For the Models 758 and 761 this assembly consists of a long, cylindrical, sealed tube approximately 1.68" (4.3 cm) in diameter and 84" (2.13 m) long. The tool assembly for the 762 is larger in diameter and measures approximately 30" (76 cm) in length. The assemblies are constructed of metal, are completely sealed, provide additional protection from damage to the capsule and would contain any tritium gas if the generator capsule should break and/or leak. The assembly used with the Models 758 and 761 is designed for use in well logging applications. The assembly used with the Model 762 is designed for use in devices which perform elemental analysis of bulk material in non-well logging applications.

LABELING:

The external surface of each neutron generator target is engraved with a target assembly I.D. number consisting of year-month-day (date of construction) and target position and the sequential serial number assigned to the neutron generator. After tritiation, the neutron generators have the model number (758, 761, or 762) and "Radioactive H3" etched or engraved on the annulus of the end Kovar piece at the pinchoff end. The remaining annular space is taken by a second engraving of the serial number.

DIAGRAMS:

See Attachments 1 and 2.

CONDITIONS OF NORMAL USE:

These neutron generators may be used in well logging applications and in devices which perform elemental analysis of bulk material such as in airports and laboratories. Well logging applications would present the most hazardous environment. Therefore, the generators are designed to withstand this type of environment.

DEVICE TYPE: Neutron Generator

CONDITIONS OF NORMAL USE: (Cont'd)

The capsules are designed for the following operating conditions:

- Operating temperature: -4°F to 325°F (-20°C to 163°C) with brief excursions of -67°F to 392°F (-55°C to 200°C) allowed for one hour or less.
- Thermal cycling (non-operating) of 50°F/min (10°C/min) with half-hour dwell limits of 32°F and 437°F (0°C and 225°C).
- Up to a 100 g shock of 8 millisecond duration along the revolution axis and any perpendicular axis.
- Sinusoidal vibration up to 7.5 g from 10 Hz to 18 Hz, except limited to 0.5" (1.27 cm) double amplitude (peak-to-peak) along the revolution axis and any perpendicular axis.
- Mechanical strength: Up to 80 psi (552 kPa) in tension.
- Storage temperature between -67°F to 122°F (-55°C to 50°C).

Operation of the generator at voltages in excess of the operational range can result in damage to the sealed envelope. Also, at temperatures above 1832°F (1000°C) desorption of the tritium will occur. If the integrity of the sealed envelope is breached at this temperature, leakage of tritium gas may result.

PROTOTYPE TESTING:

A fully operational Model 758 generator was tested for resistance to multiple shocks (50 each) at various levels ranging from 110 g to 550 g for durations of 11.5 ms to 3.4 ms respectively. The maximum expected shock during normal handling and use is 100 g.

The generator was initially tested with partial power applied. Following the test, full power was applied and the unit operated normally. The unit was retested with full power applied. Following the second series of tests, an operational check again showed that the unit performed normally. Normal operation of the unit is an indication that the integrity of the capsule has not been breached.

DEVICE TYPE: Neutron Generator

PROTOTYPE TESTING: (Cont'd)

The manufacturer states that the Model 758 has been in use since 1985 with minimal reported failures or breakages and the Model 761 has been in use since 1988 with no reported failures or breakages. The manufacturer further states the devices have been shown to have an approximate "working life" of three years under normal conditions of use. The "working life" of the unit is governed by operational efficiency.

EXTERNAL RADIATION LEVELS:

The generator only produces neutron radiation when high voltage is applied. In the "power off" condition, no neutron radiation will be produced; however, gamma radiation may be present as a result of neutron interaction with the components of the generator itself and the high voltage assembly.

The majority of the gamma radiation produced is due to activated aluminum, copper and iron with short half lives (less than 10 minute half life for the copper target and aluminum in the ceramic envelope components and less than 15 hour half life for the copper and aluminum components of the generator and the iron components of the assembly). Longer-lived activation products do not contribute significantly to the radioactive output. The radiation levels shown below were measured at ten minutes and one hour after the units were shut off following three hours of continuous operation. Three hours is a typical period of time for the units to be turned on during use.

	S/N 8227		S/N 8299	
ELAPSED TIME	10 min.	1 hour	10 min.	1 hour
DISTANCE	Radiation Levels (mrem/hr [μSv/hr])			
5 cm	3.4 [34.0]	1.2 [12.0]	4.0 [40.0]	1.0 [10.0]
30 cm	0.3 [3.0]	0.1 [1.0]	0.26 [2.6]	0.09 [0.9]
100 cm	0.08 [0.8]	0.02 [0.2]	0.02 [0.2]	0.02 [0.2]

Typically, surface gamma radiation levels will fall below .2 mrem/hr [20 μSv/hr] within twenty four hours after use.

REGISTRY OF RADIOACTIVE SEALED SOURCES AND DEVICES
SAFETY EVALUATION OF DEVICE

NO.: NR-316-D-101-S DATE: July 14, 1992

DEVICE TYPE: Neutron Generator

QUALITY ASSURANCE AND CONTROL:

The manufacturer claims to maintain a Quality plan that meets the following MILITARY STANDARDS: MIL-Q-9858 "Quality Program Requirements"; MIL-I-45208A "Inspection System Requirements"; and MIL-STD-45662 "Calibration System Requirements". All neutron generators are 100% tested for conformance to specifications, and the end product must meet the internal standards of an ultra-high vacuum device. Additionally, material procurement checks, in-process assembly inspections and performance testing are performed and documented under the manufacturer's Quality Plan.

LIMITATIONS AND/OR OTHER CONSIDERATIONS OF USE:

- The Models 758, 761 and 762 neutron generators shall be distributed only to persons specifically licensed by the NRC or an Agreement State.
- Handling, Storage, Use, Transfer, and Disposal: To be determined by the licensing authority. In view that these generators produce high levels of neutron radiation when activated, they should be handled only by experienced personnel using adequate remote handling equipment and procedures.
- This registration sheet and the information contained with the references shall not be changed without the written consent of the NRC.
- The generators shall not be subjected to environmental and use conditions outside the range of the normal operating conditions specified in the users manual and in the "Conditions of Normal Use " section above.
- REVIEWER NOTE: The generators are exempt from leak testing requirements. However, a significant reduction in the operational efficiency of the unit may indicate leakage of the source. A device that is suspected to be leaking should be taken out of service and tested for leakage using techniques capable of detecting the presence of tritium. The licensee should develop procedures for detecting and dealing with this possibility.

REGISTRY OF RADIOACTIVE SEALED SOURCES AND DEVICES
SAFETY EVALUATION OF DEVICE

NO.: NR-316-D-101-S DATE: July 14, 1992

DEVICE TYPE: Neutron Generator

SAFETY ANALYSIS SUMMARY:

Based on our review of the information and test data cited below and the past use history of the Models 758 and 761, we conclude that the Models 758, 761 and 762 neutron generators are acceptable for licensing purposes.

Furthermore, we conclude that these neutron generators would be expected to maintain their containment for normal conditions of use which might occur during the uses specified in this registration sheet.

REFERENCES:

The following supporting documents for the Models 758, 761 and 762 neutron generators are hereby incorporated by reference and are made a part of this registry document:

- EMR Photoelectric's letters dated July 16, 1991, July 17, 1991, September 5, 1991, January 13, 1992, and January 15, 1992 with enclosures thereto.

ISSUING AGENCY:

U.S. Nuclear Regulatory Commission

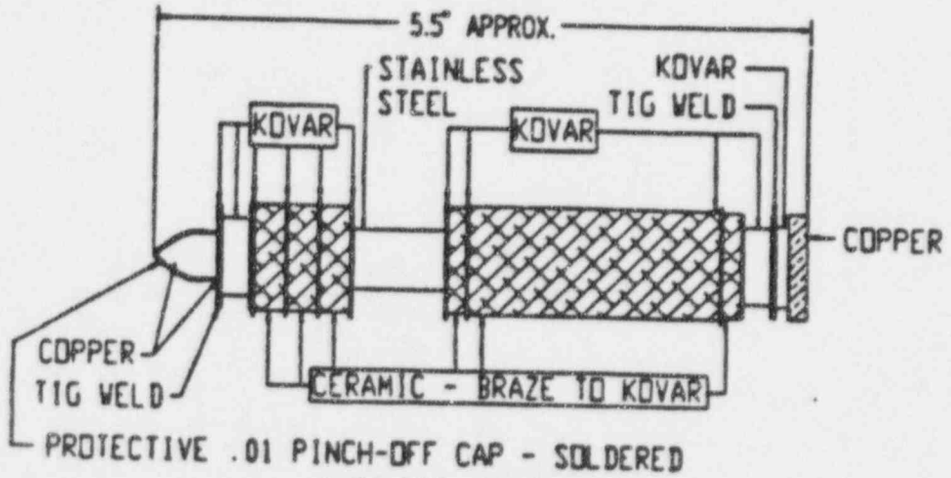
Date: July 14, 1992 Reviewer: [signature]

Date: July 14, 1992 Concurrence: [signature]

REGISTRY OF RADIOACTIVE SEALED SOURCES AND DEVICES
SAFETY EVALUATION OF DEVICE

NO.: NR-316-D-101-S DATE: July 14, 1992 ATTACHMENT 1

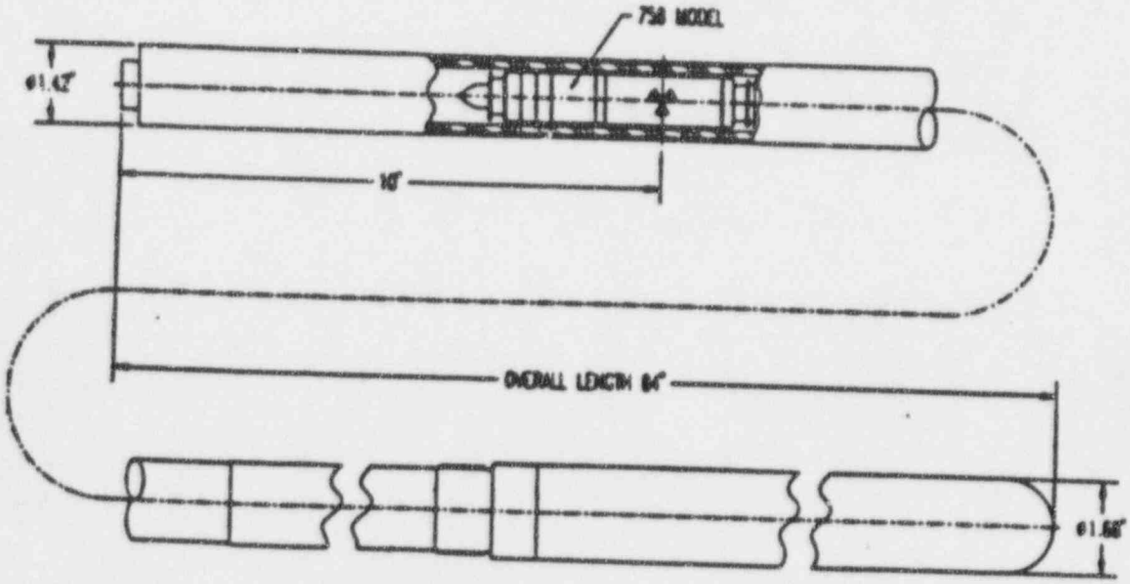
DEVICE TYPE: Neutron Generator



1.0" DIA. APPROX.

MODEL 758

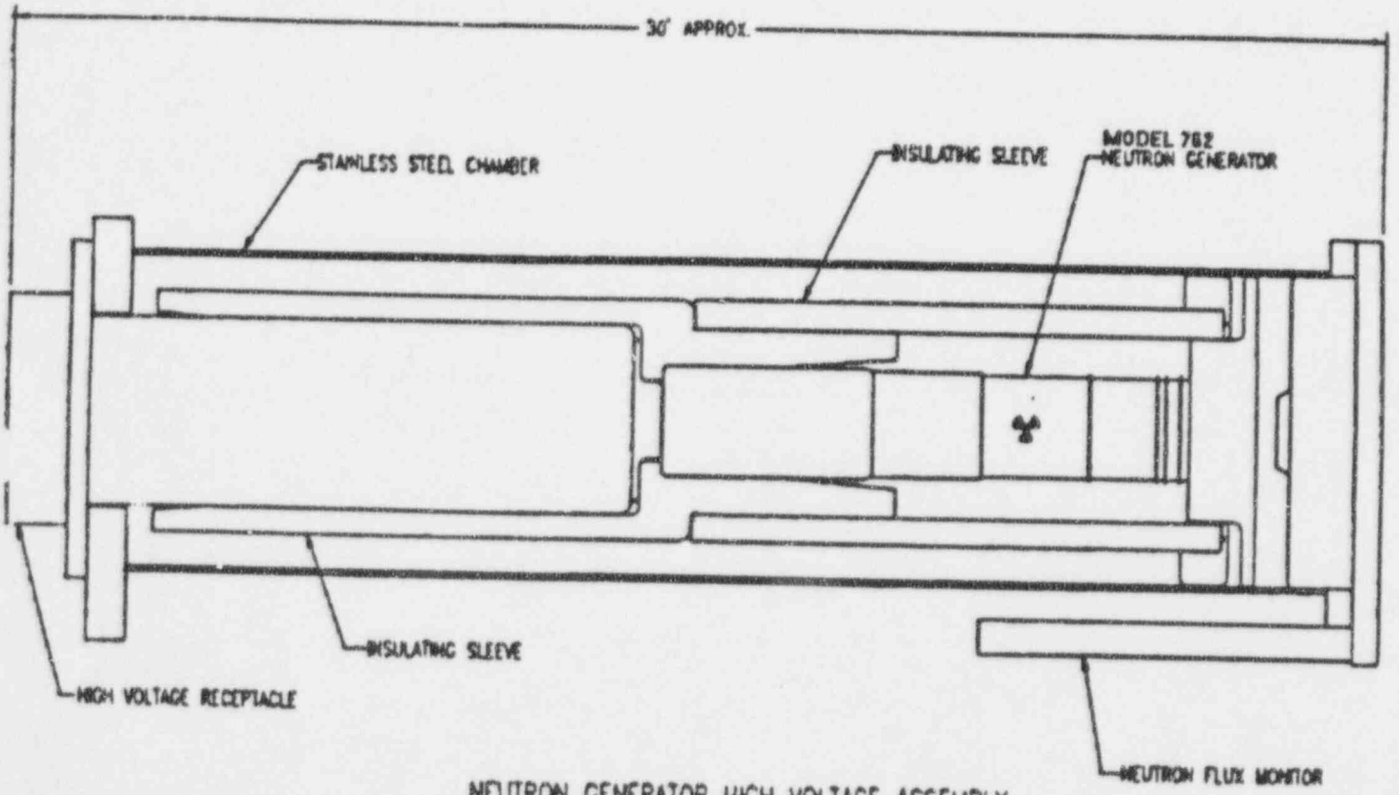
NEUTRON GENERATOR HIGH VOLTAGE ASSEMBLY W/MODEL 758



REGISTRY OF RADIOACTIVE SEALED SOURCES AND DEVICES
SAFETY EVALUATION OF DEVICE

NO.: NR-316-D-101-S DATE: July 14, 1992 ATTACHMENT 2

DEVICE TYPE: Neutron Generator



NEUTRON GENERATOR HIGH VOLTAGE ASSEMBLY
FOR GENERAL NEUTRON SOURCE APPLICATIONS.

(1) An allegation that appears to be closed

(2) Is the problem one of exposure or exposure due to activation products

(3) What do we expect to find under normal conditions?

- Conditions of use:

- What would you do if you found something? How does it relate to use?

MEMORANDUM TO: Bill M. Morris, Director
Division of Regulatory Applications
Office of Nuclear Regulatory Research

FROM: Richard L. Bangart, Director
Office of State Programs

SUBJECT: OFFICE CONCURRENCE: REVISED PART 34

We have reviewed the revisions to Part 34 submitted with your memo of May 9, 1996 and concur in the changes.

The incorporation of the requirement for two qualified individuals to be present during radiography operations and certification of radiographers will help establish uniform, national standards in industrial radiography. The return to the language currently used in Part 34.20 (b)(2), (e) and (f) will lessen confusion about performance standards for radiography equipment during time needed to re-evaluate the requirement.

If you have any questions regarding this correspondence, please contact me or the individual named below.

POINT OF CONTACT: Jim Myers
TELEPHONE: (301) 415-2328
FAX: (301) 415-3502
INTERNET: JHM@NRC.GOV

Richard L. Bangart, Director
Office of State Programs

cc: C. Trottier, RES

Distribution:
DIR RF
RLBangart
PLohaus
SDroggitis
JMyers
RES File

DCD (SP02)
PDR (YES X NO)

DOCUMENT NAME: G:\JHM\PT34FIN.JHM
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OFFICE	OSP		OSP:DD		OSP:D					
NAME	JMyers		PLohaus		RBangart					
DATE	05/ /96		/ /96		/ /96					

OSP FILE CODE: SP-0-11

CABINET FOR HEALTH SERVICES
COMMONWEALTH OF KENTUCKY
FRANKFORT 40621-0001

DEPARTMENT FOR HEALTH SERVICES

PNRS 5/29/96

May 22, 1996

PAUL H LOHAUS DEPUTY DIRECTOR
OFFICE OF STATE PROGRAMS
U S NUCLEAR REGULATORY COMMISSION
WASHINGTON D C 20555

DEAR MR. LOHAUS:

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Please inform this office if you consider the neutron activation analysis to be indicated in this situation. If additional information is needed, please contact Radiation Control staff at (502) 564-3700.

Sincerely,

John A. Volpe, Ph.D., Manager
Radiation and Toxic Agents
Section

9607090053

JIM

Jim: - Can you take the lead on this? We'll likely need to coordinate with R-II + NRMSS.

If so, can you provide an estimated due date?

Thanks
Paul 5/29

REGISTRY OF RADIOACTIVE SEALED SOURCES AND DEVICES
SAFETY EVALUATION OF DEVICE

NO.: NR-316-D-101-S DATE: July 14, 1992

DEVICE TYPE: Neutron Generator

MODELS: 758, 761, 762

MANUFACTURER/DISTRIBUTOR:

EMR Photoelectric
A Division of Schlumberger Technology Corporation
P.O. Box 44
Princeton, NJ 08542-0044

ISOTOPE:

Hydrogen-3 (Tritium)

MAXIMUM ACTIVITY:

10.0 Curies

LEAK TEST FREQUENCY: Not Required

PRINCIPAL USES: (F) Well Logging

CUSTOM DEVICE: _____ YES ___X___ NO

REGISTRY OF RADIOACTIVE SEALED SOURCES AND DEVICES
SAFETY EVALUATION OF DEVICE

NO.: NR-316-D-101-S DATE: July 14, 1992

DEVICE TYPE: Neutron Generator

DESCRIPTION:

The EMR Photoelectric Models 758, 761, and 762 neutron generators are small, high-voltage accelerators used to generate high energy neutrons (14.2 MeV, 1.42 Joules) from a deuterium-tritium fusion reaction. Neutrons emitted from the generator interact with the nuclei of surrounding material (ex. earth in well-logging applications). The results of these interactions can be detected and related to the properties of the surrounding material.

The devices are comprised of a hermetically sealed envelope made of ceramic and metal. Deuterium and tritium are adsorbed in two places inside the envelope: a thin metal film coating the face of a copper target post and in another thin metal film coating a coiled tungsten filament. The target and filament are located at opposite ends of the envelope. Neutron generation may only take place when a high voltage charge is applied to the generator. On activation, the current causes the tungsten filament to heat up releasing the deuterium and tritium into gaseous form inside the sealed envelope. The applied voltage causes a flow of ionized particles toward the copper target which, upon impact, cause neutron production through a deuterium-tritium fusion reaction.

The generator envelopes for all three models are constructed similarly from high density metallized alumina ceramic, Kovar (a trade name for a Fe/Ni/Co alloy used for sealing to ceramics), and OFHC copper. Model 758 also contains a small section of stainless steel. The metallized ceramic to metal joining is done by a brazing practice using a Cu-Ag eutectic braze material. All metal-metal joining is accomplished by a tig weld, and the final envelope seal is done with a cold-weld pinch-off which is then protected by a thin metal overlay which is soldered in place.

Wall thicknesses vary according to the material used. The metals range from approximately 0.020" to 0.030" (0.51 to 0.76 mm) thick, while the ceramics are all approximately 0.10" (2.54 mm) thick. The main structural difference between these models is that the 758 uses stainless steel for its midsection while the 761 and 762 use Kovar. Another difference of note is physical size. The 758 is approximately 5.5" (14 cm) in length by 1" (2.54 cm) in diameter, the 761 is approximately 4.7" (12 cm) in length by 1" (2.54 cm) in diameter, and the 762 is approximately 5" (14 cm) in length by 2" (5.1 cm) in diameter.

REGISTRY OF RADIOACTIVE SEALED SOURCES AND DEVICES
SAFETY EVALUATION OF DEVICE

NO.: NR-316-D-101-S DATE: July 14, 1992

DEVICE TYPE: Neutron Generator

DESCRIPTION: (Cont'd)

The neutron generators are designed to be placed inside of a metal high voltage assembly. For the Models 758 and 761 this assembly consists of a long, cylindrical, sealed tube approximately 1.68" (4.3 cm) in diameter and 84" (2.13 m) long. The tool assembly for the 762 is larger in diameter and measures approximately 30" (76 cm) in length. The assemblies are constructed of metal, are completely sealed, provide additional protection from damage to the capsule and would contain any tritium gas if the generator capsule should break and/or leak. The assembly used with the Models 758 and 761 is designed for use in well logging applications. The assembly used with the Model 762 is designed for use in devices which perform elemental analysis of bulk material in non-well logging applications.

LABELING:

The external surface of each neutron generator target is engraved with a target assembly I.D. number consisting of year-month-day (date of construction) and target position and the sequential serial number assigned to the neutron generator. After tritiation, the neutron generators have the model number (758, 761, or 762) and "Radioactive H3" etched or engraved on the annulus of the end Kovar piece at the pinchoff end. The remaining annular space is taken by a second engraving of the serial number.

DIAGRAMS:

See Attachments 1 and 2.

CONDITIONS OF NORMAL USE:

These neutron generators may be used in well logging applications and in devices which perform elemental analysis of bulk material such as in airports and laboratories. Well logging applications would present the most hazardous environment. Therefore, the generators are designed to withstand this type of environment.

DEVICE TYPE: Neutron Generator

CONDITIONS OF NORMAL USE: (Cont'd)

The capsules are designed for the following operating conditions:

- Operating temperature: -4°F to 325°F (-20°C to 163°C) with brief excursions of -67°F to 392°F (-55°C to 200°C) allowed for one hour or less.
- Thermal cycling (non-operating) of 50°F/min (10°C/min) with half-hour dwell limits of 32°F and 437°F (0°C and 225°C).
- Up to a 100 g shock of 8 millisecond duration along the revolution axis and any perpendicular axis.
- Sinusoidal vibration up to 7.5 g from 10 Hz to 18 Hz, except limited to 0.5" (1.27 cm) double amplitude (peak-to-peak) along the revolution axis and any perpendicular axis.
- Mechanical strength: Up to 80 psi (552 kPa) in tension.
- Storage temperature between -67°F to 122°F (-55°C to 50°C).

Operation of the generator at voltages in excess of the operational range can result in damage to the sealed envelope. Also, at temperatures above 1832°F (1000°C) desorption of the tritium will occur. If the integrity of the sealed envelope is breached at this temperature, leakage of tritium gas may result.

PROTOTYPE TESTING:

A fully operational Model 758 generator was tested for resistance to multiple shocks (50 each) at various levels ranging from 110 g to 550 g for durations of 11.5 ms to 3.4 ms respectively. The maximum expected shock during normal handling and use is 100 g.

The generator was initially tested with partial power applied. Following the test, full power was applied and the unit operated normally. The unit was retested with full power applied. Following the second series of tests, an operational check again showed that the unit performed normally. Normal operation of the unit is an indication that the integrity of the capsule has not been breached.

DEVICE TYPE: Neutron Generator

PROTOTYPE TESTING: (Cont'd)

The manufacturer states that the Model 758 has been in use since 1985 with minimal reported failures or breakages and the Model 761 has been in use since 1988 with no reported failures or breakages. The manufacturer further states the devices have been shown to have an approximate "working life" of three years under normal conditions of use. The "working life" of the unit is governed by operational efficiency.

EXTERNAL RADIATION LEVELS:

The generator only produces neutron radiation when high voltage is applied. In the "power off" condition, no neutron radiation will be produced; however, gamma radiation may be present as a result of neutron interaction with the components of the generator itself and the high voltage assembly.

The majority of the gamma radiation produced is due to activated aluminum, copper and iron with short half lives (less than 10 minute half life for the copper target and aluminum in the ceramic envelope components and less than 15 hour half life for the copper and aluminum components of the generator and the iron components of the assembly). Longer-lived activation products do not contribute significantly to the radioactive output. The radiation levels shown below were measured at ten minutes and one hour after the units were shut off following three hours of continuous operation. Three hours is a typical period of time for the units to be turned on during use.

ELAPSED TIME	S/N 8227		S/N 8299	
	10 min.	1 hour	10 min.	1 hour
DISTANCE	Radiation Levels (mrem/hr [μSv/hr])			
5 cm	3.4 [34.0]	1.2 [12.0]	4.0 [40.0]	1.0 [10.0]
30 cm	0.3 [3.0]	0.1 [1.0]	0.26 [2.6]	0.09 [0.9]
100 cm	0.08 [0.8]	0.02 [0.2]	0.02 [0.2]	0.02 [0.2]

Typically, surface gamma radiation levels will fall below 2 mrem/hr [20 μSv/hr] within twenty four hours after use.

REGISTRY OF RADIOACTIVE SEALED SOURCES AND DEVICES
SAFETY EVALUATION OF DEVICE

NO.: NR-316-D-101-S DATE: July 14, 1992

DEVICE TYPE: Neutron Generator

QUALITY ASSURANCE AND CONTROL:

The manufacturer claims to maintain a Quality plan that meets the following MILITARY STANDARDS: MIL-Q-9858 "Quality Program Requirements"; MIL-I-45208A "Inspection System Requirements"; and MIL-STD-45662 "Calibration System Requirements". All neutron generators are 100% tested for conformance to specifications, and the end product must meet the internal standards of an ultra-high vacuum device. Additionally, material procurement checks, in-process assembly inspections and performance testing are performed and documented under the manufacturer's Quality Plan.

LIMITATIONS AND/OR OTHER CONSIDERATIONS OF USE:

- The Models 758, 761 and 762 neutron generators shall be distributed only to persons specifically licensed by the NRC or an Agreement State.
- Handling, Storage, Use, Transfer, and Disposal: To be determined by the licensing authority. In view that these generators produce high levels of neutron radiation when activated, they should be handled only by experienced personnel using adequate remote handling equipment and procedures.
- This registration sheet and the information contained with the references shall not be changed without the written consent of the NRC.
- The generators shall not be subjected to environmental and use conditions outside the range of the normal operating conditions specified in the users manual and in the "Conditions of Normal Use " section above.
- REVIEWER NOTE: The generators are exempt from leak testing requirements. However, a significant reduction in the operational efficiency of the unit may indicate leakage of the source. A device that is suspected to be leaking should be taken out of service and tested for leakage using techniques capable of detecting the presence of tritium. The licensee should develop procedures for detecting and dealing with this possibility.

REGISTRY OF RADIOACTIVE SEALED SOURCES AND DEVICES
SAFETY EVALUATION OF DEVICE

NO.: NR-316-D-101-S DATE: July 14, 1992

DEVICE TYPE: Neutron Generator

SAFETY ANALYSIS SUMMARY:

Based on our review of the information and test data cited below and the past use history of the Models 758 and 761, we conclude that the Models 758, 761 and 762 neutron generators are acceptable for licensing purposes.

Furthermore, we conclude that these neutron generators would be expected to maintain their containment for normal conditions of use which might occur during the uses specified in this registration sheet.

REFERENCES:

The following supporting documents for the Models 758, 761 and 762 neutron generators are hereby incorporated by reference and are made a part of this registry document:

- EMR Photoelectric's letters dated July 16, 1991, July 17, 1991, September 5, 1991, January 13, 1992, and January 15, 1992 with enclosures thereto.

ISSUING AGENCY:

U.S. Nuclear Regulatory Commission

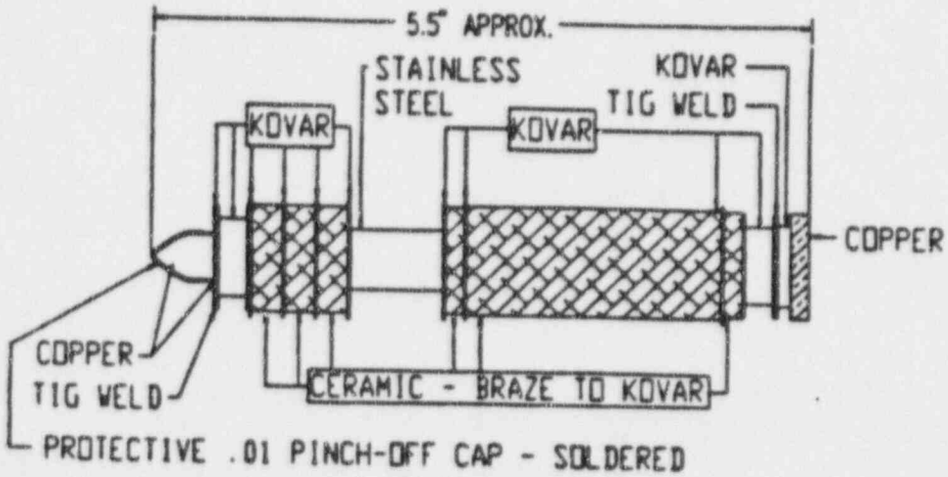
Date: July 14, 1992 Reviewer: [signature]

Date: July 14, 1992 Concurrence: Thomas W. Rich

REGISTRY OF RADIOACTIVE SEALED SOURCES AND DEVICES
SAFETY EVALUATION OF DEVICE

NO.: NR-316-D-101-S DATE: July 14, 1992 ATTACHMENT 1

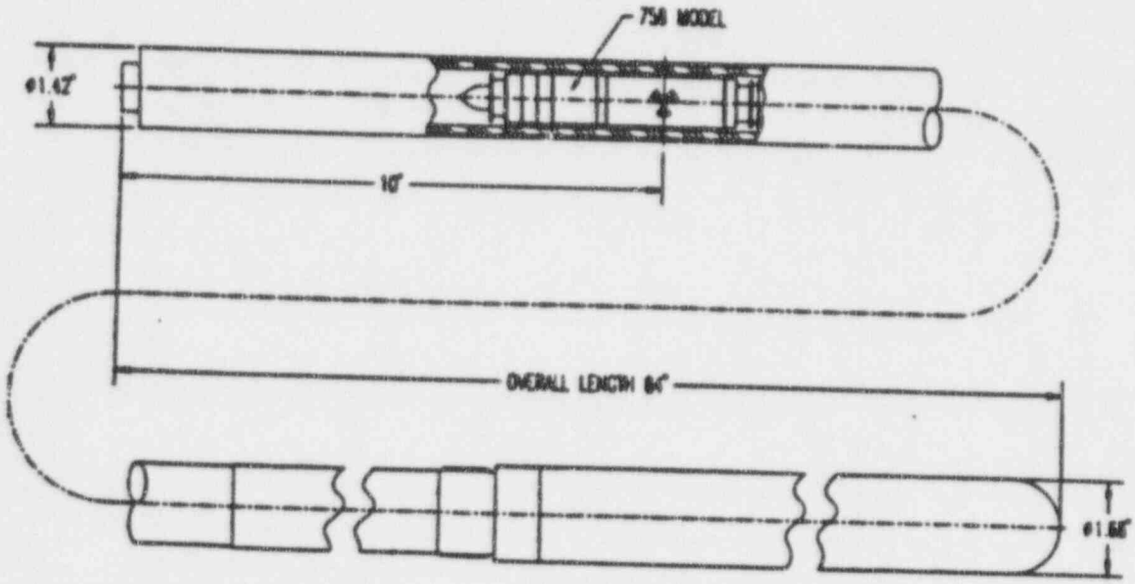
DEVICE TYPE: Neutron Generator



1.0" DIA. APPROX.

MODEL 758

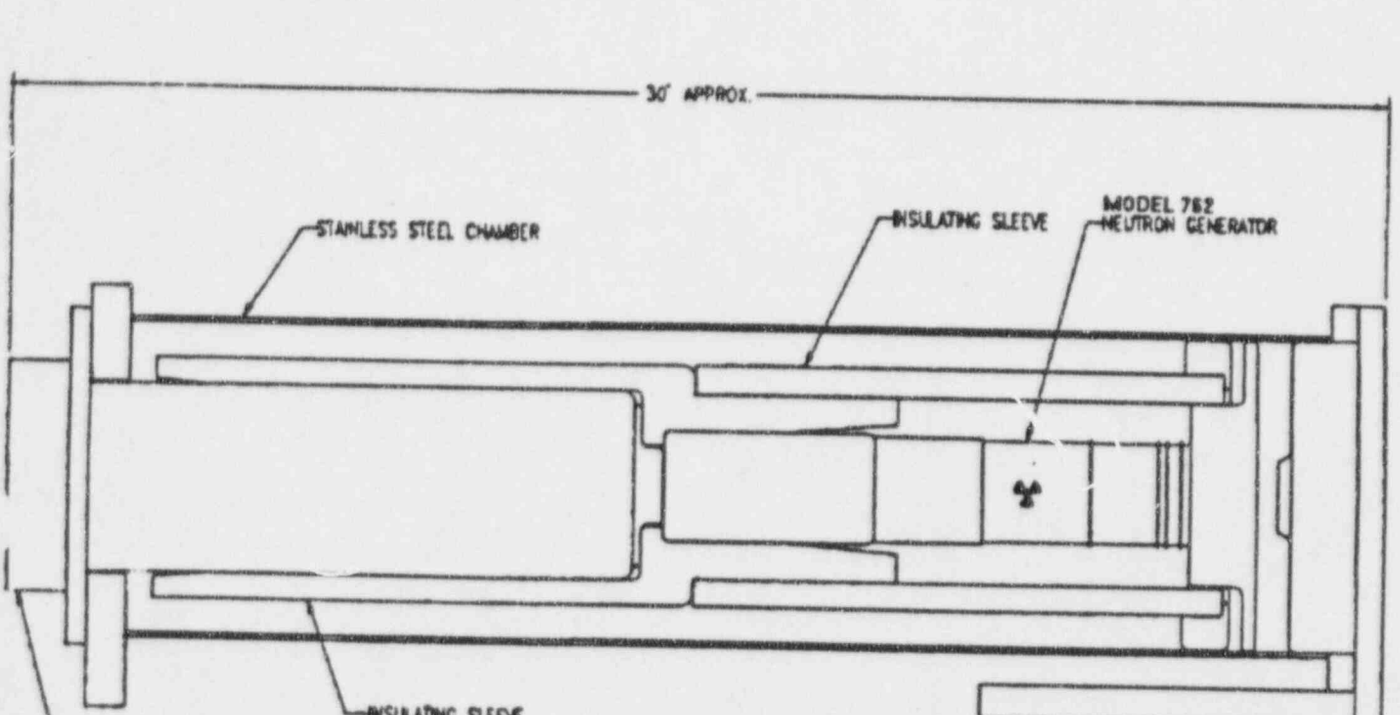
NEUTRON GENERATOR HIGH VOLTAGE ASSEMBLY W/MODEL 758



REGISTRY OF RADIOACTIVE SEALED SOURCES AND DEVICES
SAFETY EVALUATION OF DEVICE

NO.: NR-316-D-101-S DATE: July 14, 1992 ATTACHMENT 2

DEVICE TYPE: Neutron Generator



NEUTRON GENERATOR HIGH VOLTAGE ASSEMBLY
FOR GENERAL NEUTRON SOURCE APPLICATIONS.