DEFENSE NUCLEAR FACILITIES SAFETY BOARD

January 7, 1995

MEMORANDUM FOR: G. W. Cunningham, Technical Director

COPIES: Board Members

FROM: Roger Zavadoski

SUBJECT: Trip Report on the Use of Radiation Generating Devices at Pantex

1. **Purpose:** This report documents the results of a DNFSB staff and outside experts' visit to the Pantex plant to conduct a review on their use of radiation generating devices (RGDs). This review was conducted by Dr. Roger Zavadoski, DNFSB staff, and Dr. James Liverman, Outside Expert, during the period of November 29 to December 1, 1993.

2. **Summary:**

   a. The scope of this review included the installation and use of radiation generating devices located in 11-51 Bay 116, 11-51 Bay 124, 12-21 East Bay, 12-21 West Bay, 12-55 Bay 2, 12-84 Bay 1, 12-84 Bay 10 and 12-104A Bay 17. All the facilities reviewed demonstrated an adequate regard for the radiation safety of the workers utilizing the facilities.

   b. Effective controls are in place to minimize radiation dose to non-destructive examiners. The radiation exposure for the personnel involved in the non-destructive examination process (maximum individual 150 millirem for the current calendar year) is not attributable to the radiation generating devices, but to handling or being in close proximity to radioactive material.

   c. The training provided to personnel utilizing the radiation generating devices met the requirements of the "Certification Program for Industrial Radiography Radiation Safety Personnel of the American Society for Nondestructive Testing" used in the commercial industry.

3. **Background:**

   a. The utilization of radiation generating devices is not explicitly covered in the DOE orders. For radiography sources, the DOE's Radiological Control Manual suggests the use of the commercial standards found and encompassed in 10CFR34. Guidance on the application of the standards is not provided in the Radiological Control Manual. This situation will change somewhat when 10CFR835 Occupational Radiation Protection and

various implementation guides are formally issued, but even their implementation is a year or two away.

b. The radiation generating devices currently used are capable of developing beam strengths of several thousand rem per minute and field strengths up to a few thousand rem per hour. Such beams represent a potential for a lethal exposure in a period of a few seconds.

c. The commercial nuclear power industry is replete with incidences involving radiography sources, some of which have resulted in substantial exposures to individuals. In addition, commercial radiographers are constantly receiving exposures in the rem per year category, making them one of the most highly exposed groups in the commercial nuclear power industry.

4. **Discussions/Observations:** During this review, several facilities utilizing RGDs were visited. These facilities and the observations at each are detailed below. These reviews considered the following standards: (1) American National Standard N432-1980 "Radiological Safety for the Design and Construction of Apparatus for Gamma Radiography" and (2) American National Standard N43.3-1993 "Installations Using Non-Medical X-Ray and Sealed Gamma-Ray Sources, Energies up to 10 MeV."

a. **Building 12-84, Bay 10, 3 MeV Linear Accelerator:** Personnel can only enter the facility with approval of the Radiography Operator and they must sign in upon entry. Equipment used in preparing a specimen for examination and the experimental material is moved into the Bay through a double wide, double door equipment airlock. Personnel gain access through a separate double door airlock. Entry through either access is controlled by the Radiographic Operator who has the only key to the access door locks. It is the Radiographic Operator's responsibility to ensure the Bay is clear of all personnel prior to start-up of the accelerator. The start-up procedures require a "Fail Safe Systems Check" of all doors, safety devices, and alarm systems prior to start-up. While this check uses a lighted board system, it entails actual sounding of the alarming devices and physical opening and shutting the doors to test the alarming systems. An additional safeguard is the requirement that start-up requires the simultaneous insertion of two keys into the control panel. One key is assigned to the Operator and the other to the Assistant Operator. Because of the maze like arrangement of the access corridor, the levels of radiation near the exit doors for either equipment or personnel is very low even when the accelerator is fully operational. A crash bar opener on the exit/entrance doors is interlocked with the operation of the accelerator. The interlocks are such that when the machine is in operation entry cannot be made from outside the bay, conversely opening of any of the doors from the inside will immediately cause a shutdown. In addition to these safeguards for protecting workers, there are a number of emergency off switches within the different areas of the bay so that an individual, who through error may have been trapped inside, can shut off the accelerator instantly.

b. **Building 12-21, West Bay, 2.5 MeV X-Ray Van De Graaff:** A 2.5 MeV X-Ray Van De Graaff Generator produces X-Rays for examination of high explosives prior to machining and other operations. This facility lacks the maze found in Bays 1 and 10, Building 12-84. Rubber floor mats are utilized to reduce the likelihood of sparks. The lead filled doors prevent entry during operation of the generator.

The pre-operational checks for this machine includes a review of the fail-safe circuits as well as posting of areas outside the exposure cell.

c. **Building 12-21, East Bay, 3 MeV Neutron Van De Graaff:** A 3 MeV Van De Graaff uses a deuterium/beryllium target to generate neutrons for small component quality control. Neutron flux is from 10^7 - .5 X 10^5 neutrons/sec aimed directly downward at the target. Exposures are 2-2.5 hours and personnel entry must be delayed at least 5 minutes for each four hours of exposure, a practice that has been in effect for several years. There were no available calculations to verify the adequacy of this time. However, dosimetric measurements indicate the area is safe. The shielding appeared adequate based on doses measured external to the room containing the source. "Fail safe checks" and the "pre-operational checks" for this facility are utilized prior to each use.

d. **Building 12-55, Bay 2, Cobalt 60 Source:** This single remaining sealed source used for radiography is mobile and is used only in those instances where the object to be radiographed cannot be moved to one of the facilities with fixed sources. Pantex has requested funds from DOE to replace this isotopic source with a portable accelerator to reduce the potential for worker exposure. The source was properly stored.

e. **Building 12-104A, Bay 17, 2 MeV Linac:** This facility is the newest and has the largest bay. Construction started in 1986 and is completed and a new linac, state-of-the-art dosimetry, warning equipment, and access controls are installed. The facility is ready to operate, but recent changes in safety requirements make it mandatory to upgrade the SAR. In all respects but one, this facility is operationally like Bay 10, Building 12-84. This facility has an extra exit door directly from the rear of the exposure bay because fire regulations require that there must be exits within certain distances and the standard entry at the front of the facility is too far away. These new facilities have enhanced the radiation protection features of the older designs. For this reason their start up should be expedited.

f. **Building 11-51, Bay 116 and Bay 124:** Examination was made of two different commercially procured instruments, an electron microscope and a spectrograph, both used for examination and quality control of high explosives. Both instruments are being operated in accordance with manufacturers instructions. The electron scope has been in use for a number of years whereas the spectrograph has just been installed.

g. A review of logbooks recording events during operation of each of the facilities discussed in paragraph b, c, and d above indicated a reasonable record of all events that took place at each. However, for some facilities the recordings were more comprehensive than others. The supervisors indicated that comprehensiveness was related to individual motivation and that by weekly/monthly review of the logbooks with operators a continuing movement was noted toward more complete and comprehensive reporting as required by DOE Order 5480.19, "Conduct of Operations."

h. The non-destructive examination (NDE) group currently has 42 technicians. For the current calendar year, the highest exposed individual had less than 150 millirem of exposure. The exposure for the group is not attributable to operating the RGDs but rather to handling or being in close proximity of radioactive material. The lifetime exposures for longtime workers in the department were only a small fraction of their age expressed in rem. There was no apparent chronic or acute exposure problem observed.

i. Detailed discussions were held with NDE supervision about conduct of operations in the use of various devices, qualifications of personnel, the basic and advanced training needed to qualify as a radiographic technician, operator or supervisor. The general overall radiographic training at Pantex consists of three basic parts: radiation safety, process quality, and nuclear explosive safety. The training outline presented indicated the specific Mason and Hanger (MH), American Nuclear Standards Institute (ANSI), National Committee on Radiation Protection (NCRP) standards, DOE Orders and 10 CFR regulations which the training is supposed to satisfy. In these discussions with the NDE operating supervisors considerable more detail was given of training required of NDE personnel. All NDE technicians working with RGD's must take the General Education Training (GET1) and Rad Worker I courses. Operators must complete both GET1 & GET2, and be qualified as Rad Worker II. In addition, depending upon the particular areas in which the operator works (low energy X-ray, linear accelerators, cobalt sources, etc), additional NDE special training is required.

5. **Future Staff Actions.** The DNFSB staff will continue to monitor the implementation plans for the Radiation Control Manual, as well as those dealing with 10CFR825, when they are issued. It is anticipated that Pantex will have little difficulty in meeting the new guidance for RGDs with their low exposure record, well-shielded designs, and the content of their training programs. The staff should follow the start-up of the new accelerator in building 12-104A. It is also appropriate to look at RGD use at other sites in the complex.