APPLICATION FOR A SPECIAL LICENSE FOR THE POSSESSION OF SPECIAL NUCLEAR MATERIAL

Eastman Kodak Company
Research Laboratories
Rochester, New York

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APPLICATION FOR SPECIAL NUCLEAR MATERIALS LICENSE

NUCLEAR REGULATORY COMMISSION

1.0 Introduction

In 1974, Eastman Kodak Company purchased from Intelcom Rad Tech of San Diego, California, a Californium Neutron Flux Multiplier (CFX) which utilizes 1583 grams of Uranium-235. The use and possession of this Special Nuclear Material is the subject of this license application.

Eastman Kodak Company is incorporated in the state of New Jersey. The Company is engaged in the manufacture and processing of photographic products and the manufacture of chemicals. Kodak is a world-wide organization with principal offices located at 343 State Street in Rochester, New York 14650.

There is no control exercised over Eastman Kodak Company by any alien, foreign corporation or foreign government. The names, addresses and citizenship of the principal officers of Eastman Kodak Company are listed below.

NAME	CITIZEN OF	POSITION	ADDRESS
Colby H. Chandler	U.S.	Chairman of the Board of Directors and Chief Executive Officer	51 Taylor Road Honeoye Falls, NY 14472
Kay R. Whitmore	U.S.	President	35 South Ridge Trail Fairport, NY 14450
Leo J. Thomas	U.S.	Senior Vice President and Director of Research	7 Gladbrook Drive Pittsford, NY 14534

The Research Laboratories of Eastman Kodak Company in Rochester, New York, are engaged in research and development work related to information recording processes. The Laboratories employ about 2000 people who are housed in four buildings located on the edge of the main plant site (designated as Kodak Park). This plant site which contains over 600 acres of land is located in the City of Rochester and one of its suburbs and is bounded by residential and shopping areas.

The research and development activity involves most areas of chemistry, physics, and biochemistry. In the Research Laboratories a specially designed and equipped area is used for neutron activation analysis and radiotracer work. It is in this area where the CFX is installed for neutron activation analyses and for the testing of recording materials for neutron radiography.

2.0 Eastman Kodak Company Radiation Protection Program

2.1 The Radiation Protection Committee encompasses those members of the Health and Environment Laboratory (HAEL) who administer the radiation safety program. The HAEL provides technical support to Kodak Plants on health related matters, including industrial hygiene and health physics. The Director of this laboratory reports to the corporate vice-president in charge of corporate relations. R

The Radiation Protection Committee is concerned primarily with radiation policy decisions and unusual radiation problems. The committee consults technical specialists--both internal and external to Kodak--when necessary. The committee chairman is a part of Kodak management through which there is informational feedback between plant radiation safety activities and high level management. The committee secretary is the Company Radiation Safety Officer (RSO). The RSO screens plant radiation activities and speaks for the committee on routine matters. Matters which may have significant impact on the radiation protection program are brought to the attention of the committee.

The chairman shall have a Bachelor's degree (or the equivalent), hold a Kodak position of Assistant Director, Assistant Superintendent or greater, and have one year of management experience. The RSO shall have a Bachelor's degree in science or engineering (or the equivalent), a formal course in radiation safety, and one year of work experience involving ionizing radiation. The qualifications of the RSO must be acceptable to the Industrial Commissioner of the State of New York. There shall be at least one other committee member who shall have a Bachelor's degree in science or engineering (or the equivalent), and one year of work experience involving ionizing radiation.

2.2 A Radiation Safety Supervisor (RSS) is appointed for each area in which there are sources of ionizing radiation. The RSS is a member of the Department or Division which owns and uses the sources and therefore is in close contact with the sources and their use. It is the general duty of the RSS to work with departmental supervisors to assure that radiation sources are used in a safe, legal manner. The RSS shall be appointed by his/her division head with the approval of the RSO and a standard appointment form must be completed and filed with the RSO

3.0 Key Research Laboratory Personnel

The CFX is part of the neutron activation facility of the Research Laboratories, and this facility is the administrative responsibility of the Analytical Sciences Division. The organizational responsibilities for the CFX and the neutron activation facility will reside with the following:

3.1 The Director of the Analytical Sciences Division has the administrative responsibility for the CFX.

3.2 The Head of the Surface Characterization Laboratory is responsible for the supervision of the neutron activation analysis area and work. This responsibility includes the CFX and its applications.

3.3 The Group Leader's responsibility includes the neutron activation analysis work and the safe operation of the CFX. The position requires a BS level degree in the physical sciences. The group leader or another professional assigned to the group will have a minimum of two years experience working with ionizing radiation. If the professional personnel are absent, the responsibility for safe operation of the CFX will be with the Radiation Safety Supervisor.

3.4 The Radiation Safety Supervisor (RSS) is responsible for routine radiation monitoring, testing, record retention, maintaining calibration schedules and serving as the liaison with the Radiation Protection Committee. The RSS has authority to halt any operations judged unsafe and will prescribe the action to be taken when monitoring indicates that a person is contaminated. In the absence of the RSS, the Group Leader, with support from the Radiation Safety Officer, will serve as RSS.

The RSS shall have a Bachelor's degree in science (or the equivalent), two years' experience working with radioactive materials and/or x-ray equipment and a formal course in radiation safety.

3.5 Other authorized personnel working with the neutron sources will be under the immediate supervision of the Group Leader and will be at least high school graduates, but usually have higher educational background. Before any actual work is performed in the area, the new personnel will be instructed in the general nature of radiation hazards and general radiation protection principles by the Radiation Safety Supervisor. Specific instruction on potential hazards and safe practices associated with the CFX will be jointly provided by the Group Leader and Radiation Safety Supervisor. Training on potential hazards and safe practices will be repeated at least once each year. The effectiveness of the training will be monitored by the Group Leader, RSS and Lab Head. Deficiencies in job performance will be corrected with whatever actions are necessary, including removal from the neutron activation group.

3.6 Maintenance workers and visitors require special approval before entering the neutron cavity and will be protected as necessary to limit exposure to that permitted for nonradiation workers.

4.0 Facility: Description of Radiation Facility in Which the CFX Is Located

4.1 The CFX Location and Building Description

The CFX is located in the Research Laboratories building designated as Building 82 on the northeast corner of the Kodak Park plant site. Figure 1 is a map of part of Kodak Park showing the location of Building 82. This is a modern eight-story building with a full basement. The building has approximately 614,000 sq. ft. of floor space and houses about 900 people. The laboratories in this building are designed largely for chemical and photographic research. The laboratories in the northwest corner of the basement are specially designed and equipped for radiotracer work and neutron activation analyses. Three laboratories are for radiotracer work and three laboratories for neutron activation. The latter activity also utilizes an underground radiation cavity at sub-basement level which houses the 14 MeV neutron generator and the californium-252 neutron multiplier. In the neutron activation area, one laboratory serves as a control and counting room and access to the radiation cavity is from this room.

The basement area floor plan of the part of the basement area which includes the radiotracer and neutron activation facility is shown in Figure 2. A larger scale drawing of the control room, "preparatory laboratory," and radiation cavity (the latter at sub-basement level) is shown in Figure 3. The location of the CFX multiplier in the cavity is indicated.

4.2 The "preparatory laboratory" C012J and Rooms C012L, C012F, and C012E (see Fig. 2) are equipped with stainless steel fume hoods for handling radioactive materials. These hoods are exhausted through filters at the hoods. These exhaust systems are independent of the exhaust system for the rest of the building.

The radiotracer and neutron activation laboratories are under negative pressure with respect to the rest of the building and the radiation cavity is under negative pressure with respect to the neutron activation and radiotracer laboratories. The cavity is air-conditioned with a separate exhaust system to maintain air circulation in the area. The exhaust passes through a high efficiency filter (0.3 micron, DOP smoke test is 99.99%) and is vented to the outside air on the rooftop of Building 82.

An automatically activated set of sump pumps is provided to discharge seepage groundwater from around the cavity to the basement sewer system. As indicated on Figure 3, the sump pumps are located in the labyrinth leading into the cavity.

4.3 Californium Neutron Flux Multiplier (CFX)

4.3.1 General design features - (cavity) - The radiation cavity is located underground, outside and adjacent to the northwest corner of Building 82. The walls of the cavity are two-feet thick high-density poured concrete. The floor of the cavity is poured concrete two-feet thick; nine and one-third feet of earth are above the ceiling of the cavity. Seven and one-half feet (measured in a horizontal plane) of earth fill lie between the cavity wall and control room wall (outer west basement wall of Building 82). The shortest distance between the cavity ceiling and control room floor is eight and one-half feet through earth fill. The CFX is at the opposite side of the cavity from the control room. The dimensions of the cavity are 15 ft. x 24 ft. x 9 ft. high. As indicated in Figure 3, access to the cavity is through a labyrinth which is entered from the control room by means of a circular stairway (not shown). The entrance to the labyrinth is closed by a folding, accordion-type steel gate with a lock which is part of the Interlock System described later. The circular stairway and the folding gate are shown in Figure 4 which is a photograph taken from the control room. Figure 5 is a photograph taken through the gate into the labyrinth. Figure 6 is a photograph of the inside of the radiation cavity showing the 14 MeV neutron generator and the californium-252 neutron multiplier.

The shielding provided by the earth and concrete barriers of the radiation cavity are adequate to assure that sources in the cavity will produce no detectable radiation above 0.2 mR/hr in the control room or at ground level above the cavity outside of Building 82. This has been confirmed by many tests with the 14 MeV neutron generator in operation and with the CFX at full power. The integral shielding of the CFX unit (see description of the CFX) and the direction of the neutron beam for radiography (Figure 3) are such that the cavity provides adequate radiation protection for people outside the labyrinth and cavity when the CFX is operating at full power and the radiographic port is open. Under these conditions, there is a dose rate of <0.2 mrem/hr in the control room and a higher dose rate in the cavity--20-40 mrem/hr except in the direct radiographic beam where a dose rate of a few rem/hr is possible. As will be described later, there is an interlock system to prevent entry into the cavity when the CFX is on with the radiographic port open or when the 14 MeV neutron generator is on.

The radiation cavity also possesses its own exhaust system with a design flow rate of 100 cubic feet per minute. The air flow is filtered with a high efficiency particulate filter (0.3 μ - DOP smoke test is 99.99% efficient) before entering the 115 foot high emission stack.

4.3.2 Security - As shown in Figure 2, entrance to the radiotracer and neutron activation area is from a basement corridor into a hallway on either side of which are offices (C012A, C012B, and C012M) of the personnel who work in this area.

The doors from C012F and C012L to the basement corridor can be opened only from the inside and are for emergency exit only. Only authorized persons are permitted to go beyond the office area without special permission from the supervisory people who are responsible for this area.

All outside entrances to Building 82 lie within restricted areas which are surrounded by an eight-foot high chain link fence topped with barbed wire. The outside entrances of Building 82 are kept locked except during working hours.

Building 82 can also be entered from an immediately adjacent Research Laboratories building, Building 83. All outside entrances to this building, except the main entrance, are also in the restricted area enclosed by a chain link fence. The main entrance to Building 83 opens directly onto a main city street (Lake Avenue). Access to Building 83 can also be obtained by an enclosed bridge across Lake Avenue at the third floor level which connects Building 83 with Building 81, a third Research Laboratories building. All outside entrances, except the main entrance to Building 81, lie in a restricted area surrounded by a chain link fence. The main entrance of Building 81 can be entered from Lake Avenue. This entrance is unlocked only during normal working hours, and at these times is under surveillance by a trained guard. All entrances to the Research Complex are always under surveillance of a trained guard when they are unlocked. Only employees with proper picture-passes are permitted to enter the area without obtaining special permission. This permission can be given by the Division Directors, Assistant Division Directors, and Laboratory Heads of those divisions of the Research Laboratories whose personnel work in the building. These people can give permission for entry into those areas for which they have direct responsibility.

In addition to the above described restrictions on entry into Building 82, Research Laboratories Buildings 81 and 83 are patrolled by trained guards during nonworking hours (5:00 p.m. to 8:00 a.m. on working days and 24 hours a day on Saturdays, Sundays, and holidays). The guards tour the building every four hours and check specified locations along their assigned routes. One such checkpoint is the control room in the neutron activation area. As a part of the check at this location, the guard descends to the entrance of the labyrinth leading to the radiation cavity and determines that the gate across the entrance is locked.

An intrusion alarm has been installed in the labyrinth which is activated after working hours. This is described in section 5.2.6. In addition to the security provided by restricted and controlled entry to Building 82 and the radiation cavity, additional security for the Special Nuclear Material contained in the CFX is provided by the fact that its removal would require the significant disassembly of the CFX. Unauthorized removal of the Special Nuclear Material is not a credible event.

4.3.3 General design feature (CFX assembly) - Performance and design characteristics of CFX are appended in Table I, Demonstration Section A3.0

4.3.3.1 Flux trap - The flux trap is a small cube of high-density polyethylene selected for its excellent moderating power. The trap is surrounded on all sides by a fueled region of polyethylene and thin aluminum-clad uranium-aluminum alloy plates. The reflector is a region of polyethylene surrounded by the reflector/shield. Clad metallic fuel is used, since it provides for retention of fission products, particularly gaseous ones; hence, the system requires no special air monitoring or filtering.

4.3.3.2 Fuel assembly - The fuel consists of MTR-type fuel plates. Each plate has a 0.020-inch-thick core of uranium-aluminum alloy (93% enriched in ^{235}U) sandwiched between two 0.010-inch plates of aluminum. This type of fuel has been extensively used throughout the world at many low-power reactor facilities. The inherent safety of the plates has been proven over the past 20 years at burnups of up to 45 percent. At the maximum power of 3.8 watts, the burnup over the anticipated lifetime of the CFX, even if operated continuously, is negligible.

Approximately 96 percent of the fuel is loaded in four rectangular boxes which are arranged as shown in Figure 7. The remaining fuel is loaded in a small region above and below the central flux trap. Fuel plates are separated by sheets of polyethylene such that the hydrogen-to-uranium ratio is 500:1, i.e., the optimum for the minimum critical mass (Figure 8). Consequently, any credible rearrangement of the fuel and polyethylene moderator will result in a less-than-optimum ratio and a less reactive system. Each of the four major fuel containers has a pressure plate at one end to insure that no voids exist between the fuel and the moderator plates.

4.3.3.3 Reflector - The reflector consists of 4-inch thick polyethylene slabs that completely surround the fuel region. There are several penetrations through the reflector other than the safety rods that are described below. The neutron radiography port is a horizontal rectangular cone that penetrates into the center of the flux trap. The hole through the fuel region is one-inch square.

There are two penetrations for activation analysis irradiations: one into the central flux trap and another that penetrates approximately halfway into the center of one of the fuel boxes. A third penetration, into the central flux trap region, contains a guide tube for the ^{252}Cf source. During the normal operation of the CFX, the source will be located in the flux trap. When the system is shut down, the ^{252}Cf source is automatically moved into a storage pig at a location outside the reflector.

4.3.3.4 Safety rods - The system has four vertically mounted blade-type safety rods that are made of

0.020-inch thick aluminum-clad cadmium. A pair of rods, held magneti:ally as shown in Figure 9, is driven by one of two independent safety rod drives. If a scram condition is met, or a power failure occurs, the electromagnet is turned off and the rods fall by gravity action into the fuel region. The detectors for flux monitoring are located on two sides of the assembly just outside the reflector.

4.3.3.5 Outer shield - The assembly is completely surrounded by a 4-inch polyethylene reflector which provides initial shielding. The remaining shielding designed for the system consists of a lead slab (5 1/4 inches thick) in front of the assembly and an outer shield of water extended polyester and concrete blocks. A shutter door constructed of lead, polyethylene and cadmium, is provided for the radiography port.

5.0 Radiation Safety

5.1 Interlocks, Monitors, Alarms

5.1.1 Interlocks - The shielding of the CFX reduces the exposure rate at the surface (refer to A3.0 Table II) when the CFX is operating at full power. Thus, personnel can be in the radiation cavity when the CFX is on if the radiography port is closed. The following interlocks limit access to the CFX cavity when the radiographic port is open. |R

5.1.2 Plug box system - This system consists of a plug box mounted near the limited access gate (at the entrance to the labyrinth), a microswitch and associated electronic circuitry on the CFX shutter and limited access gate, and a lock on the CFX radiographic shutter. As shown in Figure 1C, either the radiographic shutter must be closed or the gate must be closed and all plugs (six) returned to the plug-box for the interlock circuitry of the CFX to be activated; thus, the CFX may be operated only when at least one of these two conditions is met. Administrative control will require each person entering the cavity to carry with him/her one plug from the plug-box. The lock on the radiographic shutter is opened by a key which is on a closed ring with the key which turns on the CFX. The CFX must, therefore, be shut down before the key which opens the shutter can be removed from the control room area. Administrative rules will require the shutter to be locked closed immediately after each use of the CFX radiographic facility.

5.1.3 Gate interlocks - This system consists of a Kirk interlock installed on the limited access gate (at the entrance to the labyrinth). This interlock operates such that if the gate is opened when the radiography port is open, the CFX will shut down. The CFX cannot be started up (with the port open) unless the gate is closed. Access to the CFX cavity is permitted when the CFX is in operation only when the radiographic shutter is closed.

5.1.4 CFX radiation monitors - Two ion chamber detectors are located in the CFX to monitor radiation levels from the device. The readouts from these detectors are located in the CFX control panel in the control room and are always functioning whenever power is applied to the control panel to operate the CFX. The conditions monitored by these detectors are the CFX power level in both linear and log scales, and the period of the flux produced by the device. Each of these conditions has an associated electronic trip level, which is recalibrated every six months, that automatically shuts down the device if one of the preset levels is exceeded.

Note: All interlocks will be physically tested by the RSS at intervals of 6 months or less.

5.2 Monitors-Alarms - The radiation level or security in the cavity will be monitored by the following systems. |R

5.2.1 Gamma monitoring - A gamma-monitoring system probe is located on the north wall of the cavity at the point where the center of the radiographic beam would strike the wall. A visible readout from the unit is located in the control room and in the cavity. In addition, there are audible and visible alarms in the cavity and the control room set to trigger when the radiation level at the probe exceeds 10 mR per hour. As discussed later in the description of the Kirk Interlock System, this will also "freeze" the Kirk Gate Key in its lock on the Control Panel and prevent entry into the cavity.

5.2.2 Neutron counter - A BF_3 neutron counter is located along the wall of the cavity near the entrance from the labyrinth to the cavity; the readout is located in the control room. The counter tube can be located wherever desired in the cavity.

5.2.3 Wipe tests - Monthly radioactive surface contamination checks are performed in the radiotracer and neutron activation facility. Designated areas are wiped with paper discs to sample removable radioactive contamination, then counted for β-activity in liquid scintillation spectrophotometers. If the removable radioactive contamination level in an area exceeds 1×10^3 pCi/100 cm^2 for tritium or 1×10^2 pCi/100 cm^2 for other β-emitters, that area will be decontaminated and retested. However, if the contamination observed is near the CFX, the cause will be ascertained to verify the containment of the Special Nuclear Material in the fuel plates.

The interior of the device is checked semi-annually by wiping the core area accessible through the radiographic port with a paper disc, and checking the disc for α-activity by scintillation or gas proportional counting. Five nCi of removable α-activity is considered an indication of leakage from the fuel plates (see Section 7.5).

5.2.4 Portable meters - Personnel entering the CFX cavity are required to carry a portable β/γ meter. A portable neutron survey meter is available. In addition, a neutron dosimeter sphere is used to monitor the neutron level in the control room. No detectable signal above background has been observed in the control room with this unit.

5.2.5 Pocket dosimeters - Pocket dosimeters for gamma radiation are required to be worn by all personnel entering the cavity. | R

5.2.6 Intrusion alarm - An ultrasonic intrusion alarm (motion monitor) is located within the CFX cavity. The alarm annunciators are located within the CFX cavity and at the security offices console in Building 83. Annunciators consist of a light and/or audible horn. | R

5.2.7 Film badges and dosimeters - The monitoring of radiation exposure to personnel regularly working in the

neutron activation and radiotracer areas including the radiation cavity is carried out by the Radiation Safety Supervisor. His/her findings are reported monthly to the Secretary of the Eastman Kodak Radiation Protection Committee with copies of the report to the Laboratory Head, the Division Director, and the respective area physician in the Kodak Park Medical Department. Any whole body exposure beyond 100 mR per month will require immediate investigation by the Laboratory Head responsible for the area and by the Radiation Safety Supervisor to determine the possible source and to prevent further exposures beyond this level. The following procedures are used to monitor personnel radiation exposure.

1. Each neutron activation worker is required to wear at all times a film badge for x, β, γ, n_f and n_t which is changed and processed monthly. A statistical summary of film badge monitoring for 1982 and 1983, as reported to the NRC, is in the demonstration section A3.0.

2. Each neutron activation worker is required to wear at all times a γ-dosimeter. These are read and the readings recorded each week and reported monthly.

3. Each person working in the area is required to make a daily check with a radiation monitor for hand, foot, and clothing contamination. If monitoring indicates contamination, the individual cannot leave the lab area unless cleared by the Radiation Safety Supervisor.

The monitoring of radiation exposure of personnel who occasionally enter the radiation cavity for work such as maintenance or to assist in setting up radiographic experiments will be carried out by an authorized person. Such persons will be required to wear, while in the area, a γ-dosimeter dosimeter. The dosimeter will be read and the reading recorded before the person enters the cavity and when he/she leaves the area.

5.2.8 <u>Criticality Monitoring</u> - Exemption from criticality monitoring (10 CFR Part 70.24) is hereby requested, based on the supporting documentation in the Appendix. This information indicates that there are no reasonable, accidental events which could result in criticality.

5.2.9 <u>Calibration</u> - Beta/gamma meters are calibrated every 6 months by a person or agency determined by the RSO. Portable neutron meters are calibrated at 6-month intervals by the RSS for the CFX facility or a designee thereof. The neutron and gamma area monitors are calibrated annually by the RSS or a designee for the CFX facility.

5.3 <u>Administrative Controls</u> -

1. The CFX control keys must be locked in a Limited Access Drawer in the control room when the CFX is not in operation. The

keys to this drawer are under the supervision of the Group Leader or the Acting Group Leader, the Laboratory Head and the Division Director.

2. All readings of the radiation monitors at the control panel must be checked and found to be normal prior to operation of the facility or prior to entry into the cavity. Abnormal readings will require consultation with the Group Leader or RSS before any action is taken except under the conditions described in the Section for Emergency Procedures.

3. Only authorized persons and those accompanied by an authorized person are allowed to enter the cavity.

4. Each person entering the cavity must remove a plug from the plug-box and must retain it when in the cavity. This limits the number of people that can be in the cavity to six at any one time.

5. It is the responsibility of the authorized person entering the cavity to carry a portable β-γ radiation monitor into the cavity.

6. Before leaving the cavity, the authorized person must check to see that all persons have left the cavity. In the event that a person is inadvertently locked in the cavity, a spare key to the limited access gate at the entrance to the labyrinth is secured in a glass, sealed container mounted on the cavity side of the gate on the labyrinth wall. A safe exit can be made by breaking the glass, removing the key, and unlocking the gate. Also, the intrusion alarm, described in Section 5.2.6, will indicate any movement within the labyrinth during and after working hours.

7. When the gate has been closed, the authorized person who has entered the cavity must return the gate key to its position in the control panel and lock the key in place.

8. It is an administrative requirement that the CFX radiographic shutter must be locked shut at all times when operations being carried out do not require the port to be open.

6.0 Operating Procedures

6.1 Review and Approval of Procedures for Experiments - The CFX has been approved by the Eastman Kodak Radiation Protection Committee for neutron activation and neutron radiographic use by established procedures. Radiation surveys of the area are made under the direction of the Radiation Safety Supervisor to determine that radiation doses are below regulatory limits for all anticipated modes of operation. Any departure from established procedure which is likely to increase radiation levels in areas occupied by personnel must be reviewed and approved by the Radiation Protection Committee before such changes are made.

The operation of the CFX facility will be the responsibility of the Group Leader in charge of neutron activation analysis and in his absence the Acting Group Leader. The operations associated with neutron activation analysis will be carried out entirely by these two people and the personnel assigned to the neutron activation area. Neutron radiography work may involve people from other divisions of the Research Laboratories in setting up the experiments. Such people will be permitted to enter the radiation cavity only on approval of the Group Leader in charge and when accompanied by him or by one of the technicians assigned to the neutron activation area who will be responsible for operation of the CFX.

6.2 Control of Access to the Radiation Cavity - Only people whose names are on the authorized list for entry into the radiation cavity will be permitted to enter without special permission. The list of authorized names has been prepared and listed under Section A1.1.

Persons who are not on the authorized list to enter the radiation cavity must obtain permission to do so from the Group Leader in charge and must be accompanied to the cavity by a person on the authorized list. If the Group Leader in charge is not available to give permission for entry, then permission can be obtained from the Radiation Safety Supervisor, the Lab Head in charge of the area or from the Director of the Analytical Sciences Division. In any of these cases, before granting permission, the person responsible will first determine the status of operations in the cavity.

The gate to the radiation cavity is normally locked. Access to the cavity may be obtained by personnel on the approved list by taking the following steps.

1. Obtain from the Group Leader in charge or acting group leader the key to the locked drawer (Limited Access Drawer) in the control room in which the Master Key for the Kirk interlock system is kept when not in use. This key must always be returned to the drawer when not in use and the drawer locked during nonworking hours. By use of the Master Key, the Gate Key can be removed from the control panel of the 14 MeV Generator.

2. Check the monitor systems in the control room to ascertain that radiation levels in the cavity are not above those normally observed with the 14 MeV neutron generator off and the CFX on at full power with the neutron radiography port of the CFX closed. The monitors to be checked are the area gamma-ray monitor and the readings from the ionization chambers of the CFX. If all readings are normal and no visible or audible alarms are on, remove the Gate Key from the control panel of the 14 MeV Generator and proceed with the next step.

3. A plug must be removed from the plug-box by each person about to enter the cavity. If the authorized person is accompanied by other persons, the authorized person must see that this procedure is followed.

4. Using the Gate Key for the Kirk interlock system, the gate at the entrance to the labyrinth leading to the cavity is unlocked and the light key removed.

5. Pick up a portable survey meter to monitor radiation in the cavity. This survey meter is kept on a table at the entrance to the cavity when not in use. Check batteries and response to standard source.

6. Disarm the motion monitor.

7. Proceed through the labyrinth to the entrance of the cavity where a single-unit Kirk interlock is located. Insert the Light Key and turn. This turns on the overhead lights in the cavity.

8. When work is completed in the cavity, the authorized person must check to see that all other persons have left the cavity. He picks up the portable survey meter and removes the Light Key from the Kirk lock at the cavity entrance. This turns off the overhead lights. On leaving the labyrinth area, the motion monitor must be rearmed.

9. Proceed to the labyrinth entry gate, leave the portable survey meter on the table, and close the gate.

10. Insert the Light Key into the double-unit Kirk lock and, using the Gate Key, lock the gate. See that all plugs are returned to the plug-box.

11. Return the Gate Key to the triple Kirk unit on the control panel of the 14 MeV Generator and lock it into position.

6.3 Operating Procedure for CFX -

1. Operating with radiographic port closed.

a. Obtain the key for the Limited Access Drawer in the control room from the Group Leader in charge.

b. Unlock drawer and obtain CFX power key and radiographic port key.

c. Place CFX power key in CFX control panel and proceed according to the operating instructions for CFX startup, as follows:

Note the date and time of startup, along with the operator's initials.

Check that the following trip, interlock and scram mechanisms are functioning properly: manual scram, linear scram, high log scram, period scram; the ten-second period check; the control rod interlock; and if the radiography port is to be used, the shutter interlock. In addition, an operational check of one of the above scram mechanisms is to be checked on a rotating basis with the ^{252}Cf source partially in (5%) and the control rods partially withdrawn (5%). The results of all of the above tests are to be recorded in the CFX operations log before actual use of the device.

d. When operation is completed, shut down the CFX and note the date and time of shutdown along with the accumulated run time.

e. Return key to limited access drawer.

2. Operating with radiographic port open.

a. Obtain the key for the Limited Access Drawer in the control room from the Group Leader in charge.

b. Obtain the Master Key and CFX power key and radiographic port key from the drawer; ascertain that the CFX is shut down and, using the Procedure for Access to the Radiation Cavity, enter the radiation cavity.

c. Unlock the CFX radiographic port and open the shutter. This is a manual operation. Retain the CFX keys.

d. Leave the cavity and close and secure the cavity according to the Procedure for Access to the Radiation Cavity.

e. Turn on the CFX as described in 1c.

f. When the operation of the CFX has been completed, shut the CFX down as in 1d.

g. Remove the CFX Keys from the CFX control panel.

h. Proceed to the radiation cavity using the Procedure for Access to the Radiation Cavity.

i. Close and lock the shutter on the radiographic port of the CFX. Retain the CFX keys.

j. Return to the control room using the reverse Procedure for Access to the Radiation Cavity.

k. Return the Gate Key to the 14 MeV Generator control panel and lock it into the Kirk lock.

l. Return CFX keys to Limited Access Drawer.

6.4 Operating Limitations -

1. At least once every seven operating days it is necessary to check that all the controls and interlocks are working properly. | R

2. Samples will not be introduced into the neutron activation positions of the CFX without approval of the authorized operators. It will be the responsibility of the Group Leader to assure that no materials of unknown nature, no Special Nuclear Materials, and no materials which may be detonated are permitted to enter the sample activation positions of the CFX.

3. No samples weighing more than 25 grams will be permitted to be placed in the neutron activation positions of the CFX.

4. Only individuals authorized to do so by the Laboratory Head or Group Leader responsible for the neutron activation analysis area will be permitted to operate the CFX. Authorized people will include the Laboratory Head responsible for the neutron activation analysis area, the Group Leader in charge of neutron activation analysis, and personnel responsible to the Group Leader in charge and approved by him to operate the CFX. | R

7.0 Emergency Procedures

7.1 General - In case of an emergency involving the CFX during normal working hours, the declaration of an emergency and initiation of emergency procedures will be the responsibility of the Group Leader in charge or in his absence the Radiation Safety Supervisor. In the case of absence of both of these people from the immediate area, the senior technical person of the neutron activation analysis group who is present will take charge until the arrival of the Group Leader or Radiation Safety Supervisor. The person in charge will see that the CFX and the 14 MeV generator are turned off if they are operating. He will see that all personnel not needed in the area evacuate the radiation cavity and control room. He will notify the RSS, the Laboratory Head responsible for the area, the company Radiation Safety Officer, and the Director of the ASD. The Laboratory Head or in his absence the Division Director will notify if deemed necessary, Plant Security.

In case of an emergency outside normal working hours, the Plant Security Guards, who have discovered the existence of possible emergency conditions while patrolling the area, will notify the Group Leader in charge of the area, or, if he is not available, the Laboratory Head responsible for the area. If the Group Leader determines that emergency conditions probably exist, he will notify the Laboratory Head and the RSS for the area. These people will proceed immediately to the area. No one will be permitted to enter the cavity until the Group Leader or the Laboratory Head arrives.

7.2 Fire - In case of a fire, the Kodak Park Fire Department will be notified. The firemen will be permitted to enter the cavity only by the Group Leader or other responsible person in charge after that person has determined that there is no radiation hazard. The firemen will be expected to consult with the Group Leader or other responsible person in charge before taking steps to combat the fire. The cavity is also protected by an automatic sprinkler system and with fire extinguishers located in the cavity and the control room. Since the cavity is underground and external to the building, the CFX is not likely to be affected by fire in the building. The Kodak Park Fire Department has been instructed in the special hazards associated with the CFX.

7.3 Flood - In case of a flood in the cavity, the Group Leader or other responsible person in charge will see that the CFX is turned off. He will call Building Maintenance people and take steps to see that the sump pumps located in the labyrinth leading into the cavity (Figure 3) are operating and if not to get them into operation. If this fails and water is rising to a flood level, the Kodak Park Fire Department will be called to pump out the cavity. It should be noted that a flood would not be a hazard for the CFX. For more information on flooding and its affect on criticality, see appended letter from C. A. Preskitt, Vice President of Intelcom Rad. Tech. (A5.0).

7.4 Airborne Radioactivity - Hazardous exposures to airborne radioactive materials are virtually impossible since the double aluminum housing should contain by-product materials and uranium for the life of the CFX. There is the very remote possibility that the aluminum housing of the fuel plates could deteriorate to the point at which gaseous by-products could escape. There is also the possibility that spills of radiolabeled compounds in the radiotracer area could enter the cavity, since the cavity is at negative pressure relative to the surrounding laboratories. The activities of agreement materials typically handled in these areas range from fractions of a microcurie to several millicuries.

Tritium could be released from a 6 curie titanium Tritide source sealed in the 14 MeV neutron generator, in the unlikely event that the double wall stainless housing was breached. R

An accident involving the release of radioactivity from the fuel plates will be indicated by abnormally high readings on the portable survey meters and/or the area gamma-ray monitor. In this case, the Group Leader, RSS, or other responsible person in charge will evacuate the cavity and shut down the CFX. He will measure the ambient radiation level in the control room and if it is greater than 0.2 mR/hr, he will determine the source of radiation and if necessary all nonessential personnel will be evacuated from the control room and the doors leading to the control room from hallway C012H and preparatory laboratory C012J (Figures 2 and 3) will be closed. The Radiation Safety Supervisor, the Laboratory Head responsible for the area, RSO and the Director of the Analytical Sciences Division will be notified. The radiation level in the control room will be rechecked by the RSS. If it is found to be over 5 mR/hr, the two doors leading to the control room will be sealed. The radiation level outside these doors will be surveyed by the RSS and a decision made by him on the need for further evacuation of the area. The RSS and Laboratory Head responsible for the area will define a control zone in which personnel will not be permitted to enter without permission of the Laboratory Head. Following consultations with the ASD Director, members of the Eastman Kodak Radiation Protection Committee, representatives of Intelcom Rad Tech, and if necessary local, state, and federal regulatory agencies, a decision will be made on the subsequent course of action.

7.5 Contamination -

7.5.1 The following results will be the basis for at least a temporary shutdown of the CFX and an investigation involving the Radiation Safety Officer.

1. 5 nCi or more of removable alpha activity in the radiography port.

2. 100 pCi/100 cm^2 or more of beta activity, other than tritium, on or near the CFX.

7.5.2 If monitoring indicates that body surfaces are contaminated, the approval of the Radiation Safety Supervisor is necessary before the contaminated individual can leave the laboratory area. Decontamination by methods other than washing with soap and water require consultation with the medical department.

8.0 Maintenance and Disposal

8.1 Maintenance - Any work which requires manipulation of the aluminum fuel container of the CFX will be performed by IRT or a similar agency which is qualified to work with fuel plates.

8.2 Disposal - There is no special nuclear material waste from the area; however the CFX and 14 Mev neutron generator activate samples contained in sealed polyethylene capsules. These capsules and the other radioactive waste from the neutron activation and radiotracer area is packaged following the requirements of the DOT and New York State. The packaged waste is shipped to a government regulated landfill.

When the fuel plates become obsolete, they will be transferred to a licensed disposal agency. The facility will be decontaminated in accordance with Annex A, Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material, Nuclear Regulatory Commission, November 1976 (or current version).

APPENDIX

(Demonstration Section)

A1.0 Personal Resumes

A1.1 Research Personnel

Dr. L. J. Garfield

BS Chemistry - University of Minnesota, 1954
PhD Physical Chemistry, University of Minnesota, 1958

Dr. Garfield joined the staff of the Eastman Kodak Research Laboratories in 1958. On March 1, 1983 he assumed the Directorship of the Analytical Sciences Division (ASD) of the Research Laboratories. This Division represents the major analytical function for the Research Laboratories and, therefore, is involved in a broad spectrum of research and development activities.

Since joining the Research Laboratories Dr. Garfield initially was a member of the Chemistry Division, where he carried on research programs in the physics and physical chemistry of polymer solutions and solids. More recently, as Laboratory Head and Assistant Division Director of Analytical Sciences Division, he has had administrative experience with active programs dealing with analytical methods and instrumentation. R

Dr. Frank Lovecchio

BS Chemistry, Syracuse University, 1965
PhD Analytical Chemistry, Syracuse University, 1970
Post Doctoral Appt, Bioinorganic Chemistry, Ohio State University, 1970-73

Dr. Lovecchio joined the staff of the Eastman Kodak Research Laboratories in July of 1973, as a member of the Analytical Sciences Division. He carried out research on the photochemistry and photophysics of image dyes, and on metal chelate based photographic imaging systems. He was laboratory head of the Special Projects group of ASD, and is now Laboratory Head of the Surface Characterization Laboratory of ASD.

Dr. Tim Z. Hossain

PhD Chemistry (Radionuclear), University of Kentucky, 1982

Dr. Hossain joined the Eastman Kodak Company in 1982. He has done extensive research using neutron activation methods. As a graduate student he had experience with the nuclear reactors at the University of Missouri and the University of Georgia Tech. He has also done several nuclear engineering experiments at Oak Ridge National Laboratory.

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Dr. Hossain is trained in the use of neutron absorption in the context of chemical analysis. His doctorate research involved the use of an isotopic neutron source such as ^{252}Cf, reactor thermal neutrons as well as 14 MeV neutrons obtained from a deuterium-tritium accelerator.

Dr. Hossain is now group leader for the Neutron Activation Analysis Area.

Mr. Craig C. Swanson

2 years (Mathematics major) Theil College, Greenville, PA

Mr. Swanson has been employed as a laboratory assistant and technician in the neutron activation area of the Analytical Sciences Division since June 17, 1974. His duties have included the preparation of samples for neutron activation analysis and the processing of data from such analyses. This has included samples for activation by the 14 MeV generator and the CFX.

Mr. Walter Mularz, Jr.

AAS, Erie County Community College
BS, University of Rochester

Mr. Mularz joined Eastman Kodak Company and the Research Laboratories in 1970. During his first six years of employment, he worked in the radiotracer area performing radioisotope labelling and radiotracer studies. In 1980, he returned to assume the radiotracer responsibilities. At this time, Walt became the Radiation Safety Supervisor in the neutron activation-radiotracer laboratory. He attended a short course in Basic Health Physics at Louisiana State University in the spring of 1980.

A1.2 Radiation Protection Committee

Thomas S. Ely, M.D., Committee Chairman - Dr. Ely received his MD degree from Georgetown University in 1948. After

internship at the U.S. Naval Hospital, Bethesda, Maryland, Dr. Ely was involved in research projects at the Naval Medical Research Institute, including studies on the biological effects of atomic weapons at Nevada and Eniwetok, and the design and construction of a 2,000-Curie cobalt-60 4π irradiator. From 1952-54, Dr. Ely served as Assistant Medical Officer on the U.S.S. Kearsarge, and in 1954 he returned to the Naval Medical Research Institute to conduct research on the biological effects of microwave radiation. From 1956-61, he worked for the U.S. Atomic Energy Commission in its Headquarters operation. In this location, he progressed from Assistant Chief of the Medical Branch of the Division of Biology and Medicine to Chief of the Health Protection Branch of the Division of Operation Safety.

From 1961-63, Dr. Ely attended the University of Rochester full time receiving an MS degree in Occupational Medicine and a Certificate in Radiation Biology.

Since 1963, Dr. Ely has been employed by the Eastman Kodak Company, and is now Director of the Occupational Health Laboratory in the Health and Environment Laboratories. He has served as the Assistant Clinical Professor of Preventive Medicine at the University of Rochester. He became a member of the Radiation Protection Committee in 1966 and chairman in 1975. R

E. Scott Harter, Committee Secretary - Mr. Harter joined the Industrial Hygiene Section of the Health and Environment Laboratories in 1978 as a staff industrial hygienist and acting Radiation Safety Officer. In 1979 he became the Radiation Safety Officer and assumed the position of Committee Secretary in 1980. Mr. Harter received an MS degree in Industrial Hygiene from the University of Cincinnati in 1979. His graduate and post graduate course work has included four courses in Health Physics. His undergraduate work was completed at the Pennsylvania State University where he received a BS in biology in 1976. Mr. Harter is certified in the comprehensive practice of Industrial Hygiene by the American Board of Industrial Hygiene.

Sharon M. Rucinski - In 1980 Ms. Rucinski joined the Health and Environmental Laboratories as an industrial hygiene technician specialized in Health Physics. Prior to working for Eastman Kodak Company she worked as a radiation therapy technologist for Strong Memorial Hospital, Rochester, New York. Ms. Rucinski received an AS degree in Radiation Therapy from Erie Community College in 1976. In 1980 she attended an ionizing radiation course presented by the National Institute for Occupational Safety and Health (NIOSH). Sharon received a BS degree in Natural Sciences from the University of Rochester in 1982. She was appointed to the position of Assistant Radiation Safety Officer in 1983. R

John H. Heyer - Mr. Heyer joined the Industrial Hygiene Section of the Health and Environment Laboratories in 1982 as a staff industrial hygienist. In 1983 he was appointed to the position of Assistant Radiation Safety Officer. Mr. Heyer R

received an MS degree in Industrial Health from the University of Michigan in 1981. His graduate curriculum included a course in Health Physics. Mr. Heyer attended a one week training course for radiation safety officers in 1983, presented by Applied Health Physics. His undergraduate work was at St. Lawrence University, where he received a BS degree in Biology in 1978.

A2.0 Instrumentation

For wipe tests: Liquid Scintillation Spectrophotometer with an Absolute Activity Analyzer, Alpha Scintillation Counter and Gas Proportional Counter

Personnel Monitor: Geiger-Mueller Beta-Gamma Hand & Foot Monitor

Area Monitors:

A. Portable
   1. Beta-Gamma Geiger Counters
   2. BF_3 Fast-Slow Neutron Counters
   3. Sphere Neutron Dosimeter (LiI Detector)

B. Stationary
   1. Geiger-Mueller Gamma Monitor
   2. BF_3 Neutron Detectors

A3.0

Table I

Performance and Design Characteristics of CFX

^{252}Cf Source	3 mg
^{235}U Loading	1582.62 grams
Uranium Enrichment	93.4%
Fuel Form	Aluminum-Clad Alloy Plates (MTR Type)
Moderator	Polyethylene
Maximum k_{eff}	0.990
k_{eff} Increase for 20-gram ^{235}U sample	0.004
Control Poison	Cadmium, Aluminum Clad
Shutdown k_{eff}	0.773
Dose Rate at Shield Surface	Less than 10 mrem/hr
Fission Power Level	11.4 Watts

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A3.0 (Continued)

Table II

CFX Exposure Dose Rate

Area	mRem/hr			
	Zero Power		Full Power	
	Gamma/ X-ray	Fast Neutrons	Gamma/ X-ray	Fast Neutrons
Top rear CFX	140	900	--	--
Top left side CFX	25	450	90	680
Top center CFX	--	--	135	450
Top right side CFX	25	170	75	170
In front of radiographic port (shutter closed)	35	9	135	450
Left front shield	1	3	5	17
Center front shield	0.8	2	60	275
Right front shielf	3	9	2	7
NE cavity corner	0.6	2	1.0	3
Cavity corridor entrance by light switch	0.7	6	2	6
Cavity corridor by sump pumps	0.1	1	0.1	0.6
Cavity corridor by stairs	<0.1	0.3	<0.1	0.2
Control room	<0.1	0.3	<0.1	0.2
Outside B-82 above CFX	--	--	<0.1	0.2

Refer to Figs. 3, 4, 5 and 6 for respective areas.

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A4.0 Statistical Summary of Film Badge Monitoring Results

The following tables describe annual whole Body Dose Ranges (Rems) for personnel working in the CFX laboratory area for 1982 and 1983. Doses include neutron, beta and gamma exposures and are for the most part a result of radioactive material handling.

SUGGESTED DRAFT FORMAT FOR THE REPORTING OF RECORDED
PERSONNEL WHOLE BODY EXPOSURES FOR CALENDAR YEAR 19 82

Licensee Reporting (Name & Address)	NRC License No(s).
Eastman Kodak Company Attn: E. Scott Harter Bldg. 320, Kodak Park Rochester, New York 14650	SNM-1513

☐ IF PERSONNEL MONITORING WAS NOT REQUIRED DURING THE YEAR, CHECK THIS BOX.

OTHERWISE, COMPLETE THE FOLLOWING TABLE:

Annual Whole Body Dose Ranges * (Rems)	Number of Individuals in Each Range
No Measurable Exposure	2
Measurable Exposure Less Than 0.100	2
0.100 -- 0.250	1
0.250 -- 0.500	
0.500 -- 0.750	
0.750 -- 1.000	
1.000 -- 2.000	
2.000 -- 3.000	
3.000 -- 4.000	
4.000 -- 5.000	
5.000 -- 6.000	
6.000 -- 7.000	
7.000 -- 8.000	
8.000 -- 9.000	
9.000 -- 10.000	
10.000 -- 11.000	
11.000 -- 12.000	
> 12.000	

Total number of individuals reported 5

The above information is submitted for the total number of individuals for whom personnel monitoring was (check one):

☒ required under 10 CFR 20.202(a) or 10 CFR 34.33(a) during the calendar year.

☐ provided during the calendar year.

*Individual values exactly equal to the values separating exposure ranges shall be reported in the higher range.

Report prepared by: E. Scott Harter (Name) (716) 722-6927 (Telephone Number)

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SUGGESTED DRAFT FORMAT FOR THE REPORTING OF RECORDED PERSONNEL WHOLE BODY EXPOSURES FOR CALENDAR YEAR 19 83

Licensee Reporting (Name & Address)	NRC License No(s).
Eastman Kodak Company Attn: E. Scott Harter Bldg. 320, Kodak Park	SNM-1513

Rochester, N. Y. 14650

☐ IF PERSONNEL MONITORING WAS NOT REQUIRED DURING THE YEAR, CHECK THIS BOX.

OTHERWISE, COMPLETE THE FOLLOWING TABLE:

Annual Whole Body Dose Ranges * (Rems)	Number of Individuals in Each Range
No Measurable Exposure	
Measurable Exposure Less Than 0.100	2
0.100 -- 0.250	2
0.250 -- 0.500	
0.500 -- 0.750	
0.750 -- 1.000	
1.000 -- 2.000	
2.000 -- 3.000	
3.000 -- 4.000	
4.000 -- 5.000	
5.000 -- 6.000	
6.000 -- 7.000	
7.000 -- 8.000	
8.000 -- 9.000	
9.000 -- 10.000	
10.000 -- 11.000	
11.000 -- 12.000	
> 12.000	

Total number of individuals reported 4

The above information is submitted for the total number of individuals for whom personnel monitoring was (check one):

[X] required under 10 CFR 20.202(a) or 10 CFR 34.33(a) during the calendar year.

[ ] provided during the calendar year.

*Individual values exactly equal to the values separating exposure ranges shall be reported in the higher range.

Report prepared by: E. Scott Harter (Name) 716:722-6927 (Telephone Number)

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A5.0 Supporting Documents from IRT

IRT
Corporation
Instrumentation / Research / Technology

April 3, 1981

Mr. C. F. Oster
Kodak Research Lab
Building 82
Rochester, New York 14650

Dear Carl:

The attached copies of correspondence cover our communication with the NRC regarding the risk of inadvertent criticality in the CFX.

The question of accidental criticality was a central issue in the design of the CFX as well as the test program that confirmed the adequacy of the design and resulted in issuance of the CFX license. Our initial authorization allowed loading of the CFX to k_{eff}= 0.950 for the purpose of conducting tests to confirm safety. These tests included simulated flooding of the activation and n-ray ports as well as the addition of test samples for activation. The fact that the system was optimally moderated was confirmed, and a small modification to the H/U ratio was made to achieve the exact optimum observed in the tests. Various other reactivity effects were investigated and reported to the NRC. Altogether, the only means to achieve criticality in the CFX is to add additional ^{235}U to the system. Measurements determined the minimum necessary amount to be 33 grams of ^{235}U when added at the activation position.

I hope this information will satisfy your needs. If additional information is required, please feel free to call either me or Kay Crosbie.

Sincerely yours,

C. A. Preskitt

C. A. Preskitt
Chief Scientist
Nuclear Systems Division

CAP:do

Enclosure: NRC Communications

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