RADIATION PROTECTION PROGRAM

KSU NUCLEAR REACTOR FACILITY

MECHANICAL AND NUCLEAR ENGINEERING DEPARTMENT

KANSAS STATE UNIVERSITY

Approved: Reactor Safeguards Committee

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5/7/2002

Date:

Table of Contents

I. INTRODUCTION

This Radiation Protection Program has been prepared by personnel of the Kansas State University TRIGA Mk II Nuclear reactor facility in response to the requirements of Title 10, Part 20, Code of Federal Regulations (10CFR20). The FACILITY is operated under LICENSE R-88 (Docket 50-188) issued by the U.S. Nuclear Regulatory Commission (NRC). The Program is executed in coordination with the Office of Radiation Safety, Department of Public Safety, Kansas State University. It has been reviewed and approved by the Reactor Safeguards Committee for the Reactor Facility. Certain aspects of the Program deal with radioactive materials regulated by the State of Kansas (an Agreement state) under LICENSE C0011-01 and the University Radiation Safety Committee has reviewed the Program, which is responsible for administration of that LICENSE.

This program is a part of the Operations Manual for the Reactor Facility, although it is published separately. A closely related part of the Operations Manual, also published separately, is the Emergency Plan. Appendix A is a glossary of terms used in the Radiation Protection Program. Appendices B and C contain lists of operational and emergency procedures referred to in the Radiation Protection Program.

The Radiation Protection Program is designed to meet requirements of 10CFR20. It has been developed following the guidance of the American National Standard *Radiation Protection at Research Reactor Facilities* [1] and Regulatory Guides issued by the NRC [2-7].

2. MANAGEMENT AND ADMINISTRATION

Radiation Protection Program preparation, audit, and review are the responsibilities of the Nuclear Reactor Facility Manager. The Reactor Safeguards Committee chaired by the Head of the Department of Mechanical and Nuclear Engineering reviews the activities of the Nuclear Reactor Facility Manager and semi-annual audits prepared under the direction of the Nuclear Reactor Facility Manager. The Reactor Safeguards Committee examines records required by the Radiation Protection Program as well as audit reports by the Nuclear Reactor Facility Manager during their semi-annual inspections.

Training, surveillance and recordkeeping are the responsibility of the Nuclear Reactor Facility Manager. ALARA activities, for which recordkeeping is the particular responsibility of the Nuclear Reactor Facility Manager, are incumbent upon all radiation workers associated with the reactor facilities.

Substantive changes to the Radiation Protection program require approval of the Reactor Safeguards Committee. Changes approved by the Reactor Safeguards Committee for operating or emergency procedures apply automatically to the Radiation protection program and corresponding changes may be made without further consideration of the Reactor Safeguards Committee.

Changes approved automatically through approval of other procedures, editorial changes, or changes to appendices may be incorporated into the Radiation Protection Program on the authority of the Nuclear Reactor Facility Manager. These changes SHALL be processed through individual change pages identified with revision level and change date. An index of changes SHALL be maintained with a summary of the reason for the change, a summary of the change, and a copy of the superceded page. The Reactor Safety Review Committee SHALL review all changes implemented since the previous review.

The Reactor Supervisor or the Nuclear Reactor Facility Manager may deviate from elements of the Program on a temporary basis for reasons of facility or personnel safety; the deviation SHALL be brought promptly to the attention of the Safeguards Committee.

2.1 Radiation Units

The traditional units of Curie, rad, rem and roentgen are to be used in recordkeeping. SI units of Becquerel, gray and sievert may be used in calculations, DOSE assessments and reports, so long as final results, conclusions, etc. are given in traditional units as well.

EXTERNAL DOSE is to be recorded in terms of DEEP or SHALLOW DOSE EQUIVALENT (index). According to the ICRP [8], the DEEP DOSE EQUIVALENT (in rem units) is within 4% of the free-field exposure rate (in roentgen units) for gamma rays with energies between 0.6 and 8.0 MeV. Therefore, survey or area monitoring instruments calibrated in roentgen units may be used for assessment of DEEP DOSE EQUIVALENT in routine surveillances.

The total EFFECTIVE DOSE EQUIVALENT (TEDE) is the sum of the DEEP DOSE EQUIVALENT for external exposure and the COMMITTED DOSE EQUIVALENT for internal exposure. Internal exposure associated with the Reactor Facility has never been a source of significant radiation exposure to workers or MEMBERS OF THE PUBLIC. Should significant exposure be considered possible (such as in connection with planned special exposures or in the conduct of ALARA reviews), evaluation should follow the guidance of 10CFR20, Regulatory Guides [3-7] or the ICRP [9-11].

2.2 Radiation Limits

Occupational does limits (except for planned special exposures, as described in Section 4.5), are given by 10CFR20.1201 as follows. Annual limits for adults, in summary, is the more limiting of the following:

RADIATION DOSE LIMITS		
POPULATION	EXPOSURE	LIMIT
Radiation Workers (OCCUPATIONAL EXPOSURE)	EFFECTIVE DOSE EQUIVALENT (TEDE)	5 rem in one year
	the lens of the eye	15 rem in one year
	SHALLOW DOSE EQUIVALENT to the skin or any extremity	50 rem in one year
	combined DEEP DOSE EQUIVALENT and COMMITTED DOSE EQUIVALENT to any organ other than the eye	50 rem in one year
MEMBER OF THE PUBLIC (NON OCCUPATIONAL EXPOSURE)	EFFECTIVE DOSE EQUIVALENT (TEDE) in one year	0.1 rem in one year
	TEDE	0.002 rem in one hour

3. TRAINING

Implementation of training for radiation protection is the responsibility of the Nuclear Reactor Facility Manager. Training guidance, a syllabus, and a sample examination are provided in Appendix D. All persons granted unescorted access to the Reactor Facility must receive the training and must complete without assistance a written examination over radiation safety and emergency preparedness. An examination score of at least 70 percent is required.

Re-training for active researchers must be administered biennially except for Reactor Operators and Senior Reactor Operators taking part in the annual Reactor Facility Requalification Program.

4. SURVEILLANCE AND MONITORING

The KSU Reactor Technical Specifications and the KSU Reactor Facility Emergency Plan independently impose other surveillance requirements related to radiation protection. Periodic surveillance requirements related to radiation protection and imposed only via the KSU Nuclear Reactor Radiation Protection Program by the Reactor Safeguards Committee are tabulated in table *"Radiation Protection Program – Periodic Surveillance Activities."*

NOTE: Surveillances related to radiation protection and required in other formally approved documents are not specified herein, except by reference.

RADIATION PROTECTION PROGRAM - PERIODIC SURVIELLANCE ACTIVITIES	
FREQUENCY	SURVIELLANCE
Monthly	Wipe test reactor bay and control room
	Inspect respirators
	Occupational Dose Record Review (when delivered)
Quarterly	Source inventory report
	Source inventory and leak test
	SPECIAL NUCLEAR MATERIALS reports
	Emergency equipment inventory
	Review extremity monitoring report, when provided
Semi-annually	Environmental surveillance (radiation levels at full power
	Radiation Protection Program Implementation
Annually	Calibration of the pool surface monitor
	Calibration of the AMS II air monitor
	Calibration of PD-10i Electronic Dosimeters
	Evacuation Alarm Response Test
Biennially	Radiation Protection Program Review

4.1 Radioactive Materials Accountability

Radioactive materials accountability is assured by a quarterly inventory report, quarterly source inventory and leak test, and semi annual inventories of special nuclear materials.

The quarterly inventory report is initiated by Radiation Safety Officer request, and returned to the RSO to ensure the byproduct material on the Kansas State University campus meets LICENSE restrictions. The quarterly source inventory and leak test is a physical check of storage location and a leak test of all sources on inventory. Semi-annual inventories of SPECIAL NUCLEAR MATERIALS include a report on the status of material leased from DOE, nuclear material transaction report indicating fuel burnup and other transfers of SNM, and inventory of SNM at the Facility. Facility MANAGEMENT and Facility Staff prepare the reports and submit to the University Radiation Safety Officer and the Department of Energy.

4.2 EFFLUENT MONITORING

Liquid EFFLUENT Surveillance

Radioactive liquid waste is collected in the reactor bay sump (typically condensate from the air handling unit, sometimes contaminated with low levels of tritium). The sump is batch-discharged to sewerage when water

quality meets permitted discharge requirements.

MONITORING of liquid EFFLUENTS to sewerage assures compliance with 10CFR20.2003. Facility Procedures 19, 20, and 21 guide assays for radionuclides emitting gamma rays, beta particles, and alpha particles.

Gaseous EFFLUENTS

Per 10CFR20.1101, air EFFLUENTS are constrained to 0.01 rem per year. Although normal, steady state operations are not capable of discharging effluent concentrations high enough to challenge this limit; an air monitor system was installed to sample air representative of reactor bay effluent stream. This monitor provides relative indication that conditions of air effluent are normal, and has an annual CALIBRATION required.

4.3 CONTAMINATION MONITORING and SURVEYS

MONITORING

At exit of known or suspect CONTAMINATION areas, personnel shall monitor at least hands and feet. If CONTAMINATION is detected, then a check of exposed areas of the body and clothing should be made. Materials, tools and equipment shall be monitored for CONTAMINATION before removal from contaminated or RESTRICTED AREAS likely to be contaminated.

SURVEYS

Wipe tests of the reactor bay and control room are required monthly. Alpha and beta particle assay for radionuclides is done following Facility Procedures 20 and 21.

Limits for Removable and Fixed CONTAMINATION

Acceptable CONTAMINATION levels for unconditional release are given in the following table. Averages apply to areas less than 1 m^2. Maxima apply to areas less than 100 cm^2.

CONTAMINATION LIMITS FOR UNRESTRICTED RELEASE			
Nuclide	Avg. dpm (fixed)	Max dpm (fixed)	Removable dpm
^{235}U, ^{238}U, and decay products (α activity)	5000 per 100 cm^2	15000 per 100 cm^2	1000 per 100 cm^2

CONTAMINATION LIMITS FOR UNRESTRICTED RELEASE			
Nuclide	Avg. dpm (fixed)	Max dpm (fixed)	Removable dpm
^{226}Ra, ^{228}Ra, ^{230}Th, ^{228}Th, ^{231}Pa, ^{227}Ac, ^{125}I, ^{129}I, and transuranics	100 per 100 cm^2	300 per 100 cm^2	20 per 100 cm^2
^{232}Th, ^{90}Sr, ^{223}Ra, ^{224}Ra, ^{126}I, ^{131}I, ^{133}I	1000 per 100 cm^2	3000 per 100 cm^2	200 per 100 cm^2
Other β-γ emitters	5000 per 100 cm^2	15000 per 100 cm^2	1000 per 100 cm^2

4.4 Environs MONITORING

Environs MONITORING is required to assure compliance with 10CFR20, Subpart F (SURVEYS and MONITORING), and specific requirements operating requirements, CALIBRATION frequency, and set point verification within the Technical Specifications for the FACILITY OPERATING LICENSE including:

a. Technical Specifications, Section C. Reactor Pool requires:

Pool surface monitor

b. Technical Specifications, Section F. Radiation Monitoring requires:

Area radiation monitor located on or near the pool bridge

Area radiation monitors in the reactor bay

Continuous air monitor

Additional MONITORING imposed by the Reactor Safeguards Committee is as follows:

a. An evacuation alarm (high radiation level) is required at the 22-ft level of the reactor. Response testing of the alarm is performed annually following Facility Procedure 18.

b. Semi-annual environmental MONITORING, involving measurement of both gamma-ray and neutron DOSE rates at the Facility operations boundary with the reactor at full-power operation

c. When shielding is changed from normal configuration:

(1) MONITORING for potential neutron and gamma exposures is required at the AREA OF INTEREST under the following conditions:

- During initial operation with the shielding configuration
- Each time a new, previously untested, configuration is established or a tested configuration is modified
- During initial operation at higher power than previous MONITORING

(2) SURVEYS of the area affected by the shielding change are required IF personnel will have access to the area.

(3) MONITORING is not required for a well-defined shielding configuration that previously met radiological LIMITS as demonstrated by MONITORING (or on restoration to normal shielding), but may be performed at the discretion of the Operator at the Controls.

(4) During operations following shielding changes, the operator at the controls should be aware of and attentive to area radiation monitor indications as potential indicators of unanticipated anomalies in shielding effectiveness.

4.5 Personnel Exposure

INTERNAL DOSE MONITORING is required only for (1) adults likely to receive in 1 year in excess of 10% of the applicable ANNUAL LIMIT ON INTAKE for ingestion and inhalation, or (2) minors or DECLARED PREGNANT WOMAN likely to receive in excess of 0.05 rem COMMITTED EFFECTIVE DOSE in one year. The KSU Nuclear Reactor Facility does not have potential for exceeding a DOSE that could require INTERNAL DOSE MONITORING.

Regulation 10CFR.1502 requires MONITORING of workers likely to receive, in one year from sources external to the body, a DOSE in excess of 10 percent of the limits given in Section 2.2 of this program, and Individuals entering a HIGH or VERY HIGH RADIATION AREA.

According to Regulatory Guide 8.7 [2], if a prospective evaluation of likely DOSES indicates that an individual is not likely to exceed 10 percent of any applicable DOSE LIMIT, then there are no requirements for recordkeeping or reporting.

Likewise, Regulatory Guide 8.34 [3] indicates that, if INDIVIDUAL MONITORING results serve as confirmatory measures, but INDIVIDUAL MONITORING is not required by 10CFR20.1502, then such results are not subject to the recordkeeping requirements of 10CFR20.2106(a) even though they may be used to satisfy 10CFR20.1501 requirements. The regulation also requires MONITORING of any individuals entering a HIGH RADIATION AREA, i.e., areas accessible to major portions of the whole body within which an individual could receive a DOSE EQUIVALENT of 0.1 rem in one hour.

As shown in Appendix E, which lists OCCUPATIONAL DOSES for the last 12 years, there have been no instances of any OCCUPATIONAL DOSE in excess of 10 percent of the above limits. Thus, retrospectively, only confirmatory MONITORING would be required and 10CFR20.2106(a) recordkeeping requirements would not apply, so long as there are no significant changes in the Facility operating procedures, or occupational expectations. If, in the view of supervisory personnel (Reactor Supervisor, Facility Manager, or Radiation Safety Officer), any action under consideration might lead to DOSE in excess of 10 percent of any applicable limit, then the ALARA program is triggered. A consequence of ALARA program planning, which is described in Section 6, might be the imposition of federally required recordkeeping procedures.

MONITORING of workers and MEMBERS OF THE PUBLIC for RADIATION EXPOSURE required by the Reactor Safeguards Committee and is described in Facility Procedure 9. Objectives implemented through Procedure 9 to ensure control of personnel RADIATION EXPOSURE include:

a. Personnel who enter the control room or the reactor bay will either hold authorization for unescorted access, or be under direct supervision of an escort (i.e., escorted individuals can be observed by and hear instructions of the escort) who holds authorization for unescorted access.

b. When the reactor is not secured, the licensed reactor operator (or senior reactor operator) at the controls SHALL be responsible for controlling access to the control room and the reactor bay.

c. Personnel who enter the reactor bay during reactor operation SHALL have a record of accumulated DOSE measured by a gamma sensitive INDIVIDUAL MONITORING DEVICE; at the discretion of the reactor operator at the controls, a single INDIVIDUAL MONITORING DEVICE may be used for INDIVIDUAL MONITORING of two people who agree to stand together in the reactor bay.

d. If there is potential for EXPOSURE of personnel to neutrons within the reactor bay, personnel who enter the reactor bay SHALL have neutron

sensitive INDIVIDUAL MONITORING; this INDIVIDUAL MONITOR SHALL be assigned only to individuals

e. Personnel who enter the reactor bay while the reactor is secured SHALL have a record of accumulated DOSE either by measurement through INDIVIDUAL MONITORING or based on assessment of data from INDIVIDUAL MONITORING DEVICES or SURVEY.

The Radiation Safety Officer distributes records of INDIVIDUAL MONITORING DEVICES used to record OCCUPATIONAL DOSE monthly for whole body monitors and quarterly for extremity monitors. These records are reviewed as specified in Section 8, *Reviews and Audits,* and posted so that individuals may be kept aware of their OCCUPATIONAL DOSE.

5. RECORDKEEPING

5.1 Administrative Records

Personnel EXPOSURE Records

The Facility is exempt from Federal recordkeeping requirements (see Section 4.5), of 10CFR20.2106(a) as long as OCCUPATIONAL DOSES and PUBLIC DOSES are controlled to less than 10% of the limiting personnel DOSE (previously noted) and as long as personnel do not enter HIGH or VERY HIGH RADIAITON AREAS. However, certain records are required to confirm that personnel exposures are less than 10 percent of applicable limits.

Records of Prior OCCUPATIONAL EXPOSURE are initially obtained, then maintained, by the Office of Radiation Safety. A sample form (NRC Form 4) is provided in Appendix F.

Training and Qualification Records

Unescorted Access Records are maintained at the Facility. A list of persons with unescorted access will be maintained on file. Results of unescorted access training examinations SHALL be maintained on file for at least 3 years. A review and assessment of persons with unescorted access, and copies of notification of individuals requiring retraining SHALL be recorded with the semi-annual radiation protection program audit.

Radiation Protection Program Review and Audit Records

Monthly Reviews of Personnel EXPOSURE Records are recorded by completion in the Maintenance and Surveillance Report. Reports not delivered to schedule will be reviewed on receipt. If investigation of cause and circumstances is required based on OCCUPATIONAL DOSE exceeding

1/2 the annual ALARA limit, the report SHALL be submitted to the RSC and file copy maintained in the RSC Notebook.

Radiation Protection Program Semi-annual Audits of implementation (Appendix F, Illustration F-16) SHALL be submitted to the RSC Notebook.

Biennial Review of the Radiation Protection Program provisions SHALL be submitted to the RSC Notebook.

5.2 Routine Operational Records

Personnel Exposure Records

Records of Occupational INDIVIDUAL MONITORING are maintained by the Office of Radiation Safety. Illustrated in Appendix F is a sample form (NRC Form 5) and samples of forms in use, namely, monthly report for the University as a whole, monthly summary report for the Nuclear Reactor Facility, and quarterly report on EXTREMITY DOSES for the University as a whole.

Records of DOSES to Individual MEMBERS OF THE PUBLIC are maintained in dosimeter records maintained at the Facility. Self-reading and electronic pocket dosimeter records are kept in a logbook. Such records are kept permanently. A sample page is illustrated

Radioactive Material Accountability

Radioactive Source Material Inventory is conducted for the Office of Radiation Protection. The Radiation Safety Office maintains records according to requirements of the Office of Radiation Protection.

Source Inventory and Leak Check is conducted to control inventory and integrity of radioactive material associated with the Facility. Records are maintained at the Facility.

Special Nuclear Material Records is conducted as required by the Department of Energy and the Nuclear Regulatory Commission. Records are maintained by DOE, NRC and at the Facility.

Survey Instrument and Self-Reading Personal Dosimeter CALIBRATION

CALIBRATION of these instruments is performed according to Procedures 13 and 14. Separate CALIBRATION records are kept for each instrument, and for 3 years at the Facility. Sample records are included in Appendix F.

Environs MONITORING

Monthly swipe SURVEYS and water sample tests are performed according to Procedure 20. Records are kept on file in the Reactor Facility for 3 years. Semi-annual SURVEYS of gamma ray and neutron DOSE RATES are required along the operations boundary with the reactor at full power. Sample records are included in Appendix F.

The results of special, non-scheduled SURVEYS at LOCATIONS OF INTEREST conducted to verify the adequacy of shielding installations are recorded in the Operations Log.

Waste Disposal

When liquid wastes are released from the Reactor Facility to sanitary sewerage, both gamma ray and alpha-particle assay are required to assure compliance with 10CFR20. Assay records and records of releases are kept on file in the Reactor Facility for 3 years. Sample records are included in Appendix F.

When solid wastes from the Reactor FACILITY to the University Radiation Safety Office, records of the transfer are kept on file in the Reactor FACILITY for 3 years. Procedure 22 may be followed in estimation of activities transferred. At the discretion of the Reactor Supervisor, a detailed report of estimated activities may be filed with the transfer records. Examples of such records and such a report are included in Appendix F.

Emergency Equipment Inventories are maintained according to requirements in the *KSU Reactor Emergency Plan*.

5.3 Planned Special Exposures

10CFR20.106 allows ADULT workers (excluding DECLARED PREGNANT WOMAN females) to receive DOSES above 10CFR20.101 limits under special circumstances, with the following considerations satisfied:

a. Alternatives to higher exposure are unavailable or impractical

b. Exposures are pre-authorized, in writing

c. Individuals involved are informed of risks and instructed in procedures

d. Individual's DOSES in excess of annual DOSE LIMITS (and from prior special exposures) are known

e. Special exposures and marginal occupational exposures over annual limits do not exceed 10CFR20.1201 limits in any one year

f. Special exposures and marginal occupational exposures over annual limits do not exceed 5 times the 10CFR20.1201 DOSE LIMITS for a lifetime

g. Records are maintained and submitted to the NRC according to 10CFR20.1201 and 10CFR20.1206

h. The exposed individual is informed within 30 days

Any planned special exposures must receive full ALARA consideration. Documents related to planned special exposures, including measurements and calculations used to assess INTERNAL DOSES SHALL be kept permanently at the Reactor Facility.

6. ALARA PROGRAM

SUMMARY OF ALARA GOALS		
Applies to:	10CFR20 Annual Limit	ALARA Goal (annual)
Workers	5000 rem TEDE	< 500 mrem annual TEDE
	50 rem combined DDE & CDE to any organ other than the eye	< 5 rem annual DOSE EQUIVALENT to any organ except the lens of the eye
	15 rem lens of the eye	< 1.5 rem annual DOSE EQUIVALENT to the lens of the eye
	50 rem SHALLOW DOSE EQUIVALENT to the skin or any extremity	< 5 rem annual DOSE EQUIVALENT to the skin
	100 mrem TEDE for DECLARED PREGNANT WOMAN workers	< 50 mrem DOSE EQUIVALENT to the fetus during pregnancy
MEMBER OF THE PUBLIC	100 mrem TEDE	< 50 mrem annual TEDE

6.1 Policy and Objectives

MANAGEMENT of the Reactor Facility is committed to keeping both OCCUPATIONAL WORKERS and MEMBERS OF THE PUBLIC radiation exposure AS LOW AS REASONABLY ACHIEVABLE (ALARA). The specific goal of the ALARA program is to assure that actual exposures result in DOSES no greater than 10 percent of the occupational limits and no greater than 50 percent of the MEMBER OF THE PUBLIC limits prescribed by 10CFR20, ALARA goals as indicated in the table, "Summary of ALARA Goals" above.

6.2 Implementation of the ALARA Program

Planning and scheduling of operations and experiments, education and training, and facility design are the responsibilities of the Reactor Supervisor and/or the Nuclear Reactor Facility Manager. Any action that, in either of their opinions, might result in personnel exposure to one-half the annual ALARA DOSE goal (Section 6.1) to any one individual in one calendar quarter requires a formal ALARA review and report. Any staff member or experimenter, or any member of the Reactor Safeguards Committee may call for an ALARA review of a proposed action. Under any of these circumstances, it is the responsibility of the Reactor Supervisor to conduct an ALARA review and report. Only with the approval of the Reactor Supervisor and the endorsement of the Nuclear Reactor Facility Manager may the action proceed.

6.3 Elements of the ALARA Review and Report

The following topics SHALL be considered, if applicable. The report SHALL include discussion of how these topics affect personnel exposure and specific actions recommended, categorized by topic:

Features for External Radiation Control

Shielding and construction materials
Radioactive material storage and disposal
MONITORING systems
Facility layout
Control of access to HIGH and VERY HIGH RADIATION AREAS

CONTAMINATION Control

Ventilation and filtration
Containment of CONTAMINATION
Confinement of CONTAMINATION spread
Construction materials to facilitate decontamination
Facility layout

EFFLUENT Control

Gaseous EFFLUENTS
Liquid EFFLUENTS
EFFLUENT MONITORING

Operations and Operations Planning

Assessment of potential individual and collective exposures
Application of *shielding, time, and distance* for DOSE reduction
Use of ventilation and decontamination to reduce COLLECTIVE DOSE

Provision of special radiac or communications instrumentation
Provision of special personnel training and practice
Provision of special supervision and surveillance
Provision of special clothing or other protective gear

6.4 Reviews and Audit

The ALARA Program SHALL be audited by the Nuclear Reactor Facility Manager integral to the general audit of the Radiation Protection Program

7. CALIBRATIONS AND QUALITY ASSURANCE

CALIBRATION requirements related to radiation protection and imposed by the Reactor Safeguards Committee are as follows:

Semi-annually	Survey meters Pocket dosimeters
Annually	Continuous air monitor Neutron "rem" meters Alpha & beta particle efficiencies for surveillance probes
Biennially	PD-10i Electronic Dosimeters

CALIBRATION procedures are prescribed in the following Facility Procedures:

No. 3	Annual Remote Air Monitor Calibration
No. 8	(Continuous) Air Monitor Calibration
No. 13	Portable Radiation SURVEY Meter Calibration
No. 14	Personnel Pocket Dosimeter Calibration
No. 19	Gamma-Ray Assay of Reactor Samples
No. 20	Liquid Scintillator Assay Methods
No. 21	Alpha-particle Assay of Reactor Liquids

8. REVIEW AND AUDIT

8.1 Occupational Dose Record Reviews

The Reactor Supervisor SHALL review personnel DOSE records monthly. If personnel DOSES exceed 1/2 annual ALARA limit, causes and circumstances SHALL be investigated and reported to the Nuclear Reactor Facility Manager. The report SHALL be reviewed and submitted to the RSC.

SUMMARY OF DOSE LIMITS, GOALS AND LEVELS FOR INVESTIGATION			
Applies to:	10CFR20 Annual Limit	ALARA Goal (annual)	Investigation Trigger (quarter)
Workers	5000 rem TEDE	500 mrem annual TEDE	250 mrem
	50 rem combined DDE & CDE to any organ other than the eye	5 rem DOSE EQUIVALENT to any organ except the lens of the eye	2.5 rem DOSE EQUIVALENT to any organ except the lens of the eye
	15 rem lens of the eye	1.5 rem DOSE EQUIVALENT to the lens of the eye	0.75 rem DOSE EQUIVALENT to the lens of the eye
	50 rem SHALLOW DOSE EQUIVALENT to the skin or any extremity	5 rem I DOSE EQUIVALENT to the skin	2.5 rem DOSE EQUIVALENT to the skin
	100 mrem TEDE for DECLARED PREGNANT WOMAN workers	50 mrem DOSE EQUIVALENT to the fetus during pregnancy	25 mrem DOSE EQUIVALENT to the fetus during pregnancy
MEMBER OF THE PUBLIC	100 mrem TEDE	50 mrem annual TEDE	25 mrem TEDE

8.2 Radiation Protection Program Implementation Audits

The Nuclear Reactor Facility Manager SHALL review implementation of the KSU Nuclear Reactor Radiation protection Program semi-annually. As a minimum, the Nuclear Reactor Facility Manager SHALL review (1) instrument CALIBRAITONS and surveillance performance and record keeping (2) results of INDIVIDUAL MONITORING and recordkeeping; and (3) planned special exposures and ALARA reviews. Appendix F, Illustration F-16 provides guidance for performing the audit.

8.3 Radiation Protection Program Reviews

The Nuclear Reactor Facility Manager SHALL review the Radiation Protection Program provisions biennially. As a minimum, the Nuclear Reactor Facility Manager shall review the Radiation Protection Program, 10CFR20, and Facility implementing procedures.

9. EMERGENCY EQUIPMENT

Equipment and supplies required to support emergency operations are identified in the *KSU Nuclear Reactor emergency Plan.* An inventory of equipment in two

storage lockers is conducted in accordance with the Plan to ensure readiness at all times.

10. REFERENCES

1. American National Standard *Radiation Protection at Research Facilities*, ANSI/ANS-15.11 (Final Draft), American Nuclear Society, La Grange Park, Illinois, October 1992.

2. *Instructions for Recording and Reporting Occupational Radiation Exposure Data*, Regulatory Guide 8.7 (Rev. 1), U.S. Nuclear Regulatory Commission, Washington, D.C., 1992.

3. Monitoring Criteria and Methods to Calculate Occupational Radiation Doses, Regulatory Guide 8.34, U.S. Nuclear Regulatory Commission, Washington, D.C., 1992.

4. *Air Sampling in the Workplace*, Regulatory Guide 8.25 (Rev. 1), U.S. Nuclear Regulatory Commission, Washington, D.C., 1992.

5. *Planned Special Exposures*, Regulatory Guide 8.35, U.S. Nuclear Regulatory Commission, Washington, D.C., 1992.

6. *Radiation Dose to the Embryo/Fetus*, Regulatory Guide 8.36, U.S. Nuclear Regulatory Commission, Washington, D.C., 1992.

7. *Interpretation of Bioassay Measurements*, Draft Regulatory Guide 8.9 (DG-8009), U.S. Nuclear Regulatory Commission, Washington, D.C., 1992.

APPENDICES

APPENDIX A

Glossary of Terms

absorbed dose. The energy imparted by ionizing radiation per unit mass of irradiated material. The units of absorbed dose are the rad and the gray (Gy).

accessible area. The area that can reasonably be occupied by a significant portion of an individual's body. (see also radiation area, HIGH RADIATION AREA, significant portion).

activity. The rate of disintegration transformation) or decay of radioactive material. The units of activity are the curie (Ci) and the becquerel (Bq).

adult. An individual 18 or more years of age.

airborne radioactive material. Radioactive material dispersed in the air in the form of dusts, fumes, particulates, mists, vapors, or gases; also commonly referred to as airborne radioactivity.

airborne radioactivity area. A room, enclosure, or area in which airborne radioactive materials, composed wholly or partly of permitted or licensed material, exist in concentrations

(1) in excess of the derived at concentrations (DACs) for controlling occupational exposures), e.g., those specified in Title 10, Code of Federal Regulations, Part 20.1001-20.2401, Appendix B [1][2] ;or

(2) to such a degree that an individual present in the area without respiratory protective equipment could exceed, during the hours an individual is present in a week, an intake of 0.6 % of the annual limit on intake (ALI) or 12 DAC-hours, or, in the case of submersion nuclides, exceed an effective dose equivalent of 30 mrem (0.3 mSv).

as low as is reasonably achievable (ALARA). To make every reasonable effort to maintain exposures to radiation as far below the dose limits as is practical, consistent with the purpose for which the permitted or licensed activity is undertaken, taking into account the state of technology, the economics of improvements in relation to the state of technology, the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to utilization of nuclear energy and permitted or licensed materials in the public interest.

annual limit on intake (ALI). The derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. ALI is the smaller value of intake of a given radionuclide in a year by the reference man that would result in a

committed effective dose equivalent of 5 rem (0.05 Sv) or a committed dose equivalent of 50 rem (0.5 Sv) to any individual organ or tissue. (ALI values for intake by ingestion and by inhalation of selected radionuclides are given in Table 1, Columns 1 and 2, of Appendix B to 10CFR 20.1001 - 20.2401)[1].

background radiation. Radiation from cosmic sources; naturally occurring radioactive materials, including radon (except as a decay product of source or special nuclear material) and global fallout as it exists in the environment from the testing of nuclear explosive devices. Background radiation does not include radiation from sources controlled or regulated by the overseeing regulatory authority.

bioassay (radiobioassay). The determination of kinds, quantities, or concentrations and, in some cases, the locations of radioactive material in the human body, whether by direct measurement (in vivo counting) or by analysis and evaluation of materials excreted or removed from the human body.

byproduct material.
(1) Any radioactive material (except special nuclear material) yielded in, or made radioactive by, exposure to the radiation incident to the process of producing or utilizing special nuclear material and
(2) The tailings or wastes produced by the extraction or concentration of uranium or thorium from ore processed primarily for its source material content, including discrete surface wastes resulting from uranium solution extraction processes. Underground ore bodies depleted by these solution extraction operations do not constitute byproduct material within this definition.

Calibration. The determination of response of an instrument or system over its range so that its output can be correlated, with acceptable accuracy, to true values of the measured parameter.

class (or **lung class** or **inhalation class).** A classification scheme for inhaled material according to its rate of clearance from the pulmonary region of the lung. Materials are classified as D, W, or Y, which apply to a range of clearance half times for Class D (days) of less than 10 days; for Class W (weeks), from 10 to 100 days; and for Class Y (years), greater than 100 days.

collective dose. The sum of the individual dose received in a given period of time by a specified population from exposure to a specified source of radiation. The units of collective dose are the person-rem and person-sievert.

committed dose equivalent ($H_{T,50}$). The dose equivalent to organs or tissues of reference (T) that will be received from an intake of radioactive material by an individual during the 50-year period following the intake. The units of committed dose equivalent are the rem and sievert (Sv).

committed effective dose equivalent ($H_{E,50}$). The sum of the products of the weighting factors applicable to each of the body organs or tissues that are irradiated and the

committed dose equivalent to these organs or tissues ($H_{E,50} = \sum w_T H_{T,50}$). The units of committed effective dose equivalent are the rem and sievert (Sv).

contamination (radioactive). A radioactive substance dispersed in materials or places where it is undesirable.

controlled area. An area, outside of a restricted area but inside the site boundary, access to which can be limited by the owner/operator or licensee for any reason (see also restricted area).

declared pregnant woman. A woman who has voluntarily informed her employer, in writing, of her pregnancy and the estimated date of conception.

deep-dose equivalent (H_d). Applies to eternal whole-body exposure; the dose equivalent at a tissue depth of 1 cm (1000 mg/cm^2). The units of deep-dose equivalent are the rem and sievert (Sv).

derived air concentration (DAC). The concentration of a given radionuclide in air which, if breathed by the reference man for a working year of 2000 hours under conditions of light work(inhalation rate 1.2 m^3 of air per hour), results in an intake of one ALI, or, in the case of submersion nuclides, that concentration that results in an external exposure of the dose limit. DAC values are given in Table 1, Column 3, of Appendix B to 1OCFR 20.1001 - 20.2401.[1]

derived air concentration-hour (DAC-hour). The product of the concentration of radioactive material in air (expressed as a fraction or multiple of the derived at concentration for each radionuclide) and the time of exposure to that radionuclide, in hours. An owner, operator or licensee may take 2000 DAC-hours to represent one ALI, equivalent to a committed effective dose equivalent of 5 rem (0.05 Sv).

dose or radiation dose. A generic term that means absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, or total effective dose equivalent, as defined in other paragraphs of this section.

dose equivalent (H_T). The product of the absorbed dose in tissue, quality factor, and all other necessary modifying factors at the location of interest within the body. The units of dose equivalent are the rem and sievert (Sv).

dosimetry processor. An individual or an organization that processes and evaluates individual monitoring equipment to determine the radiation dose delivered to the equipment (see also NVLAP).

effective dose equivalent (H_E). The sum of the products of the dose equivalent to the organ or tissue (H_T) and the weighting factors (w_T) applicable to each of the body organs or tissues that are irradiated ($H_E = \sum w_T H_T$). The units of effective dose equivalent are the rem and sievert (Sv).

effluents. Airborne and liquid radioactive releases from a research reactor facility.

embryo or fetus. The developing human organism from conception until the time of birth.

entrance or access point. Any location through which an individual could gain access to radiation areas or to radioactive materials. This includes entry or exit portals of sufficient size to permit human entry, irrespective of their intended use.

exempt quantity. A quantity determined by the licensing or chartering authority to be exempt from selected regulatory requirements.

exposure. Being exposed to ionizing radiation or to radioactive material.

external dose. That portion of the dose equivalent received from radiation sources outside the body.

extremities. Hand, elbow, arm below the elbow; foot, knee, and leg below the knee.

eye dose equivalent. Applies to the eternal exposure of the lens of the eye and is taken as the dose equivalent at a tissue depth of 0.3 centimeter (300 mg/cm^2). The units of eye dose equivalent are the rem and sievert (Sv).

facility. See research reactor facility.

HIGH RADIATION AREA. An area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.1 rem (1 mSv) in 1 hour at 30 cm from the radiation source or from any surface that the radiation penetrates.

individual. Any human being.

individual monitoring.
(1) The assessment of dose equivalent by the use of devices designed to be worn by an individual;
(2) The assessment of committed effective dose equivalent by bioassay or by determination oft he time-weighted air concentrations to which an individual has been exposed, i.e., DAC-hours; or
(3) The assessment of dose equivalent by the use of SURVEY data.

individual monitoring devices (individual monitoring equipment). Devices designed to be worn by a single individual for the assessment of dose equivalent, such as film badges, thermoluminescent dosimeters (TLDs), pocket ionization chambers, and personal ("lapel") air sampling devices.

internal dose. That portion of the dose equivalent received from radioactive material taken in to the body.

license. A permit or other similar authorization issued by the competent responsible authority.

licensee. An owner or operator holding a permit or license issued by the competent responsible authority.

limits (dose limits). The permissible upper bounds of radiation doses.

location of interest. That location in an unrestricted area where the highest dose or concentration is likely to occur.

Management. Those persons within the research reactor organization whose responsibility and authority include the radiation protection program. The levels of Management are as described in the American National Standard for Development of Technical Specifications for Research Reactors, ANSI/ANS-15.1-1990 [3].

member of the public. An individual in a controlled, unrestricted area, or in a restricted area with no direct involvement with a licensed source. However, an individual is not a member of the public during any period in which the individual receives an occupational dose.

minor. An individual less than 18 years of age.

monitoring (radiation monitoring, radiation protection monitoring). The measurement of radiation levels, concentrations, surface area concentrations or quantities of radioactive material and the use of the results of these measurements to evaluate potential exposures and doses.

nonpower reactor (NPR). See research reactor.

NVLAP (National Voluntary Laboratory Accreditation Program). A program administered by the National Institute of Standards and Technology.

occupational dose. The dose received by an individual in a restricted area or in the course of employment in which the individual's assigned duties involve exposure to radiation and to radioactive material from licensed and unlicensed sources of radiation, whether in the possession of the owner/operator or licensee or other person. Occupational dose does not include public dose, dose received from background radiation, as a patient from medical practices, or from voluntary participation in medical research programs.

owner, operator. See licensee.

permit. See license.

public dose. The dose received by a member of the public from exposure to radiation and to radioactive material released by a owner/operator or licensee, or to another source of radiation either within a owner/operator or licensee's controlled area, or in unrestricted areas, or in a restricted area with no direct involvement with a licensed source. It does not include

occupational dose or doses received from background radiation, as a patient from medical practices, or from voluntary participation in medical research programs.

radiation (ionizing radiation). Alpha particles, beta particles, gamma rays, X rays, neutrons, high-speed electrons, high-speed protons, and other particles capable of producing ions. Radiation, as used in this standard, does not include nonionizing radiation, such as radio- or microwaves, or visible, infrared, or ultraviolet light.

radiation area. An area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.005 rem (50 μSv) in 1 hour at 30 cm from the radiation source or from any surface that the radiation penetrates.

research reactor. A device designed to support a self-sustaining neutron chain reaction for research, developmental, educational, training, or experimental purposes and that may have provision for the production of radioisotopes.

research reactor facility. Includes all areas within which the owner or operator directs authorized activities associated with the reactor.

restricted area. An area, access to which is limited by the owner/operator or licensee for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials. Restricted areas do not include areas used as residential quarters, but separate rooms in a residential building may be set apart as a restricted area (see also controlled area).

SHALL, SHOULD and may. The word "SHALL" is used to denote a requirement; the word "SHOULD', to denote a recommendation; and the word "may" to denote permission, neither a requirement nor a recommendation.

SHALLOW-dose equivalent (H_s). Applies to the external exposure of the skin or an extremity; taken as the dose equivalent at a tissue depth of 0.007 centimeter (7 mg/cm^2) averaged over an area of 1 cm^2. The units of SHALLOW dose equivalent are the rem and sievert (Sv).

significant portion of the body. A portion of the body other than the extremities whose area exceeds 900 cm^2. (Note: This represents about 5% of the adult total body area and about 15% of the trunk surface area.)

site boundary. That line beyond which the land or property is not owned, leased, or otherwise controlled by the owner/operator or licensee.

soluble material. Having no significant visible turbidity or significant visible suspended solids so as not to change the characteristics as a solution, e.g., sludge.

source material.
(1) Uranium or thorium or any combination of uranium and thorium in any physical or chemical form; or

(2) Ores that contain, by weight, 0.05 %, or more, of uranium, thorium, or any combination of uranium and thorium. Source material does not include special nuclear material.

special nuclear material.
(1) Plutonium, ^{233}U, uranium enriched in the isotope 233 or in the isotope 235; but does not include source material; or
(2) Any material artificially enriched by any of the foregoing but does not include source material.

submersion nuclides. Those gaseous nuclides and other airborne nuclides whose DAC is based on the eternal dose rate resulting from submersion in an atmosphere of that nuclide.

SURVEY. An evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, or presence of radioactive material or other sources of radiation. When appropriate, such an evaluation includes a physical SURVEY of the location of radioactive material and measurements or calculations of levels of radiation, or concentrations or quantities of radioactive material present.

test reactor. See research reactor.

total effective dose equivalent (TEDE). The sum of the deep-dose equivalent (for external exposures) and the commented effective dose equivalent (for internal exposures).

true value. The actual value of a parameter.

unrestricted area. An area, access to which is neither limited nor controlled by the owner/operator or licensee.

VERY HIGH RADIATION AREA. An area, accessible to individuals, in which radiation levels could result in an individual receiving an absorbed dose in excess of 500 rad (5 Gy) in 1 hour at 1 meter from a radiation source or from any surface that the radiation penetrates. [Note: At VERY HIGH doses received at high dose rates, units of absorbed dose (e.g., rads and grays) are appropriate, rather than units of dose equivalent (e.g., rems and sieverts).]

APPENDIX B
KSU TRIGA MkII Operation, Test, and Maintenance Procedures

Number	Title
1	BIENNIAL CONTROL ROD INSPECTION
2	ANNUAL POWER LEVEL CALIBRATION
3	ANNUAL REMOTE AREA MONITOR CALIBRATION
4	SEMI-ANNUAL CONTROL ROD DROP TIME MEASUREMENT
5-1	SEMI-ANNUAL CHECK OF MINIMUM INTERLOCKS
5-2	SEMI-ANNUAL CHECK OF 110% SAFETY CIRCUITS
6	SEMI-ANNUAL PULSE ROD DRIVE CYLINDER AND AIR SUPPLY INSPECTION
7	SEMI-ANNUAL $1.00 COMPARISON PULSE
8	AIR (IODINE) MONITOR CALIBRATION
9	ENTRANCE TO THE REACTOR BAY, VISITOR CONTROL
10	FUEL ELEMENT INSPECTION
11	REACTOR STARTUP WITH PERIOD SCRAM BYPASSED
12	FUNCTIONAL PERFORMANCE CHECK OF TRANSIENT (PULSE) ROD
13	PORTABLE RADIATION SURVEY METER CALIBRATION
14	PERSONNEL POCKET DOSIMETER CALIBRATION
15	REACTOR STARTUP
16	REACTOR SHUTDOWN
17	PERIODIC REACTOR INTRUSION ALARM TESTING
18	EVACUATION ALARM RESPONSE TEST
19	GAMMA-RAY ASSAY OF REACTOR SAMPLES
20	LIQUID SCINTILLATION ASSAY METHODS
21	ALPHA PARTICLE ASSAY OF REACTOR LIQUIDS

KSU TRIGA MkII Miscellaneous Procedures

ACCOUNTING PROCEDURES FOR SPECIAL NUCLEAR MATERIAL
PROCEDURE FOR USING PuBe SOURCES IN WARD 128
EMERGENCY PROCEDURES FOR KSU TRIGA MkII REACTOR FACILITY*
RADIATION SAFETY MANUAL FOR USE AT KANSAS STATE UNIVERSITY

APPENDIX C

KSU TRIGA MkII Emergency Procedures

Number	Title
1	EMERGENCY NOTIFICATIONS
2	RADIOLOGICAL SURVEYS
3	PERSONNEL MONITORING AND DECONTAMINATION
4	EVACUATION OF ON-SITE AREAS
5	PERSONNEL ACCOUNTABILITY
6	ASSESSMENT ACTIONS
7	FIRST AID AND MEDICAL CARE
8	FIRE FIGHTING
9	RE-ENTRY OPERATIONS
10	FACILITY SECURITY
11	RECOVERY OPERATIONS
12	COMMUNICATIONS AND RECORD KEEPING
13	EQUIPMENT AND SUPPLIES
14	TRAINING AND EVALUATION
15	PREPARATION, DISTRIBUTION, AND MAINTENANCE OF PLANS AND PROCEDURES

APPENDIX D

KSU TRIGA MkII Training Syllabus

This training applies to persons given unescorted access to the Nuclear Reactor Facility. It specifically applies to reactor operators or other Facility staff members, students in nuclear engineering classes making use of the Facility. It applies to technicians and maintenance personnel. Topics to be covered in training are listed below. In addition, all trainees must be given access to copies of NRC Regulatory Guide 8.13 "Instruction Concerning Prenatal Radiation Exposure" and the appendix to NRC Regulatory Guide 8.29 "Instruction Concerning Risks from Occupational Radiation Exposure." Training is to include a comprehensive tour of the Facility during which all items of safety and emergency equipment are located and their function or operation explained.

Topics to be covered in training

1. Risks of occupational exposure
2. Risks of prenatal exposure
3. Provisions of 10CRF19 and 10CFR20
4. Provisions of the Facility Emergency Plan
5. Tour of the Nuclear Reactor Facility
6. Examination (closed book)

The examination paper is to include a signed statement of the examinee stating:

I certify that I have been given instruction, have read, have understood, and have had the opportunity to discuss and ask questions about U.S. NRC Regulatory Guides 8.13 and 8.29 concerning respectively prenatal radiation exposure and risks from occupational radiation exposure.

Standards for Protection Against Radiation (10CFR20) - Lesson Plan

General Provisions

20.1003 Definitions

Absorbed dose (rad or Gy)
Activity (Ci or Bq)
Airborne radioactive material
Airborne radioactivity area (conc. > DAC or > 12 DAC hours in 1 wk)
ALARA (as low as reasonably achievable)
ALI (annual limit on intake) 5 rem $H_{E,50}$ or 50 rem $H_{T,50}$ (any organ)
Byproduct material
Class [inhalation clearance classification D(ays), W(eeks), or Y(ears)]
Collective dose
Committed dose equivalent $H_{T,50}$ to organ T in 50 years
Committed effective dose equivalent $H_{E,50} = \sum W_T H_{T,50}$
Controlled area (beyond restricted area within site boundary)
Deep dose equivalent H_d (at 1-cm depth)
DAC (derived air concentration) 2000 DAC-hours -> ALI
Dose equivalent H_T (rem or Sv)
Effective dose equivalent H (rem or Sv) = $\Sigma W_T H_T$
HIGH RADIATION AREA (> 100 mrem in 1 h at 30 cm from source)
Quality factor Q

X,γ,β	1	
α , etc.	20	
n (any E)	10	(see regs for specific energies)
high-E p+	10	

Radiation (directly and indirectly ionizing, excluding μwaves, etc.)
Radiation area (5 mrem in 1 h at 30 cm from source))
Restricted area (for radiation protection)
Shallow dose equivalent H_s (at 0.007 cm depth)
Source material
Special nuclear material
Total effective dose equivalent TEDE = $H_d + H_{E,50}$
VERY HIGH RADIATION AREA (> 500 rad in 1 h at 1 m from source)

Organ	Weight factor W_T	
gonads	0.25	
breast	0.15	
red marrow	0.12	
lung	0.12	
thyroid	0.03	
bone surface	0.03	
remainder	0.30	(avg. dose for other 5 most affected organs, except skin or lens of eye)

Working level WL (radon daughters -> 1.3 10% MeV/L potential energy)
Working level month WLM (1 WL for 170 hours)

Occupational Dose Limits

20.1201 Occupational Dose Limits for Adults

(1) Annual limit - the more limiting of:

(a) TEDE = 5 rem
(b) H_d + $H_{T,50}$ (any organ except lens) = 50 rem

(2) Annual limits to lens, skin, and extremities:

(a) 15 rem to the lens
(b) H_s = 50 rem (skin or extremity)

20.1206 Planned Special Exposures

In addition to limits under x20.1201;

(1) The numerical values of the limits in x20.1201 in 1 year
(2) 5 times the limits in x20.1201 during worker's lifetime

20.1207 Occupational Limits for Minors

10% of limits specifiec in □20.1201

20.1208 Dose to Embryo/Fetus

500 mrem during entire term of pregnancy (see regs for evaluation)

Dose Limits for Individual Members of the Public

20.1301 Dose Limits (also see 40CFR190 - EPA regs)

(1) 2 mrem TEDE in one hour
(2) 100 mrem TEDE in one year (500 mrem with NRC approval)

20.1302 Compliance with Dose Limits

Met by effluent limits in Appendix B

Surveys and Monitoring

20.1501 General

Surveys are required to demonstrate compliance with regulations.

20.1502 Personnel Monitoring

(1) Required for adults if expect > 10% of limits of x20.1201
(2) Required for minors if expect > 1% of limits of x20.1201
(3) Required for entry into high of VERY HIGH RADIATION AREA
(4) See regs for requirements for monitoring intake

Control of External Exposures in Restricted Areas

See regulations x20.1601-1603 for special posting and entry controls for HIGH RADIATION AREAS and VERY HIGH RADIATION AREAS.

Respiratory Protection (x20.1701-1704)

Storage and Control of Licensed Material

Posting and labeling requirements are described in □20.1801-1906.

Waste Disposal

20.2003 Disposal into Sanitary Sewerage

(1) Material must be soluble or dispersible biological material
(2) One-month diluted concentration may not exceed Appendix B value
(3) Annual releases □ 5 Ci of ^{3}H + 1 Ci of ^{14}C + 1 Ci of all others
(4) Body wastes from nuclear medicine patients exempt from limits

20.2005 Disposal of Specific Wastes

See regs for limits on scintillation fluors and animal tissue

Record Keeping

Described in □2101-2206 of the regulations.

Appendix B of 10CFR20 (Examples)

Nuclide	Class	Occupational Values			Effluent Limits (Ci/mL)		
		Ingestion ALI (μCi)	Inhalation ALI (μCi)	DAC (μCi/mL)	Air[a]	Water[a]	Sewerage
^{3}H	Aqueous	$8x10^{4}$	$8x10^{4}$	$2x10^{-5}$	$1x10^{-7}$	$1x10^{-3}$	$1x10^{-2}$
^{60}Co	W	$5x10^{2}$	$2x10^{2}$	$7x10^{-8}$	$2x10^{-10}$	$3x10^{-6}$	$3x10^{-5}$
	Y	$2x10^{2}$	$3x10^{1}$	$1x10^{-8}$	$5x10^{-11}$		
^{131}I	D	$3x10^{1}$	$5x10^{1}$	$2x10^{-8}$			
		Thyroid	Thyroid				
		$(9x10^{1})$[b]	$(2x10^{2})$		$2x10^{-10}$	$1x10^{-6}$	$1x10^{-5}$
^{133}Xe	Subm.	xyz		$1x10^{-4}$			

[a]These are limits for annual average concentrations at the boundary of an unrestricted area. Inhalation or ingestion of these concentrations continuously for a year would lead to a 50 mrem TEDE.

[b]ALI is determined by the 50 rem committed dose equivalent to the thyroid (listed by name). In these circumstances, the ALI based on the 5 rem committed effective dose equivalent for stochastic effects is listed in parentheses. Effluent limits are based only on ALIs for stochastic effects.

RISKS OF PRENATAL RADIATION EXPOSURE

Instructional Lesson Plan

KSU Nuclear Reactor Facility

Regulatory Requirements

10CFR19.12 requires that all individuals frequenting any portion of a restricted area must be instructed in health protection problems associated with exposure to radioactive materials or radiation. 10CFR20 requires that radiation exposures be kept "as low as reasonably achievable." With respect to risks of prenatal exposure, NRC Regulatory Guide 8.13 prescribes the scope of instruction to be provided to female workers, their co-workers and supervisors. Key elements of the instruction are:

1) The 1971 Report-39 NCRP recommendation that, during the entire gestation period, *the maximum permissible dose equivalent to the fetus due to occupational exposure of the mother SHOULD not exceed 0.5 rem.*
2) Reasons for the recommendation (discussed below).

The Regulatory Guide stipulates that:

1) Instruction SHOULD be given both orally and in written form. Employees SHOULD be given copies of the Regulatory Guide.

2) Employees acknowledge in writing that the instruction has been received and that they have been given the opportunity to ask questions.

Note: Regulations do not require that workers be examined on their understanding of the details of the Regulatory Guide or, indeed, on the basis for the NCRP recommendation.

Implementation at Kansas State University

Workers and students frequenting the Reactor Facility are given copies and instructed to read, study, ponder, and meditate upon the Appendix to Reg. Guide 8.13. Workers are given oral instruction by the Reactor
Supervisor. Students are given oral instruction in the class NE-648 - Reactor Operations Laboratory. Written acknowledgement of instruction is made in the Reactor Supervisor's logs for workers and in the radiation-safety written examination required for participation in the NE-648 Class.

Quantitative Measure of Risk

NAS BEIR Committee report, 1972: Evidence is contradictory but suggestive of a relationship between prenatal exposure and childhood cancer, namely leukemia. Specifically: for 1 million

subjects, each exposed to 1 rem in utero, there may be a marginal increase of up to 19 cases of childhood leukemia.

Employer Responsibilities

Employers are required not only to provide instruction on risks to female workers, their supervisors, and their co-workers, but also to take all practicable steps to reduce radiation exposure.

Responsibilities and Alternatives for the Female Worker

If pregnant or expecting to be so, consult with radiation safety officer to determine whether radiation levels in the work areas might lead to in-utero exposures in excess of 0.5 rem. If so:

1) Decide whether to continue to accept work assignments, i.e., whether to accept the risk for the unborn child.
2) Reduce exposures by improving work practices.
3) Request reassignment (especially during first trimester of pregnancy).
4) Delay having children.

RISKS OF OCCUPATIONAL RADIATION EXPOSURE

Instructional Lesson Plan

KSU Nuclear Reactor Facility

Regulatory Requirements

10CFR19.12 requires that all individuals frequenting any portion of a restricted area must be instructed in health protection problems associated with exposure to radioactive materials or radiation. 10CFR20
requires that radiation exposures be kept "as low as reasonably achievable." With respect to general risks of occupational radiation exposure, NRC Regulatory Guide 8.29 prescribes the scope of instruction
to be provided to workers. The Regulatory Guide stipulates that:

1) Instruction SHOULD be given both orally and in written form Employees SHOULD receive copies of the Regulatory Guide.

2) Employees acknowledge in writing that the instruction has been received and that they have been given the opportunity to ask questions.

Note: Regulations do not require that workers be examined on their understanding of the details of the Regulatory Guide.

Quantitative Measures of Risk

Based on estimates made by the United Nations Scientific Committee on the Effects of Atomic Radiation, the National Academy of Sciences Committee on the Biological Effects of Ionizing Radiation, and the
International Commission on Radiation Protection, Regulatory Guide 8.29 states the following estimate on the cancer risk from exposure to ionizing radiation. For 1 million persons each exposed to 1 rem of
ionizing radiation, the marginal increase in cancer incidence is 150 to 450 cases of all types. The morbidity rate is half the incidence rate.

[Note added: the natural fatality rate is about 150,000 per million population.]

Topics Addressed in the Regulatory Guide

The guide is designed for self-study and is in question-answer format. Topics that might be addressed in oral instruction include:

1) Definitions of risk, prompt effects, delayed effects, and genetic effects. Distinctions between acute and chronic exposure.

2) Possible health effects from exposure to ionizing radiation exposure.
3) Mechanisms and probabilities for cancer induction.
4) Comparison of radiation risks and other occupational risks.
5) NRC internal and external dose limits and ALARA requirements - and methods of administration.
6) Typical worker exposures naturally, medically, and occupationally.
7) Personal options in risk assessment and dose limitation.
8) Radiation exposure records and worker rights of access.

Summary of Emergency Plan Provisions

KSU Nuclear Reactor Facility

Standard Operating Procedures

Apply to FIRE, EARTHQUAKE, TORNADO, REACTOR ACCIDENT

1) Shut down reactor.
2) Shut off ventilation and cooling.
3) Call for assistance.
4) Provide liaison

Medical Response

Action Levels

1) Over-exposure (5 rem total body, etc.).
2) Internal contamination (25-rem thyroid, 5 rem other).
3) Injury with external contamination (10 mrem/h).

Procedures

1) Notify Student Health Center (optional).
2) Decontaminate (unless life threatening).
3) Provide first aid.
4) RSO advises action, e.g., hospitalization (requires Unusual Event declaration).
5) After release of victim to medical authorities, cleanup area.

Emergency Classes

Unusual Event

Action levels: incident or threat with potential for escalation, e.g., security threat, non-safety related fire, suspected fuel damage, minor radiological release (10 MPC at boundary for 24 hours).

Off-site agencies are alerted but not activated.

Alert

Action levels: actual or potential substantial degradation of safety, e.g., sabotage, safety related fire, loss of shielding water, confirmed fuel damage, radiological release (50 MPC at boundary for 24 hours).

Off-site agencies are alerted and placed on standby.

Evacuation

Assembly area 1	Lobby of Ward Hall
Assembly area 2	Basement rest room area
Emergency supply cabinets	North entrance
	Assembly area 2

Local Emergency Organization

Immediate Response

Emergency Director (Facility Director)
Radiation Safety Officer
- Surveillance
- Assessment
- Protective action recommendations

Reactor Supervisor
- Recovery operations

Response Team Members
- Reactor Facility staff
- Nuclear engineering staff and faculty
- Reactor Safeguards Committee
- Radiation Safety Committee

Off-Site Agencies

State

Kansas Division of Emergency Preparedness
- Coordination and communication.
- Security and monitoring assistance.

Bureau of Radiation Control
- Technical assistance.
- Monitoring and cleanup assistance.

Kansas Highway Patrol
- Security.
- Monitoring assistance.
- Evacuation control.

Local

KSU Police Department.
Manhattan-Riley County Police Department.
Manhattan Fire Department.
Lafene Student Health Center.
Riley County Ambulance Service.
Saint Mary Hospital.
Memorial Hospital.
Riley County Emergency Preparedness (responsible for off-site evacuation).

Notifications

Declaration and Cancellation

Responsibility of Emergency Director.

Verbal Notification and Cancellation

Kansas Division of Emergency Preparedness.
Riley County Emergency Preparedness Coordinator.

Written Summary

Within 24 hours of cancellation (Unusual Event).
Within 8 hours of cancellation (Alert).
Press Releases from Facility Only by Emergency Director.
Only after cancellation.

Radiation Protection and Emergency Preparedness - Closed Book Examination

Name:

Date:

Reactor Operations Laboratory - NE-648
Safety Orientation Examination (based on 10CFR20 and Facility Emergency Plan)
Closed Book [Unless otherwise indicated, questions are valued at 7% each.]

1. Define [2% each]

   a. Byproduct material

   b. Special nuclear material

   c. Restricted area

   d. Quality factor

   e. Radiation area

   f. HIGH RADIATION AREA

   g. Byproduct material

   h. Airborne radioactivity area

2. Under normal circumstances, what is the maximum permissible whole-body dose equivalent (mrem) per calendar quarter in restricted areas?

3. When is personnel monitoring required?

4. How does one dispose of liquids collected in the Reactor Facility sump tanks?

5. How does on dispose of slightly contaminated glassware and paper?

6. Describe the types and functions of fire extinguishers available in the Reactor Facility.

7. Describe the types (GM, ion chamber, etc.) of portable radiation SURVEY instruments available in the reactor, the types of radiation measured, and the maximum range of "dose rate."

8. While you are operating the reactor, other persons are working at the 0' level. The evacuation alarm (5 R/h) sounds. Describe your actions.

9. While you are operating the reactor, with other persons present in the Reactor Facility, you become aware of a fire in vicinity of the foyer of Ward Hall. Describe your actions.

10. Give an example of circumstances that might call for declaration of an "Unusual Event."

11. Give an example of circumstances that might call for declaration of an "Alert."

12. What are the 10CFR20 dose standards for unrestricted areas?

13. Describe the personnel structure of the Facility Emergency Organization.

I certify that I have been given instruction, have read, have understood, and have had the opportunity to discuss and ask questions about U.S. NRC Regulatory Guides 8.13 and 8.29 concerning respectively prenatal radiation exposure and risks from occupational radiation exposure.

Signature Date

Examination Score: (70% required)

Appendix E

Record of Occupational Personnel Exposure

The following table lists total annual personnel exposure for staff and students at the KSU Nuclear Reactor Facility.

Year	Not measurable	< 0.1 rem	0.1-0.5 rem	> 0.5 rem
1992	28	0	0	0
1991	23	0	0	0
1990	20	0	0	0
1989	19	1	0	0
1988	23	3	1	0
1987	23	0	0	0
1986	26	1	0	0
1985	31	8	0	0
1984	33	1	0	0
1983	29	2	0	0
1982	26	7	0	0
1981	11	23	0	0

Appendix F

Sample Forms For the Radiation Protection Program

Appendix F

Sample Forms For the Radiation Protection Program

BASEMENT EMERGENCY LOCKER INVENTORY

2 dosimeter charger
5 Gamma and X-Ray pocket dosimeters
* 0-5R (1)
* 0-200mR (3)
* 0-1000mR (1)
8 Civil Defense pocket dosimeters (0-200mR)
1 first aid kit
1 high volume air sampler with spare filters
1 high range gamma survey meter (Gadora)
1 low range beta/gamma survey meter (Civil Defense)
3 water sample bottles
1 Scott air pack with spare bottle
1 full face respirator with spare filters
respirator wipes and fit test ampules
2 dust masks with spare filters
6 cloth coveralls (4 min)
2 wetsuits (top and bottom with hood)
5 polylaminated coveralls with hood
10 paper lab coats
11 sets of papers-pant and shirt (4 min)
5 pair cloth booties (4 pr min)
5 pair PVC boots (4 pr min)
13 pair rubber gloves (8 pr min)and liners
12 paper coverall
21 pair low top booties (8 pr min)
20 pair high top booties (8 pr min)
4 rolls radiation hazard tape (2 min)
1 large roll radiation tape (cloth)
plastic bags, radiation rope, signs and warning labels
2 boxes swipes (#1 Filter Paper)
1 blanket
1 disposable blanket
1 clipboard with pen
1 copy of emergency plan

MAIN FLOOR EMERGENCY LOCKER INVENTORY

2 dosimeter charger
4 Gamma and X-Ray pocket dosimeters
* 0-5R (1)
* 0-1R (1)
* 0-200mR (2)
8 Civil Defense pocket dosimeters (0-200mR)
1 full face respirator with spare filters
respirator wipes and fit test ampules
1 dust mask with spare filters
2 cloth coveralls (2 min)
16 pair high top booties (4 pr min)
15 pair low top booties (4 pr min)
6 paper pants (2 min)
4 paper shirts (2 min)
1 wet suit (top and bottom with hood)
3 polylaminated coveralls with hood
9 disposable coveralls
3 pair PVC boots
12 pair rubber gloves (4 pr min)12 pair glove liners
2 rolls tape
plastic bags, radiation rope, signs and warning labels
2 boxes swipes (#1 filter paper)
1 copy emergency plan
1 disposable blanket
1 First Aid Kit

Illustration F-17. Emergency Locker Contents

	$\dot{x}$(mR/h)	Mass(g)	Uncorrected Activity (Bq)	$G_1(a,b)$	Corrected Activity (μCi)
Bag #1	0.7	8618	57 914	0.2534	6.2
Bag #2	0.13	8618	10 755	1.2534	1.2
Bag #3	0.25	7711	18 506	0.2268	2.2
Bag #4	0.12	9978	11 495	0.2936	1.1
Bag #5	1.20	6350	73 154	0.1868	10.3

Attenuation coefficients and activity calculations assumed Co-60 was the main radioactive isotope.

Original signed by:
Matthew J. Burger
Reactor Supervisor

Radiation Protection Program Audit
KSU TRIGA MkII Nuclear Reactor Facility

Period audited _____ Auditor: _____

1. Instrument calibration and surveillance performance and recordkeeping

Action & Interval	Latest	Prior Action	Comment
Monthly			
1. Wipe tests			
2. Liquids anal..			
3. Occ. exp. records			
Quarterly			
1. Hand dose records			
Semiannually			
1. Survey inst. calib.			
2. SRPD calibration			

2. Personnel exposures review and recordkeeping.

Type of exposure	Checked	Comments
Monthly occupational		
Quarterly occupational		
SRPD (public/occupational)		

3. Planned special exposures and ALARA reviews.

Activity	Circumstances/Comments
Planned special exposures	
ALARA revues	

Illustration F-16. Radiation Protection Program audit form

Next, these activities can be corrected for self shielding using the factor $G_1(a,b)$ {See Proc. #22 for details}.

The value for $G_1(a,b)$ is the same for all of the containers. The height and radius of the containers were taken to be equal as $R = H = (V/\pi)^{1/3}$ as the drums were of an irregular shape. Values of (μ'/ρ) were taken for Co-60 energy γ-rays as it was the main radioactive isotope.

From this information we find:

$$a = b = \rho(\mu'/\rho)R = \rho(\mu'/\rho)H = 0.7275$$

Now we can find:

$$G_1(a,b) = b\tan^{-1}\left(\frac{b}{a}\right) + \frac{a}{2}\ln\left(1 + \frac{b^2}{a^2}\right)$$

or,

$$G_1(a,b) = 0.7275\tan^{-1}(1) + \frac{0.7275}{2}\ln(2) = \underline{0.8235}$$

This factor can now be used to correct for container self-absorption. $A = A'/G_1(a,b)$. Thus, we arrive at our final estimate of activity.

	Activity (Bq)	Activity (μCi)
Drum #1	826, 239	22.3
Drum #2	275, 413	7.4
Drum #3	183, 609	5.0
Drum #5	183, 609	5.0

II. Activity of Baleable Waste

Along with the resin 5 bags of baleable waste from the 22' level was transferred. This waste is composed of rubber gloves, kim wipes, tape, absorbent paper, and other miscellaneous wastes. In all cases the volume of the bags (after they were put through a compactor) was 40 115 cm^3. Due to their irregular shape $R = H = (V/\pi)^{1/3} = 23.4$ cm. Each bag was weighed individually thus we have 5 different densities and 5 different $G_1(a,b)$ values. Instead of showing the calculations in detail the table below is a summary.

Radioactive Material Transfer

Reactor Facility to University Radiation Safety Office

25 March 1992

On 3/25/92 four 50-gallon drums of used ion exchange resin and five 9 x 16 x 17 inch bags of dry baleable waste was transferred from the reactor facility to the control of the Radiation Safety Officer.

The activities of the waste being transferred was calculated using the guidelines of procedure No. 22.

I. Activity of Used Ion Exchange Resin

Attached to this report are γ-ray spectra of the 4 drums of resin transferred. These spectra show that the main isotope present is Co-60. The highest exposure rates achieved on contact with the side of each drum is as follows:

	Exp. rate
Drum #1	0.9 mR/h
Drum #2	0.3 mR/h
Drum #3	0.2 mR/h
Drum #5	0.2 mR/h

Note: Drum #4 is still being stored in the source cave at the reactor facility.

The mass of each container was approximately the same and due to the difficulty of moving the containers only one was weighed. The weights of the other drums is assumed to be equal. Drum mass = 78,751 g. The volume of the drums was 50 gallon or 189,272 cm^3. This yields a density of 0.4161 g/cm^3.

Using Procedure #22 we now find the uncorrected activity as A' = 24 $\dot{x}$/NE (See Proc. #22 for details).

	A'
Drum #1	680 408 Bq
Drum #2	226 803 Bq
Drum #3	151 202 Bq
Drum #5	151 202 Bq

Illustration F-15. Sample report on solid-waste activity

Radioactive Material Released to Radiation Safety Office
Master Log Sheet

Date of Transfer 3/25/92

Description of Material (Comments)	Isotopes Est. Activity	Received by
1 - 50 gallon drum of used Ion Exchange Resin Drum #1	22.3 μCi Co-60	R.L. Bridges
1 - 50 gallon drum of used Ion Exchange Resin Drum #2	7.4 μCi Co-60	R.L. Bridges
1 - 50 gallon drum of used Ion Exchange Resin Drum #3	5.0 μCi Co-60	R.L. Bridges
1 - 50 gallon drum of used Ion Exchange Resin Drum #4 #5	5.0 μCi Co-60	R.L. Bridges
1 Bag (2500 in^3) of dry waste (gloves, Kim wipes, tape, etc.) Bag #1	6.2 μCi Co-60	R.L. Bridges
1 Bag (2500 in^3) of dry waste Bag #2	1.2 μCi Co-60	R.L. Bridges
1 Bag (2500 in^3) of dry waste Bag #3	2.2 μCi Co-60	R.L. Bridges
1 Bag (2500 in^3) of dry waste Bag #4	1.1 μCi Co-60	R.L. Bridges
1 Bag (2500 in^3) of dry waste Bag #5	10.6 μCi Co-60	R.L. Bridges

Released By Matt Burger
KSUTMII SRO

Received By John P. Humbert
KSU RSO

NOTE: Activities were calculated using the guidelines from Procedure #22. Co-60 was assumed to be the main product in both the resin and dry waste. Attached pages show Y-survey of resin and the calculations performed to arrive at the above activities. Matt Burger, Reactor Supervisor

Illustration F-14. Sample log for solids tranfer to University Radiation Safety Office

Radioactive Material Release to Sewerage
Master Log Sheet

Date	Isotope	Concentrations			Water Volume Released (mℓ)	Total Activity Released (μci)	Released By	Comments[d]
		Alpha[a]	Beta[b]	Gamma[c]				
4/2/87	^3H	≤ Bkg	1.5×10^{-9} μCi/mℓ	≤ Bkg	2.7×10^{6}	401	JH	JACK HICKENBOTTOM
6/30/87	^3H	≤ Bkg	2.8×10^{-9} μCi/mℓ	≤ Bkg	3.3×10^{6}	920	GLD	JEFF DANIELS
8/16/87	^3H	≤ Bkg	2.5×10^{-9} μCi/mℓ	≤ Bkg	1.67×10^{6}	418	GLD	
8/17/87	^3H	≤ Bkg	2.5×10^{-9} μCi/mℓ	≤ Bkg	1.88×10^{6}	469	GLD	continuation from 8/16/87
7/12/88	^3H	≤ Bkg	7.6×10^{-6} μCi/mℓ	≤ Bkg	9.09×10^{5}	69	GLD	
7/13/88	^3H	≤ Bkg	7.6×10^{-6} μCi/mℓ	≤ Bkg	2.40×10^{6}	183	GLD	continuation from 7/12/88
7/19/88	^3H	≤ Bkg	7.6×10^{-6} μCi/mℓ	≤ Bkg	1.41×10^{6}	107	GLD	continuation from 7/12/88
8/26/88 7/26/88	^3H	≤ Bkg	1.3×10^{-9} μCi/mℓ	≤ Bkg	1.06×10^{6}	138	GLD	
7/27/88 7/27/88	^3H	≤ Bkg	1.3×10^{-9} μCi/mℓ	≤ Bkg	1.17×10^{6}	154	GLD	continuation from 7/26/88
8/28/88 7/26/88	^3H	≤ Bkg	1.3×10^{-9} μCi/mℓ	≤ Bkg	2.11×10^{6}	276	GLD	continuation from 8/26/88
12/21/88	^3H	≤ Bkg	1.77×10^{-9} μCi/mℓ	≤ Bkg	2.81×10^{6}	498	GLD	
3/24/89	^3H	≤ Bkg	9.67×10^{-5} μCi/mℓ	≤ Bkg	1.38×10^{6}	133	JW	
3/27/89	^3H	≤ Bkg	3.49×10^{-5} μCi/mℓ	≤ Bkg	4.88×10^{6}	171	JW	continuation from 3/24/89
4/13/89	None detectable	≤ Bkg	≤ Bkg	≤ Bkg	5.86×10^{5}	≤ Bkg	GLD	
4/14/89	None detectable	≤ Bkg	≤ Bkg	≤ Bkg	3.11×10^{6}	≤ Bkg	GLD	continuation from 4/13/89
7/24/89	^3H	≤ Bkg	1.55×10^{-9} μCi/mℓ	≤ Bkg	9.97×10^{5}	155	JW	
7/25/89	^3H	≤ Bkg	1.55×10^{-9} μCi/mℓ	≤ Bkg	2.52×10^{6}	391	JW	Continuation from 7/24/89

[a]Procedure No. 21 [b]Procedure No. 20 [c]Procedure No. 19 [d]Record any dilution factor required

JW = DAVID T. WHITFILL

Illustration F-13. Sample log for liquid releases to sewerage system

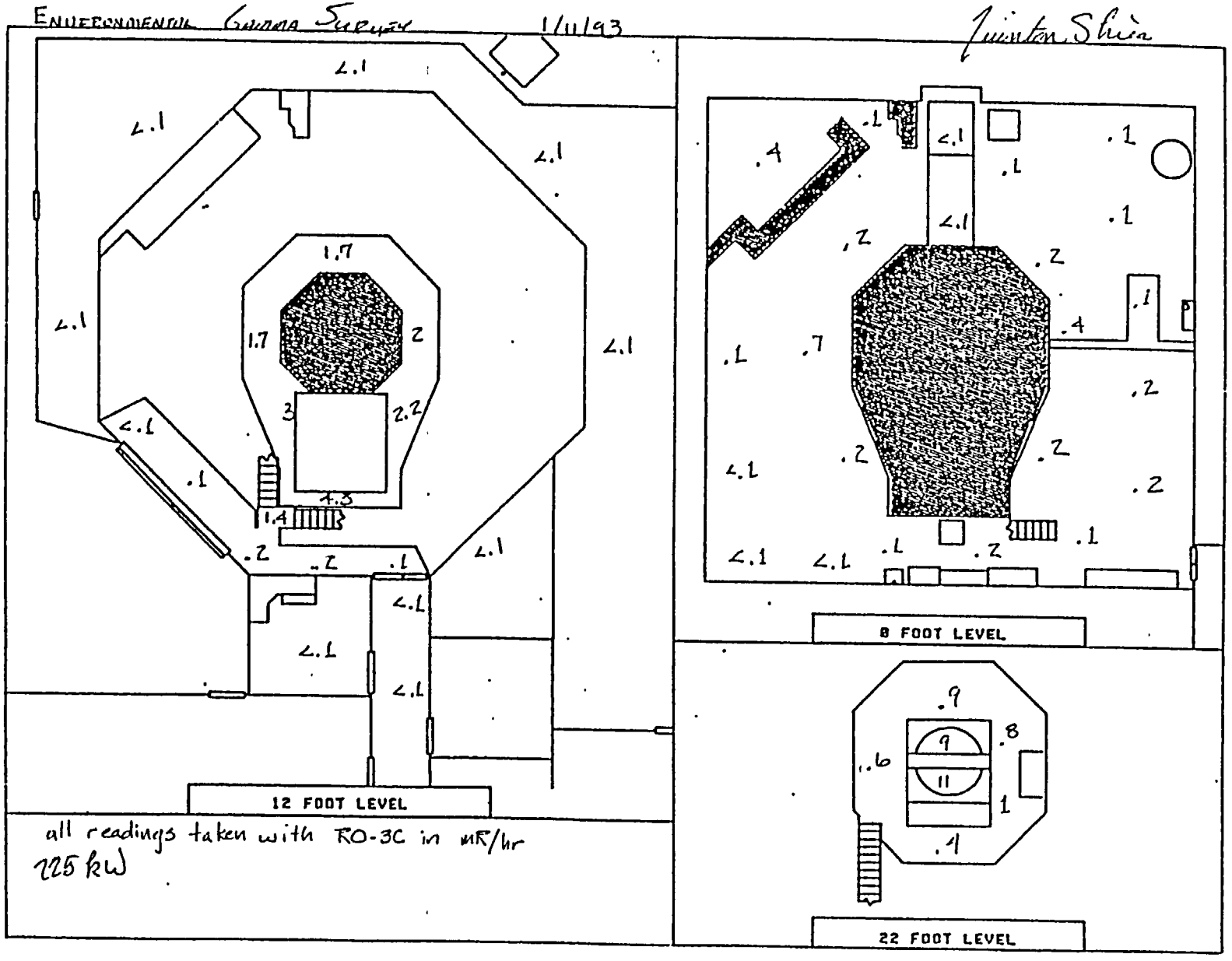

Illustration F-12. Sample semi-annual gamma-ray environs monitoring (225 kW)

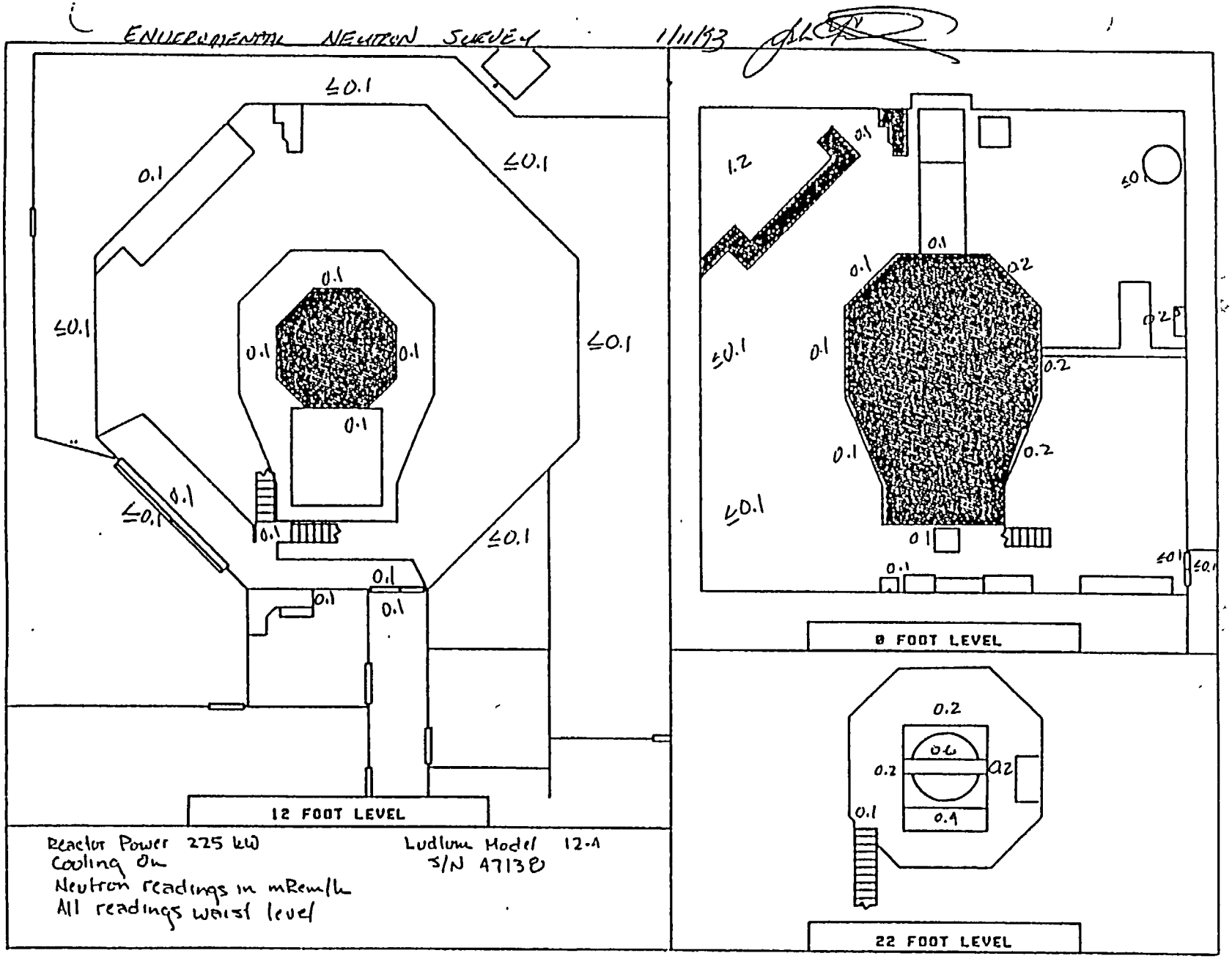

Illustration F-11. Sample semi-annual neutron environs monitoring (225 kW)

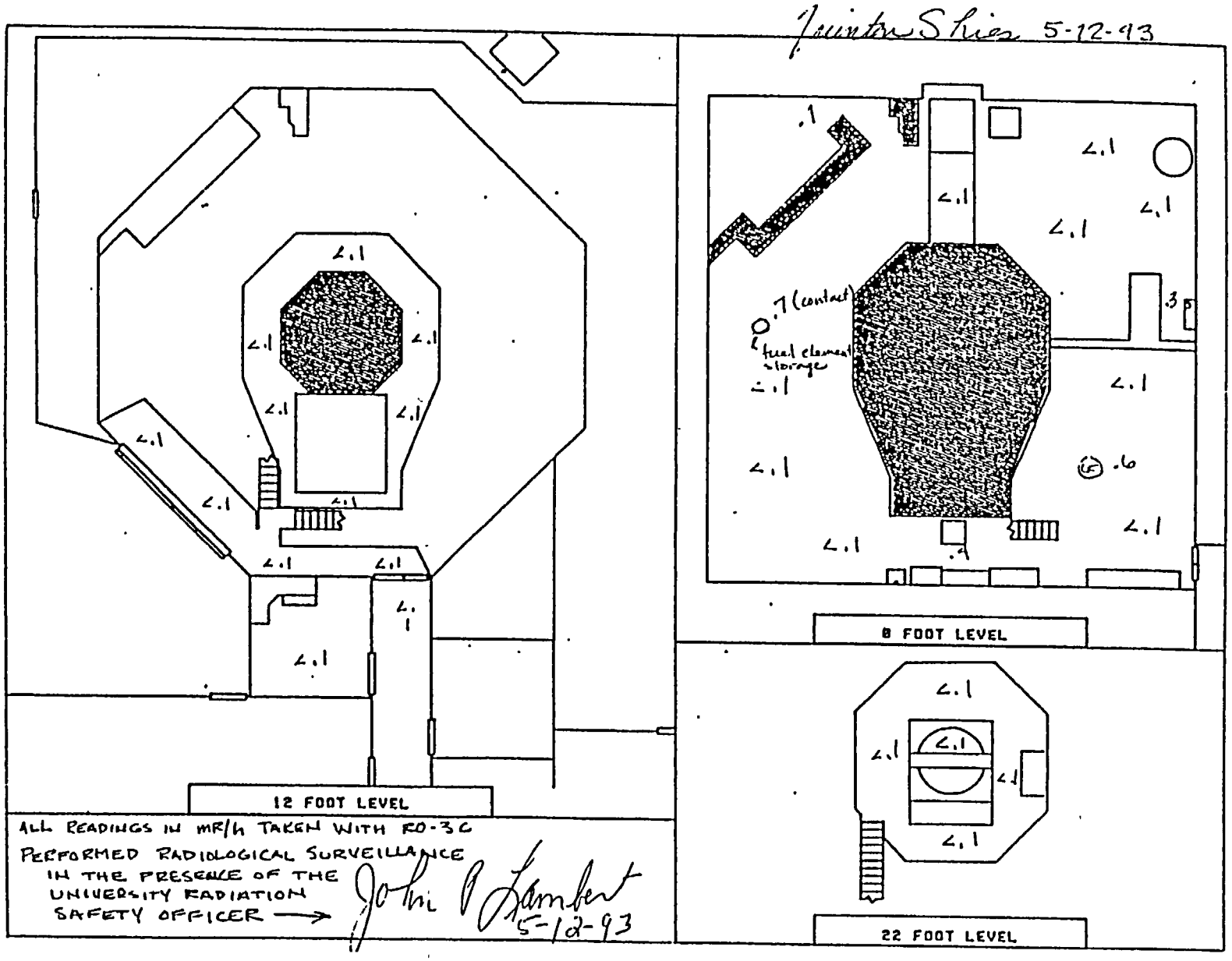

Illustration F-10. Sample monthly gamma-ray environs monitoring (zero power)

KSUTMII
SWIPE SURVEY

DATE: 5/12/93 OUTPUT FILE: may93.swp

Sample Location	Swipe #	Activity (pCi above background)	Remarks
01. Tap water (BKG)	301	<BKG	
02. Control room	302	<BKG	
03. 12' door handle	303	<BKG	
04. 12' level	304	<BKG	
05. BST Water	305	33.597537 EFF= .42903188	
06. 21' level	306	<BKG	
07. Sample table	307	<BKG	
08. RSR loading port	308	<BKG	
09. CT loading port	309	<BKG	
10. Primary water	310	1230.3079 EFF= .43312968	
11. 0' level	311	<BKG	
12. D20 Calibrator	312	<BKG	
13. 0'door handle	313	<BKG	
14. Distilled water	314	<BKG	
15. Ion exchanger	315	<BKG	
16. 0' secondary water	316	<BKG	
17. Source cave	317	<BKG	
18. 0' sink	318	<BKG	
19. Safe (floor)	319	<BKG	

NOTE: All water samples are 1 ml; all swipes approximately 100 sq.cm.
COMMENTS:

Completed: Winston Shaw 5/12/93
Signature Date

Illustration F-9. Sample monthly swipe survey

Revised 6/91

POCKET DOSIMETER CALIBRATION RECORD

		TRANSIENT MOVEMENT TEST				LEAKAGE TEST					
		Reading				Initial		Final			
Date	Check by	On charger	Off Charger	% Deviation	Pass/Fail[1]	Reading	Time	Reading	Time	% Deviation	Pass/Fail[2]
6/14/91	[illegible]	39	43	2.0	Pass	48	0801 6/13/91	48	0810 6/17/91	0.0	Pass
12/16/91	[illegible]	40	47	3.5	Pass	47	0831 12/16/91	48	0853 12/17/91	0.5	Pass
6/1/92	[illegible]	20	27	3.5	Pass	27	1106 6/1/92	27	1136 6/2/92	0.0	Pass
12/3/92	[illegible]	20	26	3.0	Pass	26	0940 12/3/92	25	0857 12/7/92	0.5	Pass

CALIBRATION TEST

Date	Calib. By	Source	Exposure Rate	Time Of Exposure	Calculated Exposure	Final Reading	Initial Reading	Measurement Reading	% Deviation	Pass/Fail[3]
6/20/91	[illegible]	Cs-137	1.634755	80	130.7804	155	38	117	6.9	Pass
12/17/91	[illegible]	Cs-137	1.510487	90	135.944	170	35	135	0.5	Pass
6/2/92	[illegible]	Cs-137	1.5332	90	138	160	27	133	2.5	Pass
12/7/92	[illegible]	Cs-137	1.579	90	142	155	25	130	6.0	Pass

[1] Not to exceed ±5% scale (dosimeter ≤300 mR)
Not to exceed ±2% scale (dosimeter ≥500 mR)

[2] Not to exceed ±2% scale in 24 hours

[3] Not to exceed ±10%

Instrument No: 2 0-200 mrad n,Y

Serial No: 0100021

Illustration F-8. Sample pocket Dosimeter calibration record

Revised 10/86

PORTABLE RADIATION SURVEY INSTRUMENT CALIBRATION RECORD

Date	Source	Calib. By		RANGE 5000	500	500	50	50	5	5			COMMENTS
6/24/91	S-467 Tech Ops Calib Device Cs-137	Burger	Exp. Rate	1130	384.8	96.21	38.48	9.621	3.848	0.9621			One point Calib on 5000 scale
			Reading	1200	390	105	41.5	10	4	1			
1/3/91	S-467 TECH OPS CALIB DEV Cs-137	RYAN LIFS	Exp. Rate	1520	380.2	96.05	42.2	10.501	4.22	.95			1 PT ON x5000 SCALE
			Reading	1520	380	97	42	10.5	4.2	1.2			
6/15/90	S-467 Tech Ops Calib Device Cs-137	Ryan Kirkland	Exp. Rate	1505	376	94	42	10.5	4.2	1			1 pt on x5000
			Reading	1500	375	95	42	10.5	4.2	1			
12/29/92	S-467 TECH OPS CALIB DEV Cs-137	RYAN HOCKADO	Exp. Rate	1487	372	92.9	41.3	10.3	4.13	1.03			1 point on x5000
			Reading	1500	375	95	41.2	10.5	4.15	1.01			
			Exp. Rate										
			Reading										
			Exp. Rate										
			Reading										
			Exp. Rate										
			Reading										
			Exp. Rate										
			Reading										

Instrument: RO-3C Ion Chamber

Serial No: 814

Illustration F-7. Sample survey instrument calibration record

6 Columns Right

	DATE	NAME	1 SCOPE NO.	2 TIME IN	3 READING IN	4 TIME OUT	5 READING OUT	6 AUTHORIZATION	
1	6-2-88	Russell Johnson	6	1010	15	1029	14		
2	6/2 88	Mark Hartman	16	10 10	12	1029	12		
3	6/3/88	Debbie Hillman	13	1346	11	1356	11		
4	6/3/88	Deanna Howard	7	1346	16	1356	16		
5	6/3/88	Kimberly Satterlee	11	1346	12	1356	12		
6	6/3/88	Tim Talbot	2	1346	10	1356	10		
7	6/3/88	Danielle Crandell	15	1346	10	1356	10		
8	6/3/88	[illegible]	5	1346	16	1356	18		
9	6/3/88	Matt McEwan	8	1346	17	1356	12		
10	6/3/88	Kobe Ericson	15	1357	10	1413	10		
11	6/3/88	Michael Hogan	8	1357	12	1414	12		
12	6/3/88	De Duthey	13	1357	11	1414	11		
13	6/3/88	Tha Pool	6	1357	18	1413	18		
14	6-3-88	Tha Poole & D Hinkle	16	1357	12	1413	12		
15	6-3-88	Terre Carmen	17	1357	18	1413	18		
16	6-3-88	Brady Bedenbach	2	1357	10	1413	10		
17	6-3-88	Sara Dahlsten	8	1414	12	1425	12		
18	6-3-88	Shary Day	13	1414	12	1425	11		
19	6-3-88	Cli [illegible]	6	1414	18	1425	16		
20	6-3-88	Mik Smith	17	1414	18	1426	17		
21	6-3-88	[illegible]	16	1414	12	1425	12		
22	6-3-88	[illegible]	9	1414	10	1425	16		
23	6-3-88	Cynthia Powell	6	1458	18	1507	18		
24	6 3 4	[illegible]	8	1458	18	1507	15		
25	6-3 88	Jeanne Langley	15	1458	11	1507	11		
26	6-3 88	[illegible]	5	1458	18	1507	15		
27	6-3 88	[illegible]	16	1458	16	1507	16		
28	6-3 88	Kristine LeBlanc	13	1458	12	1507	12		
29	6-3-88	Dave Rinz	2	1458	11	1507	11		
30	6-3-88	Scott McVay	19	1508	11	1518	11		
31	6-3-88	Jackie Jeschke	7	1508	18	1518	18		
32	6-3-88	Ray Sisto	16	1508	16	1518	16		
33	6-3-88	Frank McCleary	6	1508	18	1518	18		
34	6-3-88	Joe Dodd	2	1508	[illegible]	1518	11		
35	6-3-88	David Nielsen	13	1508	12	1518	12		
36	6-3-88	Carl Jorgensen	18	1508	12	1518	12		
37	6-3-88	Marsha Sullivan	13	1520	12	[illegible]	11		
38	6-3-88	Leslie Harshaw	2	1520	11	[illegible]	12		
39	6-3-88	[illegible]	15	1520	10	[illegible]	12		
40	6/9/88	Carol DeWeese	6	1150	20	1211	20		
41	6/9/88	Susan Dangler	4	1150	18	1211	18		
42	6/9/88	Mat Burger	13	1140	15	1211	15		

Illustration F-6. Sample page from self-reading personnel dosimeter log

ACCOUNT NO

CILITY: 72017
ATTN: RONALD BRIDGES
KANSAS STATE UNIVERSITY
DEPT OF PUBLIC SAFETY
WARD HALL
MANHATTEN KS 66506

ICN DOSIMETRY SERVICE
DIVISION OF ICN BIOMEDICALS, INC
P O BOX 19536
IRVINE CALIFORNIA 92713
TELEPHONE 1-800 251 3331

RADIATION EXPOSURE REPORT

PLEASE NOTE

DATE BADGES RECEIVED:	04/13/93			
DATE REPORT PREPARED:	04/22/93			
CALENDAR QUARTERS:				NO OF SCHEDULED SHIPMENTS
1st	JAN 01	TO	MAR 31	1
2nd	APR 01	TO	JUN 30	1
3rd	JUL 01	TO	SEP 30	1
4th	OCT 01	TO	DEC 31	1
EXPOSURE PERIOD	QUARTERLY			

TOTAL PG 1 OF 1

BADGE IDENTIFICATION							CURRENT EXPOSURE IN MILIREMS FOR PERIOD(S) INDICATED BELOW *						CUMULATIVE EXPOSURE IN MILIREMS							
													QUARTER TO DATE			YEAR TO DATE		LIFETIME		INCEPTION DATE OF PERMANENT TOTAL
PROCESS NUMBER	ASSIGNED BADGE NUMBER	LOCATION NUMBER	SLOT NUMBER	NAME OR OTHER DESIGNATION	SOCIAL SECURITY NUMBER	BIRTH DATE	SEX	BODY	1ST DAY OF EXPOSURE PERIOD	DEEP	SHALLOW	NEUTRON	NOTE	DEEP	SHALLOW	BADGES RECD	DEEP	SHALLOW	DEEP	SHALLOW	MO	YR
C860			CTRL	BADGE - TLD					01 01 93													
C[illegible]			CTRL	BADGE - TLD					03 01 93													
C860	1			BRUYETTE D		09-15-57		B	01 01 93	*	*				0	1	1	0	0	0	08	92
C860	2			BURGER M(R)		11-13-67		B	01 01 93	*	*				0	1	1	0	44	0	08	92
C860	3			BURGER M(L)		11-13-67		B	01 01 93	*	*				0	1	1	0	54	0	08	92
C860	4			CURTIS J(R)		01-08-68		B	01 01 93	*	45				45	1	1	45	91	0	08	92
C860	5			CURTIS J(L)		01-08-68		B	01 01 93	*	76				76	1	1	76	132	0	08	92
C860	6			FUNK J		02-02-60		B	01 01 93	*	19				19	1	1	19	70	0	08	92
C860	7			GRELK B (R)		10-05-63		B	01 01 93	*	*				0	1	1	0	32	0	08	92
C860	8			GRELK B (L)		10-05-63		B	01 01 93	*	*				0	1	1	0	30	0	08	92
C860	9			HOSKINSON J		01-23-61		B	01 01 93	*	44				44	1	1	44	92	0	08	92
C860	10			KIRKLAND J (R)		10-05-63		B	01 01 93	*	17				17	1	1	17	87	0	08	92
C860	11			KIRKLAND J (L)		10-05-63		B	01 01 93	*	52				52	1	1	52	111	0	08	92
C860	13			LIES G (R)		09-13-70		B	01 01 93	*	*				0	1	1	0	47	0	08	92
C860	14			LIES G (L)		09-13-70		B	01 01 93	*	*				0	1	1	0	39	0	08	92
C860	15			NELSON N		02-09-61		B	01 01 93	*	42				42	1	1	42	105	0	08	92
C860	16			RAY B C		09-07-67		B	01 01 93	*	*		U		0	1	1	0	183	0	08	92
C860	17			REICHWEIN M (R)		02-12-58		B	01 01 93	*	*				0	1	1	0	44	0	08	92
C860	18			REICHWEIN M (L)		02-12-58		B	01 01 93	*	*				0	1	1	0	42	0	08	92
C860	19			REINHART B		01-23-69		B	01 01 93	*	*				0	1	1	0	40	0	08	92
C860	20			RYAN B (R)		02-12-58		B	01 01 93	*	*				0	1	1	0	40	0	08	92
C860	21			RYAN B (L)		02-12-58		B	01 01 93	*	29				29	1	1	29	112	0	08	92
C860	22			SCHAWE B(R)		09-20-69		B	01 01 93	*	*				0	1	1	0	41	0	08	92
C860	23			SCHAWE B(L)		09-20-69		B	01 01 93	*	*				0	1	1	0	81	0	08	92
C860	24			WILSON FRED		12-23-37		B	01 01 93	*	*				0	1	1	0	34	0	08	92
C860	25			ZAMANI H		05-18-54		B	01 01 93	*	*				0	1	1	0	51	0	08	92
CP[illegible]	27			HUFF A		07-22-71	M	B	01 01 93	*	*				0	1	1	0	0	12	92	
C[illegible]	28			BENORDEN A		11-29-67	F	B	03 01 93	*	*				0	1	1	0	0	03	93	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23

COLUMN REFERENCE
SEE REVERSE SIDE FOR COMPLETE REPORT DETAILS BY COLUMN NUMBER

CODE FOR COLUMN 9 - BADGE TYPE
1 FILM BODY
2 FILM WRIST
3 TLD BODY
4 TLD-WRIST
5 FILM OTHER
6 FILM AREA
7 TLD-OTHER
8 TLD RING
9 TLD NEUTRON
10 TLD-AREA
11 FILM RIGHT WRIST
12 FILM-LEFT WRIST
13 TLD RIGHT WRIST
14 TLD-LEFT WRIST
15 TLD RIGHT RING
16 TLD LEFT RING

Illustration F-5. Typical quarterly report on extremity exposures

Nuclear Engineering Report of Film Badge Readings February 17, 1993

	ID Number	SS Number	Month of January	1st Quarter	Year 1993	Permanent
Burger, Matt	7		M	M	M	30
Curtis, John	14		M	M	M	M
Donnert, Herman	17		M	M	M	20
Eckhoff, Norman	18		M	M	M	2140
Faw, Richard	20		M	M	M	790
Grelk, Brian	26		M	M	M	10
Kirkland, John	38		M	M	M	30
Lies, Quinton	45		M	M	M	M
Reichwein, M.	56		M	M	M	M
Ryan, Brendan	60		M	M	M	M
Schawe, Barton	63		M	M	M	M
Shultis, John	64		M	M	M	670
Starr, William	65		M	M	M	150
Wilkinson, L.	71		M	M	M	M

- indicates no readings for that period
exposure in mRem
M is minimal (less than 15 mRem)

Illustration F-4. Typical monthly report for the Nuclear Reactor Facility

ACCOUNT NO:

FACILITY: 72005
ATTN: RONALD BRIDGES
KANSAS STATE UNIVERSITY
DEPT OF PUBLIC SAFETY
WARD HALL
MANHATTEN KS 66506

ICN DOSIMETRY SERVICE
DIVISION OF ICN BIOMEDICALS, INC
P O BOX 19536
IRVINE, CALIFORNIA 92713
TELEPHONE 1-800 251-3331

RADIATION EXPOSURE REPORT

PLEASE NOTE

DATE BADGES RECEIVED:	05/06/93			
DATE REPORT PREPARED	05/11/93			
CALENDAR QUARTERS				NO OF SCHEDULED SHIPMENTS
1st	JAN 01	TO	MAR 31	3
2nd	APR 01	TO	JUN 30	3
3rd	JUL 01	TO	SEP 30	3
4th	OCT 01	TO	DEC 31	3
EXPOSURE PERIOD:	MONTHLY			

BADGE IDENTIFICATION								CURRENT EXPOSURE IN MILIREMS FOR PERIOD(S) INDICATED BELOW					CUMULATIVE EXPOSURE IN MILIREMS									
													QUARTER TO DATE			YEAR TO DATE		LIFETIME		INCEPTION DATE OF PERMANENT TOTAL	
PROCESS NUMBER	ASSIGNED BADGE NUMBER	LOCATION NUMBER	SLOT NUMBER	NAME OR OTHER DESIGNATION	SOCIAL SECURITY NUMBER	BIRTH DATE	SEX	BADGE TYPE	1ST DAY OF EXPOSURE PERIOD	DEEP	SHALLOW	NEUTRON	NOTE	DEEP	SHALLOW	NO. PERIODS REPORTED	DEEP	SHALLOW	DEEP	SHALLOW	MO	YR
W861			CTRL	BADGE - TLD					040193												
W861	1			ALI R M **		04-27-64		9	040193	*	*	*		0	0	12	0	0	0	0	08	92
W861	2			BEN-ITZHAK I **		02-15-52		9	040193	*	*	*		0	0	12	0	0	20	20	08	92
W861	3			BEYER K W **		03-07-73		9	040193	*	*	*		0	0	12	0	0	0	0	08	92
W861	5			BRIDGES R L **		11-15-46		9	040193	*	*	*		0	0	12	0	0	0	0	08	92
W861	7			BURGER M J **		11-13-67		9	040193	*	*	*		0	0	12	0	0	0	0	08	92
W861	9			CARNES K D **		04-26-57		9	040193	*	*	*		0	0	12	0	0	0	0	08	92
W861	10			CHEN C Y **		01-16-65		9	040193	*	*	*		0	0	12	0	0	0	0	08	92
W861	12			COCKE C L **		12-24-40		9	040193	*	*	*		0	0	12	0	0	0	0	08	92
W861	13			CURNUTTE B **		03-01-23		9	040193	*	*	*		0	0	12	0	0	0	0	08	92
W861	14			CURTIS J H **		01-08-68		9	040193	*	*	*		0	0	12	0	0	0	0	08	92
W861	16			DEPAOLA B D **		03-30-55		9	040193	*	*	*		0	0	12	0	0	0	0	08	92
W861	17			DONNERT H J **		01-20-29		9	040193	*	*	*		0	0	12	0	0	0	0	08	92
W861	18			ECKOFF N D **		04-10-38		9	040193	*	*	*		0	0	12	0	0	0	0	08	92
W861	20			FAW R E **		06-22-36		9	040193	*	*	*		0	0	12	0	0	0	0	08	92
W861	21			FROHNE M V **		08-13-56		9	040193	*	*	*		0	0	12	0	0	0	0	08	92
W861	25			GRAY T J **		12-02-37		9	040193	*	*	*		0	0	12	0	0	0	0	08	92
W861	26			GRELK B J **		09-07-72		9	040193	*	*	*		0	0	12	21	21	21	21	08	92
W861	28			HAGMANN S **		09-04-48		9	040193	*	*	*		0	0	12	0	0	0	0	08	92
W861	30			HIDMI H **		07-03-59		9	040193	*	*	*		0	0	12	0	0	0	0	08	92
W861	33			HUANG M T **		07-26-65		9	040193	*	*	*		0	0	12	0	0	0	0	08	92
W861	34			HUANG X **		03-23-63		9	040193	*	*	*		0	0	12	0	0	0	0	08	92
W861	35			KELLY S C **		02-22-53		9	040193	*	*	*		0	0	12	0	0	0	0	08	92
W861	38			KIRKLAND J C **		10-05-63		9	040193	*	*	*		0	0	12	0	0	0	0	08	92
W861	40			KRAUSE R D **		10-02-46	M	9	040193	*	*	*		0	0	12	0	0	0	0	08	92
W861	41			LAMBERT J P **		02-04-33		9	040193	*	*	*		0	0	12	0	0	0	0	08	92
W861	42			LANDERS A L **		06-03-70		9	040193	*	*	*		0	0	12	0	0	0	0	08	92
W861	43			LEGG J C **		09-17-36		9	040193	*	*	*		0	0	12	0	0	0	0	08	92
W861	44			LIAO C **		06-25-64		9	040193	*	*	*		0	0	12	0	0	0	0	08	92
W861	45			LIES G S **		09-13-70		9	040193	*	*	*		0	0	12	0	0	0	0	08	92
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23

COLUMN REFERENCE
SEE REVERSE SIDE FOR COMPLETE REPORT DETAILS BY COLUMN NUMBER

CODE KEY: COLUMN 9 - BADGE TYPE

1 FILM BODY	3 TLD BODY	5 FILM-OTHER	7 TLD OTHER	9 TLD NEUTRON	11 FILM RIGHT WRIST	13 TLD RIGHT WRIST	15 TLD RIGHT RING
2 FILM WRIST	4 TLD WRIST	6 FILM AREA	8 TLD RING	10 TLD AREA	12 FILM-LEFT WRIST	14 TLD LEFT WRIST	16 TLD LEFT RING

Illustration F-3. Typical monthly report on occupational exposures (University wide)

INSTRUCTIONS AND ADDITIONAL INFORMATION PERTINENT TO THE COMPLETION OF NRC FORM 5

(All doses should be stated in rems)

1. Type or print the full name of the monitored individual in the order of last name (include "Jr," "Sr," "III," etc.), first name, middle initial (if applicable).

2. Enter the individual's identification number, including punctuation. This number should be the 9-digit social security number if at all possible. If the individual has no social security number, enter the number from another official identification such as a passport or work permit.

3 Enter the code for the type of identification used as shown below:

CODE	ID TYPE
SSN	U.S. Social Security Number
PPN	Passport Number
CSI	Canadian Social Insurance Number
WPN	Work Permit Number
IND	INDEX Identification Number
OTH	Other

4. Check the box that denotes the sex of the individual being monitored.

5. Enter the date of birth of the individual being monitored in the format MM/DD/YY.

6. Enter the monitoring period for which this report is filed. The format should be MM/DD/YY - MM/DD/YY.

7. Enter the name of the licensee.

8 Enter the NRC license number or numbers.

9A. Place an "X" in Record or Estimate Choose "Record" if the dose data listed represent a final determination of the dose received to the best of the licensee's knowledge. Choose "Estimate" only if the listed dose data are preliminary and will be superseded by a final determination resulting in a subsequent report. An example of such an instance would be dose data based on self-reading dosimeter results and the licensee intends to assign the record dose on the basis of TLD results that are not yet available.

9B Place an "X" in either Routine or PSE. Choose "Routine" if the data represent the results of monitoring for routine exposures. Choose "PSE" if the listed dose data represents the results of monitoring of planned special exposures received during the monitoring period. If more than one PSE was received in a single year, the licensee should sum them and report the total of all PSEs.

10A. Enter the symbol for each radionuclide that resulted in an internal exposure recorded for the individual, using the format "Xx-###x," for instance, Cs-137 or Tc-99m.

10B. Enter the lung clearance class as listed in Appendix B to 10 CFR Part 20 1001-2401 (D, W, Y, V, or O for other) for all intakes by inhalation.

10C. Enter the mode of intake. For inhalation, enter "H." For absorption through the skin, enter "B." For oral ingestion, enter "G." For injection, enter "J."

10D. Enter the intake of each radionuclide in μCi.

11. Enter the deep dose equivalent (DDE) to the whole body.

12. Enter the eye dose equivalent (LDE) recorded for the lens of the eye.

13. Enter the shallow dose equivalent recorded for the skin of the whole body (SDE,WB).

14. Enter the shallow dose equivalent recorded for the skin of the extremity receiving the maximum dose (SDE,ME).

15. Enter the committed effective dose equivalent (CEDE) or "NR" for "Not Required" or "NC" for "Not Calculated".

16. Enter the committed dose equivalent (CDE) recorded for the maximally exposed organ or "NR" for "Not Required" or "NC" for "Not Calculated".

17. Enter the total effective dose equivalent (TEDE). The TEDE is the sum of items 11 and 15.

18. Enter the total organ dose equivalent (TODE) for the maximally exposed organ. The TODE is the sum of items 11 and 16.

19. Signature of the person designated to represent the licensee.

20. Enter the date this form was prepared.

21. COMMENTS.
In the space provided, enter additional information that might be needed to determine compliance with limits. An example might be to enter the note that the SDE,ME was the result of exposure from a discrete hot particle. Another possibility would be to indicate that an overexposed report has been sent to NRC in reference to the exposure report.

PRIVACY ACT STATEMENT

Pursuant TO 5 U.S.C. 552a(e)(3), enacted into law by Section 3 of the Privacy Act of 1974 (Public Law 93 579), the following statement is furnished to individuals who supply information to the U S. Nuclear Regulatory Commission on NRC Form 5. This information is maintained in a system of records designated as NRC-27 and described at 55 Federal Register 33984 (August 20, 1990), or the most recent Federal Register publication of the Nuclear Regulatory Commission's "Republication of Systems of Records Notices" that is available at the NRC Public Document Room, Gelman Building, Lower Level, 2120 L Street NW, Washington, D C.

1. AUTHORITY: Sections 53, 63, 65, 81, 103, 104, 161(b), and 161(o) of the Atomic Energy Act of 1954, as amended (42 U S C. 2073, 2093, 2095, 2111, 2133, 2134, 2201(b), and 2201(o)) The authority for soliciting the social security number is 10 CFR Part 20

2. PRINCIPAL PURPOSE(S): The information is used by the NRC in its evaluation of the risk of radiation exposure associated with the licensed activity and in exercising its statutory responsibility to monitor and regulate the safety and health practices of its licensees The data permits a meaningful comparison of both current and long term exposure experience among types of licensees and among licensees within each type. Data on your exposure to radiation is available to you upon your request.

3. ROUTINE USE(S): The information may be used to provide data to other Federal and State agencies involved in monitoring and/or evaluating radiation exposure received by individuals employed as radiation workers on a permanent or temporary basis and exposure received by monitored visitors. The information may also be disclosed to an appropriate Federal, State, or local agency in the event the information indicates a violation or potential violation of law and in the course of an administrative or judicial proceeding.

4. WHETHER DISCLOSURE IS MANDATORY OR VOLUNTARY AND EFFECT ON INDIVIDUAL OF NOT PROVIDING INFORMATION: It is voluntary that you furnish the requested information, including social security number, however, the licensee must complete NRC Form 5 on each individual for whom personnel monitoring is required under 10 CFR 20 2106 Failure to do so may subject the licensee to enforcement action in accordance with 10 CFR 20 2401 The social security number is used to assure that NRC has an accurate identifier not subject to the coincidence of similar names or birthdates among the large number of persons on whom data is maintained

5. SYSTEM MANAGER(S) AND ADDRESS:
REIRS Project Manager
Office of Nuclear Regulatory Research
U S. Nuclear Regulatory Commission
Washington, DC 20555

Illustration F-2. Operational exposure record for a monitoring period (NRC form 5) [cont'd]

NRC FORM 5
(6-92)
10 CFR PART 20

U.S. NUCLEAR REGULATORY COMMISSION

OCCUPATIONAL EXPOSURE RECORD FOR A MONITORING PERIOD

APPROVED BY OMB NO. 3150-0006
EXPIRES:

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST: MINUTES. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (MNBB 7714), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0006), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503

1. NAME (LAST, FIRST, MIDDLE INITIAL)	2. IDENTIFICATION NUMBER	3. ID TYPE	4. SEX ☐ MALE ☐ FEMALE	5. DATE OF BIRTH

6. MONITORING PERIOD	7. LICENSEE NAME	8. LICENSE NUMBER(S)	9A.	9B.
			☐ RECORD	☐ ROUTINE
			☐ ESTIMATE	☐ PSE

INTAKES

10A. RADIONUCLIDE	10B. CLASS	10C. MODE	10D. INTAKE IN μCi

DOSES (in rem)

DEEP DOSE EQUIVALENT	(DDE)	11.
EYE DOSE EQUIVALENT TO THE LENS OF THE EYE	(LDE)	12.
SHALLOW DOSE EQUIVALENT, WHOLE BODY	(SDE,WB)	13
SHALLOW DOSE EQUIVALENT, MAX EXTREMITY	(SDE,ME)	14.
COMMITTED EFFECTIVE DOSE EQUIVALENT	(CEDE)	15.
COMMITTED DOSE EQUIVALENT, MAXIMALLY EXPOSED ORGAN	(CDE)	16.
TOTAL EFFECTIVE DOSE EQUIVALENT *(BLOCKS 11 + 15)*	*(TEDE)*	17.
TOTAL ORGAN DOSE EQUIVALENT, MAX ORGAN *(BLOCKS 11 + 16)*	*(TODE)*	18.

19. COMMENTS

20 SIGNATURE -- LICENSEE

21. DATE PREPARED

Illustration F-2. Operational exposure record for a monitoring period (NRC form 5)

NRC FORM 5 (6-92)

INSTRUCTIONS AND ADDITIONAL INFORMATION PERTINENT TO THE COMPLETION OF NRC FORM 4

(All doses should be stated in rems)

1. Type or print the full name of the monitored individual in the order of last name (include "Jr," "Sr," "III," etc), first name, middle initial (if applicable).

2. Enter the individual's identification number, including punctuation. This number should be the 9-digit social security number if at all possible. If the individual has no social security number, enter the number from another official identification such as a passport or work permit.

3. Enter the code for the type of identification used as shown below:

CODE	ID TYPE
SSN	U S. Social Security Number
PPN	Passport Number
CSI	Canadian Social Insurance Number
WPN	Work Permit Number
IND	INDEX Identification Number
OTH	Other

4. Check the box that denotes the sex of the individual being monitored.

5. Enter the date of birth of the individual being monitored in the format MM/DD/YY.

6. Enter the monitoring period for which this report is filed. The format should be MM/DD/YY - MM/DD/YY.

7. Enter the name of the licensee or facility not licensed by NRC that provided monitoring.

8. Enter the NRC license number or numbers.

9. Place an "X" in Record, Estimate, or No Record. Choose "Record" if the dose data listed represent a final determination of the dose received to the best of the licensee's knowledge. Choose "Estimate" only if the listed dose data are preliminary and will be superseded by a final determination resulting in a subsequent report. An example of such an instance would be dose data based on self-reading dosimeter results and the licensee intends to assign the record dose on the basis of TLD results that are not yet available.

10. Place an "X" in either Routine or PSE Choose "Routine" if the data represent the results of monitoring for routine exposures. Choose "PSE" if the listed dose data represents the results of monitoring of planned special exposures received during the monitoring period. If more than one PSE was received in a single year, the licensee should sum them and report the total of all PSEs.

11. Enter the deep dose equivalent (DDE) to the whole body.

12. Enter the eye dose equivalent (LDE) recorded for the lens of the eye.

13. Enter the shallow dose equivalent recorded for the skin of the whole body (SDE,WB).

14. Enter the shallow dose equivalent recorded for the skin of the extremity receiving the maximum dose (SDE,ME).

15. Enter the committed effective dose equivalent (CEDE).

16. Enter the committed dose equivalent (CDE) recorded for the maximally exposed organ.

17. Enter the total effective dose equivalent (TEDE). The TEDE is the sum of Items 11 and 15.

18. Enter the total organ dose equivalent (TODE) for the maximally exposed organ The TODE is the sum of Items 11 and 16.

19. Signature of the monitored individual. The signature of the monitored individual on this form indicates that the information contained on the form is complete and correct to the best of his or her knowledge.

20. Enter the date this form was signed by the monitored individual.

21. [OPTIONAL] Enter the name of the licensee or facility not licensed by NRC, providing monitoring for exposure to radiation (such as a DOE facility) or the employer if the individual is not employed by the licensee and the employer chooses to maintain exposure records for its employees.

22. [OPTIONAL] Signature of the person designated to represent the licensee or employer entered in Item 21. The licensee or employer who chooses to countersign the form should have on file documentation of all the information on the NRC Form 4 being signed.

23 [OPTIONAL] Enter the date this form was signed by the designated representative.

PRIVACY ACT STATEMENT

Pursuant TO 5 U S C. 552a(e)(3), enacted into law by Section 3 of the Privacy Act of 1974 (Public Law 93-579), the following statement is furnished to individuals who supply information to the U.S. Nuclear Regulatory Commission on NRC Form 4. This information is maintained in a system of records designated as NRC-27 and described at 55 Federal Register 33984 (August 20, 1990), or the most recent Federal Register publication of the Nuclear Regulatory Commission's "Republication of Systems of Records Notices" that is available at the NRC Public Document Room, Gelman Building, Lower Level, 2120 L Street NW, Washington, D C.

1. **AUTHORITY:** Sections 53, 63, 65, 81, 103, 104, 161(b), and 161(o) of the Atomic Energy Act of 1954, as amended (42 U.S C 2073, 2093, 2095, 2111, 2133, 2134, 2201(b), and 2201(o)). The authority for soliciting the social security number is 10 CFR Part 20.

2. **PRINCIPAL PURPOSE(S):** The information is used by the NRC in its evaluation of the risk of radiation exposure associated with the licensed activity and in exercising its statutory responsibility to monitor and regulate the safety and health practices of its licensees. The data permits a meaningful comparison of both current and long term exposure experience among types of licensees and among licensees within each type Data on your exposure to radiation is available to you upon your request.

3. **ROUTINE USE(S):** The information may be used to provide data to other Federal and State agencies involved in monitoring and/or evaluating radiation exposure received by individuals employed as radiation workers on a permanent or temporary basis and exposure received by monitored visitors The information may also be disclosed to an appropriate Federal, State, or local agency in the event the information indicates a violation or potential violation of law and in the course of an administrative or judicial proceeding

4. **WHETHER DISCLOSURE IS MANDATORY OR VOLUNTARY AND EFFECT ON INDIVIDUAL OF NOT PROVIDING INFORMATION:** It is voluntary that you furnish the requested information, including social security number; however, the licensee must complete NRC Form 5 on each individual for whom personnel monitoring is required under 10 CFR 20 2106 Failure to do so may subject the licensee to enforcement action in accordance with 10 CFR 20 2401 The social security number is used to assure that NRC has an accurate identifier not subject to the coincidence of similar names or birthdates among the large number of persons on whom data is maintained.

5. **SYSTEM MANAGER(S) AND ADDRESS:**
REIRS Project Manager
Office of Nuclear Regulatory Research
U S. Nuclear Regulatory Commission
Washington, DC 20555

Illustration F-1. Cumulative occupational exposure history (NRC Form 4) [continued]

PAGE ____ OF ____

NRC FORM 4
(8-92)
10 CFR PART 20

U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0005
EXPIRES:

CUMULATIVE OCCUPATIONAL EXPOSURE HISTORY

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST: MINUTES. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (MNBB 7714), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0005), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

1. NAME (LAST, FIRST, MIDDLE INITIAL)	2. IDENTIFICATION NUMBER	3. ID TYPE	4. SEX: MALE ☐ FEMALE ☐	5. DATE OF BIRTH

6. MONITORING PERIOD		7. LICENSEE NAME		8. LICENSE NUMBER		9. RECORD ☐ ESTIMATE ☐ NO RECORD ☐	10. ROUTINE ☐ PSE ☐
11. DDE	12. LDE	13. SDE, WB	14. SDE, ME	15. CEDE	16. CDE	17. TEDE	18. TODE
6. MONITORING PERIOD		7. LICENSEE NAME		8. LICENSE NUMBER		9. RECORD ☐ ESTIMATE ☐ NO RECORD ☐	10. ROUTINE ☐ PSE ☐
11. DDE	12. LDE	13. SDE, WB	14. SDE, ME	15. CEDE	16. CDE	17. TEDE	18. TODE
6. MONITORING PERIOD		7. LICENSEE NAME		8. LICENSE NUMBER		9. RECORD ☐ ESTIMATE ☐ NO RECORD ☐	10. ROUTINE ☐ PSE ☐
11. DDE	12. LDE	13. SDE, WB	14. SDE, ME	15. CEDE	16. CDE	17. TEDE	18. TODE
6. MONITORING PERIOD		7. LICENSEE NAME		8. LICENSE NUMBER		9. RECORD ☐ ESTIMATE ☐ NO RECORD ☐	10. ROUTINE ☐ PSE ☐
11. DDE	12. LDE	13. SDE, WB	14. SDE, ME	15. CEDE	16. CDE	17. TEDE	18. TODE
6. MONITORING PERIOD		7. LICENSEE NAME		8. LICENSE NUMBER		9. RECORD ☐ ESTIMATE ☐ NO RECORD ☐	10. ROUTINE ☐ PSE ☐
11. DDE	12. LDE	13. SDE, WB	14. SDE, ME	15. CEDE	16. CDE	17. TEDE	18. TODE
6. MONITORING PERIOD		7. LICENSEE NAME		8. LICENSE NUMBER		9. RECORD ☐ ESTIMATE ☐ NO RECORD ☐	10. ROUTINE ☐ PSE ☐
11. DDE	12. LDE	13. SDE, WB	14. SDE, ME	15. CEDE	16. CDE	17. TEDE	18. TODE

19. SIGNATURE OF MONITORED INDIVIDUAL	20. DATE SIGNED	21. CERTIFYING ORGANIZATION	22. SIGNATURE OF DESIGNEE	23. DATE SIGNED

NRC FORM 4 (8-92)

Illustration F-1. Cumulative occupational exposure history (NRC Form 4)