KSU Mechanical & Nuclear Engineering

Nuclear Research & Education Reactor

23 January 2001

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

Gentlemen:

Pursuant to 10CFR50.59(b) the following items are submitted for the Kansas State University TRIGA Mark II Nuclear Reactor Facility for the period 1 Oct 2000 through 30 Sep 2001.

A. Changes to the Facility

Systems and Equipment Modifications In Progress
– Submitted to RSC review August, 2001

Air Monitor System Modifications

This modification involves removal of the reactor bay exhaust fan trip on air monitoring system alarm. Alarms will be observed and diagnosed by the reactor operator, consistent with alarm conditions for the continuous air monitor, pool surface & water box monitor, and the area radiation monitors. Prior to implementation of this modification, guidance will be established for actions to be taken in response to alarm conditions.

Background. The KSU reactor bay HVAC was originally configured with a set of air conditioners built into the reactor bay walls, maintaining negative pressure in the reactor bay and therefore establishing a dynamic confinement and ventilation system to control routine releases of gaseous radioactive material (principally Argon 41). During major, university wide modifications to the HVAC systems on campus, a single air-handling unit was installed in the reactor bay. The distributed air conditioners were abandoned in place, and hot/chill water services routed to the new air-handling unit.

As part of the modifications, four related initiatives were accomplished. First, instrumentation to support continuous air monitoring over the reactor pool was installed as an effluent monitor. Instruments to monitor air particulate activity, radioactive iodine and radioactive noble gas were installed. Note that there is also an independent (original) installation monitoring radioactive iodine concentration in the reactor bay. Second, a reactor bay exhaust fan (original equipment, mounted in the center of the reactor bay dome) was renovated to maintain negative reactor bay pressure. The AMS has multiple alarms, including low airflow, rate of rise, high DAC and independent high count-rate on the iodine, noble gas and particulate channels. Any alarm from any detector (including high activity or low sample flow) will cause the reactor bay exhaust fan to trip. Third, the exhaust fan was interlocked with the new (effluent) air monitor so that the exhaust fan trips on alarm condition. Finally, a Technical Specification amendment was implemented which requires the exhaust fan to be in operation when the reactor is operating.

A020

The monitoring system is sensitive to changes in airflow from buildup of dust on filter paper and changes in radon daughter product concentrations from changes in atmospheric conditions. The monitoring system has unstable readings following maintenance such as changing filter paper or airflow adjustment. Alarms from these conditions currently result in exhaust fan trips and require immediate reactor shutdown to meet the Technical Specifications Limiting Conditions of Operation noted above. Normal gaseous releases from the reactor pool inventory are therefore allowed to concentrate in the reactor bay.

No other radiation alarms cause equipment required by Technical Specifications to be secured. The operator at the controls evaluates all other radiation alarms, and takes action appropriate to the condition.

This change is consistent with safe operating practice and no negative impact on safety.

22-Foot Level Alarm System and Pool Surface Monitor Modifications

This proposed modification permits removal of the old-pool surface and area evacuation monitors, with the functions replaced by Radiation Monitoring System channels.

Background. The Radiation Protection Plan requires an evacuation alarm on the 22-foot level that will initiate at 5 R/hr. The KSU Technical Specifications requires a radiation monitor directly above the pool surface. One channel of the Radiation Monitoring System is currently being used as the pool surface monitor; the Department of Energy has provided acquisition of an additional channel that will replace the 5 R/hr monitor on the rail around the pool.

This change is consistent with safe operating practice and no negative impact on safety.

Systems and Equipment Modifications Completed

Cooling and Cooling Makeup Flow Monitoring

In-line flow monitors were installed in the primary and secondary cooling systems. This change improves system operational monitoring and has no negative impact on safety.

Reactor Bay Air Monitoring System

The reactor bay (effluent) air monitoring system (AMS) detectors have been moved to a more accessible location, and the sampling lines have been changed from tygon to vacuum rated hose.

Although the AMS instruments are portable, they are located to sample a specific volume of air in the reactor bay. The original effluent air monitoring system installation was positioned at the edge of a barrier surrounding the reactor pool on the 22-foot level. The installation required lead shielding to reduce background radiation levels at the detectors, with extremely difficult access for maintenance. Radon daughter products in the reactor bay atmosphere sometimes require particulate and/or iodine filter replacement; housekeeping and atmospheric conditions influence how often routine maintenance is required. The sample-pump is located on the 12-foot level; lines from the pump to the detectors are excessive, resulting in frequent failures that collapsed the airline. Sections of the tygon-tube that collapsed under vacuum were subsequently replaced with transparent tubing rated for operation as a vacuum line. However, detector

membranes have experienced pressure transients and failed multiple times, causing the exhaust fan to be secured and resulting in termination of operations due to an inability to meet Technical Specifications. Difficulties in balancing flow so that adequate flow (i.e., greater than the low flow alarm setpoint) has been mitigated by installation of external flow manometers.

These changes provide more reliable maintenance and operations, and have no negative impact on safety.

Secondary Cooling System, Pump Replacement

Although the modification is approved, the secondary pump replacement (with a higher capacity pump) has not been accomplished. Parts need to be fabricated for the pump replacement.

This change provides higher cooling capacity, and has no negative impact on safety

Completed

Secondary Cooling System Modifications

The secondary heat exchange and a cooling tower fan were replaced with higher capacity components.

A surge tank maintains net positive suction head on the secondary cooling pump. When the surge tank water level is low, the operator at the console initiates a fill mechanism. The water level indicator was a rubber float in a site glass on the surge tank, located at the opposite side of the bay from the control room, difficult to see from the control room. This modification installed a green lamp to indicate the surge tank level is above the minimum level, and a red lamp when the level falls below the minimum required level that requires fill to be initiated.

These changes provide more reliable operations, and have no negative impact on safety.

Makeup Water System

The building demineralized water header was disconnected from the makeup water system. A pressure demand pump was installed on the small surge tank capable of charging the line to the Bulk Shield Tank (BST)/Makeup Water Pump or discharging directly to the reactor pool. A low level cutoff switch was installed so that the pump will deenergize when the surge volume is empty. Piping to the BST pump in the reactor bay was reconfigured to provide better access to the pump and filters.

Background. The cooling water makeup system contains two surge tanks. One is fed directly from a water distillation unit; the other is connected to a tank that was pressurized in the initial configuration (changed in 1993) to provide water to the laboratories in Ward Hall. This modification accomplished several specific changes. When the original makeup water system failed, a system was installed incapable of pressurizing the demin water header. A valve to the building supply was shut, and Ward Hall laboratories that need demin water now transfer the water in carboys. The demin

water system was connected to the Bulk Shield Tank recirculation system to provide pumping for reactor pool makeup. The connection required the water line to be routed over the reactor bay door to room 14, creating a natural loop seal. A prime water connection was required to ensure the pump could perform.

These changes provide more reliable maintenance and operations, and have no negative impact on safety.

Personnel

Dr. S. Bajorek (Mechanical and Nuclear Engineering faculty holding a Reactor Operator license) left employment with Kansas State University for employment with the USNRC.

B. Changes in procedures

Procedure Changes In Progress
– Submitted to RSC review August, 2001

PROPOSED RADIATION PROTECTION PROGRAM (RPP) CHANGES

Overview (Revised RPP attached):

Editorial grammar corrections (prompted by the word processor)

Consistent use of terms

Reserved terms (in the definition section) are capitalized

Ex officio RSC chair position corrected

Tabulation of limits, requirements, etc.

Changes to survey requirements following shielding configuration changes

Deletion of requirements from other sources (e.g., Tech Specs surveillance requirements

Addition of PDi10 dosimeters to personnel dosimetry

Changes to personnel monitoring requirements

These changes are minor in nature, and do not reduce the effectiveness of the Radiation Protection Program as approved

EXPERIMENT AND OPERATING PROCEDURE CHANGES

During a previous Emergency Plan revision, Emergency procedure 5, Personnel Accountability, was deleted. The procedure is still referenced in the Emergency Plan, and needs to be re-instated. This will require renumbering procedures 5 and above.

The procedure for pocket dosimeter calibration is ambiguous in acceptance criteria. The proposed change is to reword the acceptance criteria to reflect that is it based on a % of full scale rather than a % of the target exposure.

The reactor has acquired 10 electronic pocket dosimeters. The proposed procedures will incorporate manufacturers in instructions for operation and calibration of the devices.

These changes do not have safety significance.

Approved During the Reporting Period:

None

C. Changes in Test and Experiments

Procedures and experiments for conducting radiography prohibit personnel entry in the reactor bay until reactor power level is below 5 watts, unless the Radiation Safety Office is present. Experience has demonstrated this is overly conservative. The proposed change is to prohibit whole body exposures in the high radiation area around the beam.

These changes do not pose a negative impact on safety.

Sincerely,

Paul M. Whaley
KSU Nuclear Reactor Facility

Cc M. Mendonca, USNRC Office of Nuclear Reactor Regulation
S. Holmes, USRNC Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission Region IV
KSU Nuclear Reactor Safeguards Committee

RADIATION PROTECTION PROGRAM

KSU NUCLEAR REACTOR FACILITY

MECHANICAL AND NUCLEAR ENGINEERING DEPARTMENT

KANSAS STATE UNIVERSITY

Approved: Reactor Safeguards Committee

M. H. Hosni, Chairman

Date:

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B. Operation Test and Maintenance Procedures

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(1) Cumulative Occupational Exposure History (USRNC Form 4)

(2) Operational Exposure Record for a Monitoring Period

(3) Typical Monthly Report on Occupational Exposures (KSU)

(4) Typical Monthly Report on Occupational Exposures (Reactor Facility)

(5) Typical Quarterly Report on Extremity Exposures

(6) Sample Page from Individual Monitoring Device Logbook

(7) Sample Survey Instrument Calibration Record

(8) Sample Pocket Dosimeter Calibration Record

(9) Sample Monthly Swipe Survey

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(11) Sample Monthly Gamma-Ray Environmens Monitoring (Zero Power)

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(14) Sample Log for Solids Transfer to University Radiation Safety Office

(15) Sample Report on Solid Waste Activity

(16) Radiation Protection Program Audit Form

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 Program has been reviewed by the University Radiation Safety Committee, 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 Reactor Manager and semi-annual audits prepared under the direction of the Reactor Manager. The Reactor Safeguards Committee examines records required by the Radiation Protection Program as well as audit reports by the Reactor Manager during their semi-annual inspections.

Training, surveillance and recordkeeping are the responsibility of the Reactor Manager. ALARA activities, for which recordkeeping is the particular responsibility of the Reactor 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 Reactor 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 Reactor 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 Reactor 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 SURVIELLANCES	
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 a request from the Radiation Safety Officer, and returned to the RSO to ensure the byproduct material on the Kansas State University campus meets LICENSE restrictions for radionuclides. 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 NUCLER 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 assay 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
^{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

CONTAMINATION LIMITS FOR UNRESTRICTED RELEASE			
Nuclide	Avg. dpm (fixed)	Max dpm (fixed)	Removable dpm
^{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

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.

4.5 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.

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 or VERY HIGH RADIATION AREA 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 include 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 to single 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 radiation fields. 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 Reactor 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 Reactor 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 Reactor 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 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 Reactor 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 Reactor Manager SHALL review implementation of the KSU Nuclear Reactor Radiation protection Program semi-annually. As a minimum, the Reactor 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 Reactor Manager SHALL review the Radiation Protection Program provisions biennially. As a minimum, the Reactor 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.