Volume IV

Facility Procedures:
Administration, Health Physics, Maintenance,
Surveillance, Operation,
Fuel and Experiment Facilities (reactivity),
Emergency and Security Procedures,
Other Procedures (not included)

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DEPARTMENT OF ZOOLOGY
THE UNIVERSITY OF TEXAS AT AUSTIN
Austin, Texas 78712-1064

April 28, 1989

Dr. Bernard Wehring, Director
Nuclear Engineering Teaching Laboratory
Mechanical Engineering

Dear Dr. Wehring:

Section I.C. of the University's "Manual of Radiation Safety" states, " The Radiation Safety Officer acts as the delegated authority in the day-to-day implementation of policies and practices regarding the safe use of radioisotopes and sources of radiation as determined by the Radiation Safety Committee." The Committee interprets this statement as allowing the Radiation Safety Officer to sign NETL Experiment Authorization Approvals.

Welcome to the University and any time that you feel our Committee can be of assistance, please let us know.

Sincerely,

H. Eldon Sutton, Chairman
Radiation Safety Committee

cc: D. Klein
H. Marcus
T. Bauer ✓
B. Bryant

NUCLEAR ENGINEERING TEACHING LABORATORY

ADMN. 1, REV. A

PROCEDURE OUTLINE AND CONTROL

Approvals:

Thomas L. Bauer — 6/4/90
Reactor Supervisor — Date

Bernard W. Wehring — 6/5/90
Director, NETL — Date

[signature] — 6/6/90
Chairperson, Reactor Committee — Date

List of Pages: 1 2 3

Attachments:

Record for Procedure Changes
Format for Procedure Documentation

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Step	Action and Response	Comment or Correction

I. PURPOSE

This procedure is intended to define the standard format and controls that determine development, revision, approval and issuance of an official procedure.

II. DESCRIPTION

The activities that require written procedures are requirements of license documents. Procedure control is necessary to provide assurance that adequate consideration has been given to conditions that define or change procedural activities. The format of this procedure should be a guideline for other procedures.

III. REFERENCES

Docket 50-602
Technical Specifications
Section 6.3 and 6.4

IV. MATERIALS, EQUIPMENT, OTHER PROCEDURES

V. PROCEDURE

Action and Response	Comment or Correction
1. Assign a procedure number, page numbers, title, revision and date.	Go to step 5 to revise an existing procedure.
OPER-#	ts 6.3a
FUEL-#	ts 6.3b
MAIN-#	ts 6.3c
SURV-#	ts 6.3d
ADMN-#	ts 6.3e
HP-#	ts 6.3f
PLN-#	ts 6.3g
EXP-#	ts 6.4
other-#	
2. Define purpose and provide description of procedure.	

Step	Action and Response	Comment or Correction
3.	Document important references, key materials, equipment, and requirements for other procedures.	
4.	Define and check each instruction step.	Go to step 8
5.	Maintain a log of procedure changes.	Notes on procedure are for guidance only.
6.	Record change in log. Record procedure number, page, change and date in log. Change requires approval and initial by <u>senior operator</u>: OPER, FUEL, SURV, ADMN MAIN, PLN, EXP, other <u>health physicist</u>: EXP, HP, other	Minor or temporary changes
7.	Draft of changes requires approval and review as a new procedure.	Major or permanent changes
8.	Prepare draft and approve procedure for submittal, by <u>senior operator</u>: OPER, FUEL, SURV, ADMN, MAIN, PLN, EXP, other <u>health physicist</u>: EXP, HP, other	HP may request review of other procedures as necessary to comment on safety
9.	Submit to Director and Nuclear Reactor Committee. Also submit HP and EXP procedures to Radiation Safety Committee.	Submittal of other procedures to both committees should be a consideration when a significant safety issue exists.
10.	Issue and implement procedure.	

Record of Procedure Changes

Page	*Date	*Initial	*Change
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NUCLEAR ENGINEERING TEACHING LABORATORY

PROCEDURE ADMN-2., REV. 1

PROCEDURES FOR DESIGN FEATURES AND QUALITY ASSURANCE

Approvals:

Thomas L. Bauer — 1/24/92
Reactor Supervisor — Date

Bernard W. Wehring — 1/24/92
Director, NETL — Date

Chairperson, Reactor Committee — 1/24/92
Date

1/31/92

List of Pages: 1 2 3 4 5

Attachments: Quality Control Record

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ORIGINAL

I. PURPOSE

Design features and conditions that are set by the Safety Analysis Report determine the requirements for quality assurance of specific facility features. This procedure provides the guidance for review and identification of structures, systems and components that require quality assurance of design changes.

II. DESCRIPTION

The level of quality assurance is relative to the safety features or design conditions of a structure, system or component. Two activities require the application of all sections of the quality assurance program. One structure or system is the clad system for the fuel elements that provides the primary physical barrier against fission product release. The second system is any transportation package, Type B, that will transport radioactive fuel elements.

Other building features, systems and components that are important to safety do not require complete quality assurance documentation. These building features or support systems none-the-less, may require quality assurance review to obtain an acceptable level and type of performance. Systems such as the instrumentation control and safety system, radiation monitoring or measuring systems and life safety equipment are examples of systems or components that should require implementation of one or more sections of the quality assurance plan. Application of any section will be to assure appropriate levels of system or equipment performance.

III REFERENCES

Safety Analysis Report
Instrument, Control and Safety Manual
Mechanical Equipment Manual
Quality Assurance Plan, Revision 0 1990

IV. EQUIPMENT

Fuel element cladding
Reactor structure system
Instrument Control and Safety System
Reactor Water Systems
Air Confinement System
Area and Air Radiation Monitoring System

Step	Action and Response	Comment or Correction

A. Design Conditions

1. Evaluate each system or component change to determine the appropriate requirements and specifications.

2. Review the Safety Analysis Report for specific design conditions.

3. Review appropriate plans and specifications for design details.

4. Identify the criteria, performance or standards appropriate for the design conditions or changes.

5. Determine whether a design change requires an amendment of the Safety Analysis Report, Safety Evaluation Report and License.

6. Assure that design conditions meet the safety analysis and license amendments.

7. Assure that design conditions meet other specified criteria, performance or standards.

8. Implement quality assurance program elements of the next section as necessary for safety items or to assure other quality control activities.

Step	Action and Response	Comment or Correction

B. Quality Assurance

1. Identify quality assurance item as referenced by the Q-list (Section C).

2. Determine the elements of the quality assurance program according to Attachment. Refer to the Quality Assurance Plan for the specification of each QA requirement.

   a. Specify or verify the QA documentation title, description, and quality level.

   b. Specify or verify the participation and responsibility of personnel and the documentation applicable to quality control.

   c. List the applicable sections of the quality assurance program.

3. Complete the quality control elements for each applicable section noting item identification, and quality assurance program section number according to Attachment.

   a. Specify quality conditions.

   b. Record comments on quality control.

   c. Date and initial the initiation and acceptance of the quality control activities.

4. Review the complete quality assurance activity.

Step | Action and Response | Comment or Correction

C. Q-list

Designation	Item Identification	Level
A	Fuel element, Fuel-control element	1
B	Fuel shipping package	1
C	Reactor core structure	2
D	Tank structure	2
E	Shield structure	2
F	Beam tube components	2
G	Rotary rack system	2
H	Pneumatic tube components	2
I	Installed core system	2
J	Instrumentation system	2
K	Control system	2
L	Safety system	2
M	Pool coolant system	2
N	Water purification system	2
O	Room confinement components	2
P	Area ventilation components	2
Q	Area radiation monitoring system	2
R	Air radiation monitor system	2
S	Fuel Storage Wells/Racks	2
T	All Other Systems*	3

*Level 3 quality requirements, if any, depend on user specifications and requirements for each system. Documentation or record, if any, of quality assurance will be the responsibility of the system user.

Number	Title	Rev. 1
ADMN-2	Design Features, Quality Assurance	Date 12/90

Quality Control

1.0 Title:

Item identification: ____________________
(designate A, B, C, ...) ______ (quality level 1, 2, or 3) ______

Item description:

1.1 Participation:
(personnel-task assigned)

1.2 Documents:
(procedures applicable)

(special provisions)

Applicable Section (#.#):

Section #.#:

Conditions:

Comments:

Dates:

Activity Initiated ____________________ Initial ______

Activity Accepted ____________________ Initial ______

Audit of activities:

Review by ____________________ Date: ___/___/___

ORIGINAL

Quality Control
Continuation Sheet

NUCLEAR ENGINEERING TEACHING LABORATORY

PROCEDURE ADMN-3, REV. 0

PROCEDURES FOR PERSONNEL AND OPERATOR QUALIFICATIONS

Approvals:

Thomas J. Bauer — 1/24/92
Reactor Supervisor — Date

Bernard W. Wehring — 1/24/92
Director, NETL — Date

[signature] — 1/27/92
Chairperson, Reactor Committee — Date

[signature] — 1/31/92
Chairperson, Radiation Safety Committee — Date

List of Pages: 1 2 3 4

Attachments: None

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ORIGINAL

Step	Action and Response	Comment or Correction

I. PURPOSE

The choice of personnel for job positions at the NETL facility includes license commitments and university job classification requirements.

II. DESCRIPTION

The special nature of key job positions, such as persons that direct the operation of reactor operators and persons that are reactor operators require training and qualification that exceed the standard university job description. Guidelines for review of personnel requirements and standards are set forth. Permits for reactor operation responsibilities require special training to maintain license status.

III. REFERENCES

ANS 15-4 Selection and Training of Personnel for Research Reactors
Operator Requalification Program

IV. PROCEDURE

Step	Action and Response	Comment or Correction

A. Staff Personnel

1. Evaluate job tasks to determine the knowledge, skills, training and experience required.

2. Determine whether the job tasks specify the qualifications of a Director, Supervisor, reactor operator, health physics research support personnel or technician support personnel.

3. Review the appropriate university job descriptions and the applicable ANS standard.

4. Assure that the qualifications of a director or supervisor meet the criteria of the Safety Analysis Report and guidance documents.

5. Assure that qualifications of personnel that are to obtain certification as operators demonstrate the potential to complete successful qualification of personnel that will become reactor operators or senior operators.

6. Develop plans to provide qualification of personnel that will become reactor operators or senior operators.

7. Provide the appropriate training evaluation and examination necessary to complete the issuance of senior or operator permits.

8. Research support personnel should have the requisite qualifications appropriate to the specified job tasks.

9. Technician support personnel should have the requisite qualifications appropriate to the specified job tasks.

10. Provide initial and review training to students, faculty, staff and researchers.

ORIGINAL

Step	Action and Response	Comment or Correction

B. Reactor and Senior Operators

1. Conduct appropriate training sessions in the subject matter specified in the training program over a period not to exceed two years.

2. Circulate changes in design, licenses, and procedures to all certified personnel in a timely manner.

3. Assure the maintenance of the Operator Qualification documentation in a timely manner.

4. Provide for the review of the contents of all abnormal and emergency procedures annually.

5. Prepare a written examination(s) covering the subject matter specified in the training program.

6. Evaluate the performance and competency of each certified operator.

7. Provide accelerated retraining for personnel who score below the acceptance criteria.

8. Schedule a physical examination of all certified personnel during each two year requalification cycle.

9. Prepare a specific training program, utilizing pertinent portions of these procedures, for operator trainees.

NUCLEAR ENGINEERING TEACHING LABORATORY

ADMN-4, REV. 0

RADIATION PROTECTION PROGRAM

Approvals:

Thomas L. Bauer — 1/24/92
Reactor Supervisor — Date

Bernard W. Wehring — 1/24/92
Director, NETL — Date

[signature] — 1/29/92
Chairperson, Reactor Committee — Date

[signature] — 1/31/92
Chairperson, Radiation Safety Committee — Date

List of Pages: 1 2 3

Attachments: None

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Step	Action and Response	Comment or Correction

I. Purpose

Provide adequate equipment, measurements and evaluation to assure worker radiological safety and compliance with regulatory requirements.

II. Description

The unique facility hazards associated with exposures to radiation fields and radiological materials require special considerations. These considerations include training of personnel, monitoring of work areas and provisions for unusual conditions. Importance of the radiation safety program requires the assignment of one person with the primary responsibility to provide implementation of the radiation protection program. The regulations of 10CFR20 are the ultimate basis for the procedures and requirements of the program.

Texas is an agreement state that regulates radioactive materials and issues material licences. The NETL radiation protection program must meet the requirements of both the federal and state regulations. License requirements are set forth in the NRC reactor license R-129 for the facility and State of Texas broad license TDH6-485 for the university.

III. References

10CFR20 Standards for Protection Against Radiation Exposure
Texas Regulations for Control of Radiation
UT Manual of Radiation Safety
UT Safety Analysis Report
HP Procedures (HP1-HP7)
Emergency Plan Docket 50-602
Procedures PLAN-0 and PLAN-E

Step	Action and Response	Comment or Correction

IV. <u>Instructions</u>

A. Radiation Protection - personnel

1. Establish a personnel monitoring system for occupants of the reactor facility.
2. Provide radiological safety training for facility personnel.
3. Identify radiation protection personnel and their responsibilities.
4. Verify that radiation areas are properly identified.
5. Review exposure records to insure compliance with ALARA principle.
6. Review documentation of Radiation Protection Program activities.

B. Radiation Protection - material

1. Designate storage areas for radioactive materials.
2. Establish controls for the movement of radioactive material.
3. Maintain an inventory system for radioactive material.
4. Provide for review of the adequacy of the materials control program.
5. Verify documentation in appropriate logs.

NUCLEAR ENGINEERING TEACHING LAB

ADMN-5, REV. 0

PROTECTION PROGRAMS

Approvals:

Thomas L. Bauer — Reactor Supervisor — Date: 1/24/92

Bernard W. Wehring — Director, NETL — Date: 1/24/92

[signature] — Chairperson, Reactor Committee — Date: 1/29/92

[signature] — Chairperson, Radiation Safety Committee — Date: 1/31/92

List of Pages: 1 2 3 4

Attachments: None

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ORIGINAL

Step	Action and Response	Comment or Correction

I. Purpose

Provide for facility protection, including security of materials, response to emergencies, and fire - safety programs.

II. Description

Physical security and emergency response are the responsibility of NETL staff through the documentation of the respective plans. Fire and other safety programs include coordination with university programs.

III.References

Physical Security Plan
Emergency Plan

Step	Action and Response	Comment or Correction

IV. Procedure

A. Physical Security

1. Establish, maintain and implement a physical security plan.

2. Establish and maintain an access control system.

3. Review access control records each semester.

4. Notify University officials and regulatory agencies of security system failures as required.

5. Review the adequacy of the physical security plan at intervals not to exceed two years.

6. Review documentation of Physical Security Plan activities.

B. Emergency Response

1. Establish, maintain and implement an emergency plan.

2. Initiate agreements with non-university emergency service agencies. Review agreements at two-year intervals.

3. Establish and maintain communications with off-site elements of the emergency response team.

4. Designate locations for the posting of the current emergency call list. Update list at intervals not to exceed one year.

5. Notify university officials and regulatory agencies of emergency conditions as required.

6. Review the adequacy of the emergency plan at intervals not to exceed two years.

7. Review documentation of Emergency Plan activities.

Step	Action and Response	Comment or Correction

C. Fire-safety Protection

1. Maintain a continual awareness of any changes to building features or hazardous conditions. Identify the possible impacts on passive or active fire protection systems or other safety equipment.

2. Evaluate any changes to the building that change the passive fire protective functions of the building layout, barriers or materials.

3. Perform checks, at approximately regular intervals, on the components of the active fire protection elements.

4. Identify and record significant ignition and combustion sources so that steps can be taken to prevent or mitigate potential accidents.

5. Initiate review of the fire protection program at intervals not to exceed two years.

6. Approve each activity such as welding, cutting, open flames, or other sources that affect fire protection. Log approvals with fire safety program documentation.

7. Verify documentation of Fire Safety Program activities.

8. At all times good safety practices should be applicable for worker safety.

NUCLEAR ENGINEERING TEACHING LABORATORY

PROCEDURE, Revision 1.00

AUTHORIZATION OF EXPERIMENTS

Approvals:

Thomas L Bauer	7/14/92
Reactor Supervisor	Date
Bernard W. Wehring	7/22/92
Director, NETL	Date
Randall J. Charbeneau	1/15/93
Chairperson, Reactor Committee	Date
[signature]	1/27/93
Chairperson, Radiation Safety Committee	Date

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Attachments:
Exp. Review Guide 1 2 3 4 5
Authorization Form
Operation Request
Sample Irradiation - Exposure
Non Reactor Experiments

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ORIGINAL

Step	Action and Response	Comment or Correction

I. Purpose

The purpose of this procedure is to establish specific controls to review and analyze experiments. The process applies prior to the use of any experiment in the reactor and subsequent to initial operation to evaluate the routine application of the experiment.

II. Description

Reactor safety is a function of 3 basic physical condition, (1) the reactivity available for changing the reactor criticality conditions, (2) the effects of temperature and hydraulic flow conditions that change coolant flow or neutron peak powers and (3) mechanical stress that might rearrange structures or components of the core configuration. An evaluation of each of the materials that will be in each experiment is done to identify both operational hazards and possible potential hazards. Limits will be set on experiments to assure that the proper safety conditions are met. Procedures may be necessary for some experiments to assure safe reactor and experiment operation.

III. References

Reg guide 2.2
ANS 15.1 Technical Specifications
Docket 50-602 Safety Analysis Report
Docket 50-602 Technical Specifications
10CFR 50.59 Changes, Tests, and Experiments

Step	Action and Response	Comment or Correction

Instructions:

1. Submit experiment request to the Supervisory Operator (class A; SRO). All experiment requests involving materials placed in the pool or exposed to direct radiations from the pool require authorization.

2. Determine experiment description; operation requirements, class (A, B, C, or D), facility, materials, estimate times, and the experiment type (special or routine).

3. Review the experiment:

   3.1 Special Experiment - Nuclear Reactor Committee and Reactor Supervisor or class A operator (SRO) shall:
   (a) Review experiment request for approval. Request is to be comparable to the guidance criteria.
   (b) Refer to Experiment Review.
   (c) Document review on Experiment Authorization form.
   (d) Attach the analysis and any special procedures to the authorization form as a file record.
   (e) Authorize approval as a special experiment by signature of the Supervisory Operator and by designated member of committee.

   3.2 Routine Experiments - Reactor Supervisor or Class A operator (SRO) shall:
   (a) Verify experiment conditions for approval. Conditions are to be equivalent to the experiment authorization.
   (b) Refer to Experiment Review.
   (c) Complete applicable Operation Request form, Sample
   (d) Note any deviations from the authorization and any special safety hazards or instructions.
   (e) Authorize experiment by signature of supervisory operator.

   3.3 Minor deviations from the routine experiment may be approved although routine deviations shall require experiment amendment and reactor committee approval.

4. Verify operator's and experimenter's knowledge of experiment and procedures.

5. Perform the experiment following procedures specified by the experiment authorization.

6. Review experimental results:

Step	Action and Response	Comment or Correction

6.1 Special experiments - Nuclear Reactor Committee and Reactor Supervisor or class A operator (SRO) shall:
(a) Review experiment results by comparison to guidance criteria.
(b) Document comments on Experiment Authorization form.
(c) Authorize approval as a routine experiment by signature of the Supervisory Operator and by designated member of the committee.

6.2 Routine Experiments - Reactor Committee should:
(a) Verify experimental results are equivalent to the experiment authorization.
(b) Review should be noted by signature of the Supervisory Operator on applicable forms (Operation Request, etc.)

6.3 Reclassification as a routine experiment may not be appropriate for certain types of experiments that are not intended for periodic applications.

Experiment Classes:

a. Class A experiments require a senior operator (Class A, SRO) to perform or direct an activity or experiment.
b. Class B experiments require only an operator and if necessary an experimenter(Class B, RO) to perform the experiment.
c. Class C experiments are all non-reactor experiments.

Experiment Types:

a. A special experiment is an experiment which is authorized for one application.
b. A routine experiment is an experiment which is authorized for repeat applications.

Safety Analysis of Experiments

Descriptive Information

(1) Experiment title
(2) Description and purpose of experiment
(3) Experimental requirements:
  (a) Experiment facility and location
  (b) Maximum reactor power
  (c) Maximum operation time

The experiment review should evaluate each of the credible physical experiment effects and the possible material hazards. Document appropriate analysis for each experiment. Guidance of this review is similar to Regulatory Guide 2.2. Specific conditions of the Technical Specifications shall control all experiments. Experiments that do not meet the conditions of this review shall require reevaluation of the Safety Analysis Report and the Technical Specifications.

Physical Experiment Effects

(1) Reactivity
  (a) Evaluate magnitude of each experiment's reactivity
    (i) Static Reactivity (Measurable experiment reactivity resulting from normal experiment movement to or from reactor core).
      Limits: Compare estimate with actual measurement prior to functional acceptance of experiment.
    (ii) Potential Reactivity (Maximum experiment reactivity resulting from accident conditions such as abnormal movement, voiding, flooding, etc).
      License Limits:
      Single Moveable Experiment ≤ $1.00
      Single Secured Experiment ≤ $2.50
      Sum of all Experiments < $3.00
  (b) Positive step reactivity insertion of each secured or removeable experiment's potential reactivity will not cause transient leading to excess doses.
    Dose Limits: 10 CFR Part 20
  (c) Positive step reactivity insertion of each moveable or unsecured experiment's potential reactivity will not cause a safety limit or minimum shutdown margin violation.
    Safety Limit: Fuel Temp 1150°C at Clad Temp < 500°C
    Fuel Temp 950°C at Clad Temp > 500°C
    Min. Shutdown Margin: 0.2% ($0.14) with
    (i) Core in reference configuration
    (ii) Most reactive control rod fully withdrawn
    (iii) Highest worth experiment in most reactive state

(d) Control system's ability to compensate for reactivity insertions resulting from intentionally moving any combination of unsecured or moveable experiments.
License Limit: One experiment ≤ \$1.00

(e) The sum of the static reactivity experiment worths of all unsecured experiments which coexist should not exceed the lesser of :
(i) Maximum potential reactivity authorized for a single removeable experiment (sec (a) above)
(ii) The minimum shutdown margin excluding items (ii) and (iii) (see (c) above)
License Limit: Sum of all experiments ≤ \$1.00

(2) Thermal Hydraulic:
(a) Actual and potential thermal effects on reactor safety
Limit; See 1 (c) above
(b) Flux peaking; flow blockage, redistribution, or phase changes
Limit See 1 (c) above
(c) Experiment boundary surface temperatures leading to:
(i) Reactor coolant phase change
(ii) Elevated corrosion rates
(iii)Material strength reduction
Limits: Dependent on experiment material properties

(3) Mechanical Stress:
(a) Potential storage and possible uncontrolled release of mechanical energy
Limits: Maintain reactor core and fuel element integrity
(b) Potential for projectiles or objects with substantial momentum
Limits: Maintain reactor core and fuel element integrity
(c) Structural ability to withstand external forces generated during installation, operation, or removal and internal forces generated by unintended but credible changes of confined materials
Limits: Capable of operation at twice normal stress anticipated
(d) Requirement for prototype tests
Limits: Experiment dependent

Material Evaluation

(1) Radioactivity:
(a) Quantities and types of materials
(b) Expected isotopes, quantities, and decay modes
(c) Radiation doses resulting from the accidental release of all gaseous, volatile, or particulate components (calculate per Tech. Specs. and Reg Guide 2.2) limit to:

Step	Action and Response	Comment or Correction

(i) For Singly Encapsulated Material - less than 10% of the equivalent annual doses stated in 10CFR20 for persons occupying (1) unrestricted areas continuously for 2 hours starting at the time of release or (2) restricted areas during the time required to evacuate the restricted area.

(ii) For Doubly Encapsulated or vented Materials - (1) 0.5 rem whole body or 1.5 rem thyroid to any person occupying an unrestricted area continuously for a period of 2 hours beginning at the time of release of (2) 5 rem whole body or 30 rem thyroid to any person occupying a restricted area during the time required to evacuated the restricted area.

(d) Presence of fissionable materials which when irradiated will produce isotopes in quantities greater than those specified in the Technical Specifications
Limits: Double encapsulation requirement
Isotopes of I^{131} thru I^{135} < 750 mCi
Strontium < 2.5 mCi

(2) Material Hazards:

(a) Trace element impurities which may represent a significant radiological hazard
Limits: Refer to exposure limits

(b) High cross section elements (fuels or absorbers)
Limits: Refer to reactivity limits

(c) Flammable, volatile, or liquid materials
Limits: Seal and test encapsulation

(d) Explosive chemicals
Limits: Less than 25 milligram quantity
Detonation pressure does not rupture container

(e) Corrosive chemicals
Limits: Double encapsulation requirement

(f) Chemicals highly reactive with water
Limits: Double encapsulation requirement

(g) Radiation sensitive materials which when exposed to radiation exhibit degradation of mechanical properties, decomposition, chemical changes, or gas evolution
Limits: Maintain integrity of encapsulation

(h) Toxic compounds
Limits: Personnel safety requirements

(i) Cryogenic liquids
Limits: Specific hazard authorization

(j) Unknown materials
Limits: No authorization for unknown materials

Experiment Classification:

Three classes of experiments will define the type of personnel requirements that are necessary to perform the tasks of each experiment class. Class A experiments will require performance or supervision of all experiment requirements by a Senior Operator. A Reactor Operator may perform the work of a class A experiment but a Senior Operator must review and approve each experiment task prior to continuation of operation. Class B experiments require a Senior Operator only for approval of startup, shutdown, significant changes in reactivity (power level changes that exceed 200 kilowatts) and recovery from any non-intentional scram condition. A Reactor Operator may perform the routine operation tasks of this experiment class. Class B experiments will include two subgroups of experiments that specify whether or not operation coordination is necessary with an experimenter. All other experiments, that do not require the presence of a Senior Operator or Reactor Operator, are class C experiments. A class C experiment may require approval by a Senior Operator or Reactor Operator if the experiment is in the reactor pool or the reactor bay.

The following schedule lists the general classification of experiments. Experiment reviews will document the safety analysis for each type of experiment. If necessary specific reviews or amendments will apply to special types of experiments. Any experiment that substantially deviates from the general classifications will become a new authorization within the appropriate category.

Step — Action and Response — Comment or Correction

Schedule of Experiments

A. Class A Experiment (Senior Operator Supervision)

A1.0 ICS Operation
- 1.1 ICS prestart checks
- 1.2 ICS system calibration
- 1.3 ICS system changes

A2.0 Core reactivity adjustments
- 2.1 Critical mass experiment
- 2.2 Fuel element movements
- 2.3 Control rod elements

A3.0 Radiation shield configurations
- 3.1 Vertical beam ports
- 3.2 Beam ports 1,2, &4
- 3.3 Beam ports 3 & 5

A4.0 Special Projects

B. Class B Experiments (Reactor Operator & Experimenter Tasks)

B1.0 Routing Operations - training (Reactor Operator Tasks)
- 1.1 Reactivity coefficients - voids and materials
- 1.2 Reactivity coefficients - power and temperature
- 1.3 Step reactivity insertion - positive and negative

B2.0 Routine operations - demonstration
(Experimenter Participation)
- 2.1 Power operation
- 2.2 Pulse operation
- 2.3 Special projects

B3.0 Neutron Activation
- 3.1 Neutron activation (long-lived) Reactor Operator task
- 3.2 Neutron activation (short-lived) Experimenter participation
- 3.3 Special projects

B4.0 Isotope Production
- 4.1 Isotope production (long-lived) Reactor Operator task
- 4.2 Isotope production (short-lived) Experimenter participation
- 4.3 Special projects

B5.0 Reactor core exposures

B6.0 Beam port exposures

C. Class C Experiments (Non reactor experiment)

C1.0 Gamma irradiator
C2.0 Subcritical assembly
C3 0 Neutron generator
C4.0 Portable xray unit

Experiment Authorization

Date: _____/_____/_____ Class _______________

Requested by: ___________________________ Phone ______________ No. _______

Experiment Title:

Physical experiment effects:

Reactivity Extimates (in cents) ________ static ________ potential

Thermal Hydraulic ____

____

Mechanical Stress ____

____

Material Evaluation:

Radioactivity Material Hazards

Isotopes (major) ______________ ________________ Limits: ________

Activity (max) ______________ ________________ Limits: ________

Dose (   )_____mR/hr ____cm ____hr ________________ Limits: ________

Review of Safety Questions:

i) increases probability or consequence yes___ no___

ii) creates different type safety condition yes___ no___

iii) reduces margin of safety yes___ no___

Procedure Requirements:

Experiment Restrictions:

Special Experiment Results: Date Performed _____/_____/_____

____

Experiment Approvals:		Special	Routine
Reactor Supervisor	________________________	___/___/___	___/___/___
Health Physicist	________________________	___/___/___	___/___/___
Laboratory Director	________________________	___/___/___	___/___/___
Nuclear Reactor Comm.	________________________	___/___/___	___/___/___

Number	Title	Rev. 1
ADMN-6	Authorization of Experiments	Date 12/90

Operation Request

Date: _____/_____/_____ Req. No._____

Requested by: ____________________ Phone __________ Exp. No._____

Project Description:

Mode of Operation: [ ] Manual [ ] Pulse [ ] Auto [ ] Square

Power level _____kw's Pulse transient _____$'s
Time at power _____hr's Number of pulses _____##

[ ] Class A experiment, senior operator: ____________________
[ ] Class B experiment, reactor operator: ____________________
[ ] Class C experiment, operator ____________ experimenter: ____________

Irradiation: [ ] In-core RSR PNT CTR Other ________________
Exposure: [ ] Ex-core BP 1 2 3 4 5 Other ________________

Material: ______________________________

Neutron Flux: __________________________ n/cm^2 - sec
Radiation dose: __________________________ rads/sec

[ ] Class D experiment (non reactor) experimenter: ________________

Experiment in Reactor Pool [ ] Experiment in Room [__________]
Experiment in Reactor Area [ ]

Time Estimates: Setup and breakdown time ________________
Time of Operation (hrs) ________________
Total time (min. 1.0 hr) ________________

Experiment type: Authorization [ ] Special [ ] Routine [ ]

Special Requirements/Notes:

Approval for Operation: ____/____/____ Review of Operation: ____/____/____

Reactor Supervisor ________________ Reactor Supervisor ________________

ORIGINAL

Sample Irradiation or Exposure

Date: ______/_____/_____ Exp. No. ____

Requested by: ______________________________________ Req. No. ____

Project Description: ______________________ In-core _____ Ex-core _____

# of samples _____ _____n/cm^2 - sec __________KW's
sample facility _____ _____rads/sec __________KWHR's

Sample Data:
per sample _____ grams (solid) _____ ml (liquid)
Composition ____

Matrix:	Element	Isotope	Trace:	Element	Isotope
a			a		
b			b		
c			c		
d			d		
e			e		
f			f		
g			g		
h			h		
i			i		
j			j		

Radiolysis: ______________ gas evolution __________________
Chemical Reactions: ______________ corrosive_____explosive________
Thermal Equilibrium: ______________ degree temp. change ___________

Encapsulation:

Sample vial _____________ Type: seal ______________ test _______
Safety capsule _____________ Type: seal ______________ test _______
Irradiation container: ________________________________

Load/Unload Instruction:

Approved for Irradiation: Review of Irradiation:

Reactor Supervisor ___________|__________ Reactor Committee ________________

ORIGINAL

Non-Reactor Experiment

Date: _____/_____/_____

Exp. No. _____

Requested by: ________________________________

Req. No. _____

Project Description: ______________________________ Time: ________ Hours

In-pool____ In-bay____

Gamma irradiator ____________ X-ray equipment ____________

Subcritical assembly __________ Neutron generator ____________

Other ____

Material:

Dose: _____kilorads

Containment:

Neutron source:

Fissions: _____ estimate

Activation products:

Special requirements: yes___ no___ Reactor operation: yes___ no___

Safety Hazards:

___ chemical reactions
___ thermal equilibrium
___ radioactive material
___ other

Other Instructions:

Approved Experiment:

Reactor Supervisor ____________ ___/___/___

Review of Experiment:

Reactor Committee ______________

ORIGINAL

NUCLEAR ENGINEERING TEACHING LABORATORY

REV. A

Nuclear Reactor Committee Charter

Approvals:

Bernard W. Wehring — 8-21-90
Director, NETL — Date

[signature] — 8-21-90
Chairperson, Reactor Committee — Date

John R. Howell — 8-27-90
Chairperson, Mechanical Engineering — Date

Herbert H. Woodson — 8-31-90
Dean, College of Engineering — Date

List of Pages: 1 2 3

Attachments: Technical Specifications 6.2, docket 50-602 (2 pages)

BALCONES RESEARCH CENTER
THE UNIVERSITY OF TEXAS AT AUSTIN

NUCLEAR REACTOR COMMITTEE CHARTER

Composition of this committee shall be a chairman plus at least four other members. Appointment to or removal from this committee shall be by the Dean of Engineering on the basis of qualifications and interests, and the members are responsible to him.

A maximum of two persons may belong to both the Nuclear Reactor Committee and the Radiation Safety Committee, provided that he not be chairman of both committees.

Meeting frequency shall be once each three months but not to exceed six months.

The quorum shall be sixty percent of the committee members.

Items to be voted upon will pass by a majority vote of those present. However, NETL personnel shall not represent more than one half of the voting members.

The chairman shall cause written records to be kept of all committee actions, which will include distribution, review and approval of minutes.

Use of subgroups by the committee is at the discretion of the chairman.

Functions of this committee are:

1. To assist the Nuclear Engineering Teaching Laboratory Director in establishing operational goals.

2. To transmit to the Nuclear Engineering Teaching Laboratory Director or Supervisor whatever suggestions or comments they consider desirable.

3. To meet as needed to approve or disapprove reactor experiments as submitted by the Nuclear Engineering Teaching Laboratory Director.

4. To meet as needed to approve or disapprove proposed changes in Nuclear Laboratory procedures and proposed significant alterations to reactor systems and proposed changes in the NRC utilization facility license.

5. To order a reactor experiment to be stopped and/or the reactor not to be operated if, in their opinion, any significant hazard exists.

6. To review facility operations and facilitate the audit of activities as per the requirements of the license Technical Specifications Section 6.2 (see attachment).

Modifications of the above may be made with the written approval of all of the following:

Dean of Engineering

Chairman, Mechanical Engineering

Chairman, Nuclear Reactor Committee

Director, Nuclear Engineering Teaching Laboratory

Issue Date: 6/25/90

Attachment

Technical Specifications Section 6.2
Docket 50-602, The University of Texas at Austin

6.2. Review and Audit

6.2.1 Composition and Qualifications

A Nuclear Reactor Committee shall consist of at least three (3) members appointed by the Dean of the College of Engineering that are knowledgeable in fields which relate to nuclear safety. The University Radiological Safety Officer shall be a member or an ex-officio member of the Nuclear Reactor Committee. A supervisory senior reactor operator shall be an ex-officio member. The committee will perform the functions of review and audit or designate a knowledgeable person for audit functions.

6.2.2 Charter and Rules

The operations of the Nuclear Reactor Committee shall be in accordance with an established charter, including provisions for:

a. Meeting frequency (at least once each six months).

b. Quorums (not less than one-half the membership where the operating staff does not represent a majority).

c. Dissemination, review, and approval of minutes.

d. Use of subgroups.

6.2.3 Review Function

The review function shall include facility operations related to reactor and radiological safety. The following items shall be reviewed.

a. Determinations that proposed changes in equipment, systems, tests, or procedures do not involve an unreviewed safety question.

b. All new procedures and major revisions thereto, and proposed changes in reactor facility equipment or systems having safety significance.

c. All new experiments or classes of experiments that could affect reactivity or result in the release of radioactivity.

d. Changes in technical specifications or license.

e. Violations of technical specifications or license.

f. Operating abnormalities or violations of procedures having safety significance.

g. Other reportable occurrences.

h. Audit reports.

6.2.4 Audit Function

The audit function shall be a selected examination of operating records, logs, or other documents. An audit will be by a person not directly responsible for the records and may include discussions with cognizant personnel or observation of operations. The following items shall be audited and a report made to the Reactor Supervisor and Nuclear Reactor Operation Committee:

a. Conformance of facility operations with license and technical specifications at least once each calendar year.

b. Results of actions to correct deficiencies that may occur in reactor facility equipment, structures, systems, or methods of operation that affect safety at least once per calendar year.

c. Function of the retraining and requalification program for certified operators at least once every other calendar year.

d. The reactor facility emergency plan and physical security plan, and implementing procedures at least once every other year.

10 EXPERIMENTAL FACILITIES AND UTILIZATION

10.1 Introduction

The purpose of Chapter 10 of the safety analysis report (SAR) is to discuss and describe the experimental facilities at a non-power reactor facility, their intended use, and the experimental program. The SAR should contain a description of the proposed experimental program and the safety analyses for each type of experimental facility. The design, construction, and placement of each experimental facility should be analyzed for inherent safety questions that exist apart from the experiments accommodated therein. The experiments would be reviewed by using a separate experiment safety analysis methodology which would show compliance to the Technical Specifications, primarily the associated limiting conditions for operation (LCOs) for experiments as indicated in Chapter 14, "Technical Specifications." The applicant must provide sufficient information to demonstrate that no proposed operations involving experimental irradiation or beam utilization will expose reactor operations personnel, experimenters, or the general public to unacceptable radiological consequences. In addition to the guidance in this document, References 1 and 2 contain additional guidance in the area of technical specifications and experimental programs that may be useful to the applicant in preparing the SAR.

Non-power reactors may be used for many purposes including radiation physics, chemistry and biology studies, materials irradiation, radionuclide production, and educational purposes. The experimental facilities may penetrate the reactor core or reflector or be located near the core. Neutron or other radiation beams can be extracted from the core region through the biological shield. For many non-power reactors, the experimental facilities are designed as integral components of the entire reactor.

Considerations of utility, integrity, longevity, versatility, diversity, and safety should be applied to the experimental facilities in the same manner they are applied to the reactor core and its operational components and systems. Therefore, the safety analyses of the reactor facility should include the experimental facilities and their interactions with the reactor components and systems. If changes in reactor operating characteristics are considered, potential interactions between the core and the experimental facilities should be analyzed.

Experimental programs and the range of experiments vary widely among non-power reactor facilities. Furthermore, as the licensee and the facility users gain experience and as technology develops, the experimental program and many of the specific experiments may change over the life of the reactor. This makes it very difficult and impractical for the applicant to describe specific experiments in the SAR. The applicant should describe and analyze in the SAR and incorporate into the facility technical specifications enveloping conditions of experiment attributes such as reactivity limits or material properties to allow the greatest flexibility in the experimental program. Potential experimental needs should be considered when establishing these limiting safety aspects in the SAR, so that expeditious 50.59 determinations can be made. Experience has demonstrated that most licensees have successfully implemented changes in experimental programs without prior NRC approval under the provisions of 10 CFR 50.59. This regulation allows licensees to (a) make changes in the facility as described in the SAR, (b) make changes in the procedures as described in the SAR, and (c) conduct tests or experiments not described in the safety analysis report without prior Commission approval, unless the proposed change, test, or experiment involves a change in the technical specifications incorporated in the license or an unreviewed safety question. A proposed change, test, or experiment is deemed an unreviewed safety question (a) if the probability of occurrence or the consequences of an accident or malfunction of equipment important to safety previously evaluated in the SAR may be increased; or (b) if a possibility for an accident or malfunction of a different type than any evaluated previously in the SAR may be created; or (c) if the margin of safety as defined in the basis for any technical specification is reduced.

Some non-power reactors are operated as critical facilities to demonstrate fuel loading and perform reactor physics studies. In such cases, the reactor itself can also be considered an experimental facility. In this case, the safety analysis and experiment technical specifications will include the limitations on core configurations and operational limitations when the core is the experiment.

The SAR must provide analysis to demonstrate that the reactor and experimental facilities can be operated safely. This analysis should include the range of normal operations, accidents, and malfunctions of experimental facilities. The analysis should address any impact the experimental facility imposes on the reactor and any adverse impact the reactor imposes on the experimental facility.

Consideration should be given to the possibility of the experimental facility causing an accident that requires analysis in Chapter 13, "Accident Analysis." In some cases, the failure of an experiment can be the maximum hypothetical accident (MHA) for the reactor. This possibility is most prevalent with fueled experiments. Experiments can result in the maximum uncontrolled reactivity addition accident at a facility. Limiting experiment failure should be considered in Chapter 13.

The SAR should be written to accommodate the nature of varying experiments and meet the requirements of future experimentation. The applicant should show that there is no undue risk to the health and safety of the public.

Discussions in Chapter 10 should include design bases, facility descriptions, functional and safety analyses, and applicant safety conclusions for all experimental facilities. The structural design and its potential impact on reactor operation shall be analyzed for those experimental facilities that are permanently attached to the reactor support structure, reactor vessel, or pool hardware. For those experimental facilities that penetrate the reactor vessel below any primary coolant water level, an analysis of the experimental design should demonstrate that the design is resistant to failure and that if failure occurs, it is bounded by the analysis in Chapter 13 for loss-of-coolant accident (LOCA). The placement or use of experimental facilities shall not compromise the functionality of any reactor safety system or engineered safety feature. The discussion should include the capabilities, limitations, and controls on reactor operation, including engineering or procedural controls for experiments, that ensure radiation doses do not exceed the requirements in 10 CFR Part 20 and are consistent with the facility program to keep exposure to radiation as low as reasonably achievable (ALARA).

Because of the potentially unlimited variety of experiments that can be accommodated in a non-power reactor, the applicant must show that administrative controls are adequate to ensure that the health and safety of the public are protected. The actual experiments to be performed need not be discussed in the SAR in detail, but the limiting and enveloping features of the experiments and the administrative procedures used by the licensee to review, approve, and safely control experiments should be described in the SAR. The SAR should provide the bases for experiment-related LCOs and for a detailed description and justification of the experiment review and acceptance program that are then specified in the Technical Specifications.

10.2 Summary Description

In this section of the SAR, the applicant should briefly describe and summarize the principal features of the experimental and irradiation facilities associated with the reactor. The SAR should clearly discuss the scope of the experimental program and define what is considered to be an experiment. Discussions should include experimental compatibility with normal reactor operations and accidents and measures taken to avoid interference with the reactor shutdown and other systems.

The applicant should include the following items:

- general focus of the experimental program (radiation science, medical, materials testing, teaching, etc.)
- a list of experimental facilities
- basic type of experiments that will be conducted (incore, thermal column, external beam, etc.)
- a brief description of experiment monitoring and control and the interaction between the experiment and the reactor control and safety systems
- a brief overview of the experiment design requirements and the review and approval process

Simple block diagrams and drawings may be used to provide the location, basic function, and relationship of each experimental facility to the reactor. The summary description should provide enough information for an overall understanding of the functions of the experimental facilities and the experiment review and approval process.

The following is a brief description of typical experimental facilities found at non-power reactors. This list is not exhaustive:

- **Incore Facilities.** Incore facilities are those facilities that are surrounded on at least two sides by fuel. Such facilities are commonly called void tubes, flux traps, central irradiation facilities, in-core irradiation facilities, radioisotope facilities, dummy and demountable fuel elements, fast and thermal neutron irradiation facilities, or central and offset thimbles. If the cross-sectional area of an incore facility is greater than 16 square inches, the reactor is considered a test reactor if the thermal power level exceeds 1 megawatt. The facility will also be considered a test reactor if there is a circulating loop through the core for conducting fuel experiments and the reactor power exceeds 1 megawatt.

- **In-reflector Facilities.** In-reflector facilities are those facilities that are physically located in the reflector and are surrounded either on all sides or on at least three sides by reflector material. In-reflector facilities might include lazy susans, void tubes, flux traps, thimbles, standpipes, or thermal neutron irradiation facilities.

- **Automatic Transfer Facilities.** Automatic transfer facilities, sometimes called "rabbits," are a special class of incore and in-reflector experimental facility. They often protrude into or are adjacent to the core or reflector and contain the experimental material. However, rabbit facilities allow the experimental material to be quickly moved into and out of the desired flux region of the core by pneumatic, hydraulic, or mechanical means. The material can be moved while the reactor is operating if limits on reactivity changes in the reactor are observed.

- **Beam Ports.** Beam ports are hollow tubes that can abut the core or protrude into the core or reflector. However, unlike the previously described incore and in-reflector facilities, they may or may not contain the experimental material. Instead, they may be used to channel radiation from the core to a position, usually outside the reactor vessel and the biological shield, where the experiment is located. Neutrons and gamma-ray beams are tailored to suit the experiment needs.

- **Thermal Columns.** Thermal columns function similar to beam ports in that they allow transport of radiation away from the core to areas where the experiment is located. Rather than a tube to guide radiation beams, they consist of a neutron moderator, typically a large volume of graphite blocks, enclosed in a container. The column is located at one face of the reactor in place of the reflector. Fast neutrons are thermalized within the moderator, and may be used outside or inside the reactor shield for experiments.

- **Irradiation Rooms.** Rooms or other dry cavities in the biological shield may be located adjacent to the reactor core (or the core moved into position) for irradiation of large volumes of material or objects.

- **Cold Neutron Sources.** A special type of beam port is the cold source. The neutrons are passed through a very cold moderator, such as frozen heavy water or hydrogen cooled by active cryostatic systems, to reduce their energy to below the normal thermal range and increase the relative flux densities of very-slow-speed neutrons. This allows a wider range of materials to be probed and allows the probability of interactions in some materials to increase. These cold neutron beams are sometimes used with neutron guides which can carry the neutrons substantial distances from the reactor without significant losses.

  If the source includes hydrogenous neutron moderators and cryogenic equipment, unique safety questions could arise. The acquisition of such a source could be included in the initial reactor design, obtained by later modification of an existing reactor, or installed in an approved experimental facility, such as a beam port or thermal column, of an existing reactor.

10.3 Experimental Facilities

All experimental facilities should be described and discussed in detail in this section. The final design should ensure that risks to the public, staff, and experimenters are acceptable. This section presents topics that should be addressed.

Experimental facilities, including related specifications and important design and operating parameters, should be described and discussed. Design details should be presented for the experimental facilities. The physical size, including all dimensions, should be given. Simplified engineering drawings or schematics may be used, especially for more complex facilities. The applicant should discuss the location of the experimental facility in relation to the core, safety systems, core support, neutron detectors, coolant system components, and any other reactor systems, components, or structures.

Features of the experimental facility that could interfere with safe reactor shutdown or with adequate core cooling must be included. The source of experiment coolant and any dependence on or interaction with the reactor cooling system should be discussed. For any experimental facilities that require a special cooling system independent of the reactor primary system, the technical evaluation considerations are similar to those for the reactor cooling system. The applicable guidance in Chapter 5, "Reactor Coolant Systems," should be followed for independent experiment cooling systems.

Experimental facility integrity is important, and the ability to contain or withstand any postulated pressure pulse and preclude any inadvertent primary coolant leakage or facility collapse must be discussed. Analysis should be presented for vessel or pool penetrations that could impact the risk of a LOCA. For experimental facilities that penetrate the reactor vessel below the water level of the pool surface, the SAR should show that if a LOCA does occur, the consequences are bounded by the LOCA analyses in Chapter 13. The LOCA analysis should also apply to the experimental facility if the facility must be cooled.

The SAR should discuss the materials used in the construction of the experimental facilities, addressing radiation and chemistry impacts. Materials and design, including physical dimensions, should limit any rapid reactivity insertion if the facility is suddenly voided or flooded. The supporting analysis should be included in Chapter 13, where the limiting experiment failure reactivity change is analyzed. The bases of applicable LCOs for the Technical Specifications should be developed and justified.

The radiological considerations associated with the design and use of the experimental facilities, generation of radioactive gases (including argon-41), release of fission products or other radioactive contaminants, and exposure of personnel to neutron and gamma beams should be summarized here and discussed in greater detail in Chapter 11, "Radiation Protection Program and Waste Management."

Direct radiation streaming from the experimental facilities and the effect of scattered (skyshine) radiation should be summarized here and analyzed in Chapter 11. The analysis should clearly show all pertinent radiation sources, distances, dimensions, materials, radiation scattering, and material attenuation factors.

Facilities that could fail and release Ar-41 or other airborne radioactivity into the facility air or to the environment should be analyzed. The analysis performed in Chapter 13 and summarized here should show the concentrations of radioactive material in the experimental facility, the release pathway, and the concentrations of radioactive material in the reactor facility and the outside environment. In some cases, this type of failure could be the MHA for the reactor, which is analyzed in Chapter 13.

Any radiation monitors specifically designed and placed to detect experiment radiation and to monitor personnel should be summarized here and discussed in greater detail in Chapters 7, "Instrumentation and Control Systems," and 11. Additionally, reactor operating characteristics, including scrams and runbacks associated with experimental measurements, should be analyzed.

Any physical restraints, shields, or beam catchers, both temporary and permanently installed, that are used to restrict access to radiation areas associated with experimental facilities should be described and analyzed. Descriptions and analyses should show that the placement, dimensions, and materials (1) are sufficient to limit the expected radiation doses to experimenters, reactor operators, and other personnel to levels below those required by 10 CFR Part 20 and (2) are consistent with the facility ALARA program. For reactor beams, the applicant should describe the approach to compliance with the regulations concerning access to high-radiation areas and very-high-radiation areas, as appropriate. These issues should be analyzed in Chapter 11 and briefly summarized here.

Permanently installed safety instrumentation for the experiment facility, including the location and function of sensors, readout devices, and scram or interlock capabilities, should be summarized here, and discussed in greater detail in Chapter 7.

Cold sources, because of their unique safety considerations, require the following information in addition to the applicable information discussed above:

- describe the cold source facility, including the operating principles and the design of the systems and components,

- describe the relevant ambient environmental conditions, such as radiation intensities and actual thermal sources, and their potential impact on the cold source components and materials,

- discuss the physical and chemical characteristics of the neutron moderator and coolant fluids, handling systems, volumes and states of matter at the operating temperatures and at ambient temperature, and all hardware, shielding, control, and safety features of the cold source,

- describe all applicable operations for preparing and using the facility, such as information for inserting and removing moderator and coolant fluids, storage, sensing, and measuring inventories and locations, determining contamination and leakage, chemical and physical changes of fluids and interactions with hardware, and producing and monitoring the operating temperatures and pressures,

- discuss the effect of the radiation environment, such as radiolysis and other radiolytic changes, in fluids, ozone and other gas formation or release, heating of fluids and components caused by radiation and by conduction or convection from nearby shield and structural components, and radioactivity of fluids and components,

- discuss the effect of leakage of fluids, such as toxicity, flammability, and potential to detonate addressing changes in composition, mixtures, or other characteristics of neutron moderator and coolant fluids with use and cycling, and

- describe provisions for safe (passive) shutdown of the cold source and reactor as a system.

Technical specifications for experimental facilities, as discussed in Chapter 14, should be presented and justified in this section of the SAR.

10.4 Experiment Review

Because of the variety of experiments that can be conducted in a non-power reactor, the administrative controls of the applicant must be adequate to ensure the protection of the public. The administrative procedures used by the applicant to review and approve experiments should be described in detail in Chapter 10, and summarized in Chapter 12, "Conduct of Operations," with operating limits included in the Technical Specifications. The SAR should state the safety analysis requirements for the experiment safety analysis report, the experiment review and approval methodology, and should briefly discuss the authority and role of the experiment review committee.

The SAR should discuss experiment classification and approval authority. The SAR should state the methodology used to categorize proposed experiments according to risk potential, the categories expected at the reactor facility, and the safety requirements for each category. The methodology should describe how 10 CFR 50.59 will be used in the review of all experiments not described in the SAR, as well as how Regulatory Guides 2.2, "Development of Technical Specifications for Experiments in Research Reactors," and 2.4, "Review of Experiments for Research Reactors," (Appendix 10.1 and 10.2) will be used. The appropriate level of review authority required to approve experiments in each category should be discussed. The facility SAR should be specific in delineating the bounds of the risk categories, such as gram amounts, temperature degree limits, radioactivity limits, or reactivity limits, and should develop the bases of applicable technical specifications. The experiment safety analysis process should demonstrate compliance with these limits and establish any special controls on the experiment.

The SAR should discuss experiment administrative controls. The SAR should list the administrative controls used to protect facility personnel and the public from radiation or other possible hazards, such as chemical releases, in the performance of the experimental program. Where appropriate, the discussion should delineate areas in which reactor operations and experiment operations are performed under separate authority and by different personnel. Areas of discussion should include access to experiment facilities and areas, lockout procedures, communications with reactor operating personnel, alarms, and reactor scrams. The administrative procedures should address basic protection and recovery procedures following a malfunction of experiments or experimental facilities.

The SAR should discuss the generic safety assessment of experiment materials and limitations consistent with the guidance in Regulatory Guide 2.2, from which experiment and reactor LCOs are incorporated in the Technical Specifications. Malfunctions or failures of experiments with significant potential for radiological consequences should be analyzed in Chapter 13 of the SAR, and summarized here. For some reactors, the most serious accident or the MHA could be initiated by an experiment malfunction. Areas of assessment should include the following:

- fissile materials, and radiological risks from radiation fields or release of radioactive material
- trace elements and impurities
- effects on reactivity, both positive and negative
- explosive, corrosive, and highly reactive chemicals
- radiation-sensitive materials
- flammable or toxic materials
- cryogenic liquids
- unknown materials
- radiation heating or damage that could cause experiment malfunction
- heating that could cause departure from nucleate boiling on surfaces

Appendix 10.1

Regulatory Guide 2.2

Development of Technical Specifications for Experiments in Research Reactors

November 1973

U.S. ATOMIC ENERGY COMMISSION
REGULATORY GUIDE
DIRECTORATE OF REGULATORY STANDARDS

REGULATORY GUIDE 2.2

DEVELOPMENT OF TECHNICAL SPECIFICATIONS FOR EXPERIMENTS IN RESEARCH REACTORS

A. INTRODUCTION

Paragraph 50.34(b)(4) of 10 CFR Part 50, "Licensing of Production and Utilization Facilities," requires that each application for an operating license provide a final analysis and evaluation of the design and performance of structures, systems, and components of the facility with the objective of assessing the risk to public health and safety resulting from operation of the facility. Section 50.36 of 10 CFR Part 50 requires that each such application also include proposed technical specifications derived from the analyses and evaluation performed for the safety analysis report (SAR).

This guide describes information that should be included in proposed technical specifications for experiments in research reactors. It identifies considerations that should be addressed in the evaluation of experimental programs as well as considerations that should be addressed to define limits and other requirements to be included in the technical specifications. It is expected that the guidelines delineated here will be adapted, as required, to specific features and characteristics of individual research reactors.

B. DISCUSSION

Each safety analysis report (SAR) contains a description of the proposed experimental program and safety analyses for each type of experimental facility proposed. It includes descriptions of and safety analyses for permanently installed facilities such as beam tubes, thermal columns, hydraulic or pneumatic tube systems, and other types of capsule irradiation facilities, and movable experimental facilities (in some types of reactors) which accommodate placement of shells, tubes, trays, baskets, or other guiding or positioning devices in or adjacent to the reactor core. Safety analyses for special modes of reactor system or component use to accommodate individual, repetitive, or multiple experiments should also be provided. These can include such categories as reactor pulsing, use of reactor coolant or fuel as gamma radiation sources, or use of fuel in subcritical arrays separated from the core.

The design, construction, and placement of each experimental facility should be analyzed for inherent safety questions that exist apart from experiments accommodated therein. In addition, for each experimental facility and mode of reactor system or component use, the descriptions and safety analyses should address the types and scopes of experiments intended to be performed.

The purposes of presenting such safety analyses are (1) to demonstrate that the experimental program as envisioned at the time of presentation of the SAR can be carried out without undue risk to the public health and safety, (2) to demonstrate the technical ability to carry out the kind of safety analyses which is expected to be done on a continuing basis throughout the evolution of the experimental program, (3) to establish bases against which unreviewed safety questions can be measured pursuant to paragraph (c) of §50.59, and (4) to develop subject matter appropriate for inclusion in technical specifications.

Safety in research reactor experimentation requires that consideration be given to any feature of the design or conduct of an experiment, including intended functions and possible malfunctions, which can create, directly or indirectly, a radiological exposure hazard. Safety analyses for experiments should consider (1) any interaction of an experiment with the reactor system that has the potential for breaching any primary barrier to fission product release from fuel, (2) any interaction of an experiment with the reactor system that could adversely affect any engineered safety features or control system features designed to protect the public from a fission product release, (3) any inherent feature of an experiment that could create beams, radiation fields, or unconfined radioactive materials, and (4) any potentially adverse interaction with concurrent experimental and operational activities.

A variety of specific technical factors, considered against the foregoing criteria, can give rise to safety problems as follows:

1. Factors in experiments which could cause a breach in any of the fission product barriers.

a. Reactivity effects as a result of placement or removal of an experiment or of motion of material within the experiments due, for example, to forced or natural convection of fluids, phase changes, chemical or radiolytic dissociation, or mechanical instability.

b. Thermal effects on fuel which alter local heat generation or heat transfer rates as a result of neutron flux perturbations, gamma heating, electrical heating, or alteration of coolant temperature or flow by experiment components or failure thereof due to heating, radiation degradation, or radiolytic dissociation.

c. Mechanical forces on fuel cladding arising from the manipulation of experimental components, from tools used for such manipulation, from thermal stress, vibration, or shock waves, or from missiles arising from functioning or malfunctioning experiments.

d. Chemical attack, including corrosion, resulting from the use in or escape of materials into the fuel environment or accelerated corrosion due to elevated temperatures.

2. Factors in experiments which could adversely affect engineered safety features or control system features.

a. Neutron flux perturbations affecting calibrations of safety channels and/or rod worths.

b. Mechanical forces adversely affecting shielding or confinement arising from causes as in 1.c. above.

c. Radiation fields or radioactive releases from experiments which can mask the performance of an operational monitoring system intended for the detection of fission product releases at early stages.

d. Physical interference by experiment components with reactor system components such as control or safety rods or physical displacement of reactor system shielding.

3. Factors in experiments which could create radiological risks due to radiation fields or unconfined radioactive material.

a. Use of materials which are or become chemically unstable or highly reactive or are subject to buildup of temperature or pressure, e.g., pressure buildup in special beam port plugs.

b. Irradiation of finely divided solids, liquids, or gases which are readily airborne if inadequately confined.

c. Degradation or failure of materials intended to confine experiments, e.g., by radiation decomposition of nonmetallic capsules, weld failures, gasket failures, excessive internal heat generation, or inadequate cooling.

d. Degradation or failure of vent systems or filter installations or inadequate shielding thereof.

e. Degradation or failure of safety-related instruments or control devices on experiments.

f. Mechanical instability resulting in unintended movement of an experiment relative to its shielding, e.g., by faulty stacking of lead brick, by exceeding floor loading capabilities, or by capsules becoming buoyant in water.

g. Use of inadequate devices for shielding and handling experiment components or capsules following irradiations.

4. Factors relating to interactions with other experiments or with operational activities.

a. Reactivity effects of concurrent motion occurring in two or more experiments.

b. Potentially adverse interactions resulting from the use of common electric circuits and supplies and common portions of fluid systems such as manifolds for cooling water, vent, or drain systems.

c. Physical interference by experiments with patterns of operational activity which could impede or prevent a safety or emergency function, e.g., blocking of access routes.

d. Creation of industrial hazards such as the generation or release of toxic or noxious materials which could impair the ability of operators to perform necessary reactor safety functions.

e. Special modes of reactor operation such as pulsing, abnormal occurrences in reactor operation, or reactor accidents which could trigger failures in experiments.

The proposed technical specifications that are relevant to experiments in research reactors should (1) have bases relating to safety considerations as required by §50.36(a), (2) address subject areas that are clearly under the direct control of the licensee, and (3) fall under the categories of limiting conditions for operation, surveillance requirements, design features, or administrative controls, as specified in §50.36. Situations may arise in which the safety analyses of some unique experiments establish the need to consider the effects of such experiments on the safety limits and limiting safety system settings for reactor operation.

Technical specifications should provide reasonable flexibility to perform experiments, install new experimental facilities, or change or remove from use facilities previously described. Proposed technical specifications should address safety-oriented considerations, as distinct from functional or end-use descriptions of experimental programs. On the other hand, all safety considerations implicit in each individual experiment proposed must be enumerated and evaluated to determine whether or not they fall within the safety analysis for reactor operation presented in the SAR. In addition the proposed experiment should be evaluated in detail and its execution controlled so as to reduce any radiation dose to plant personnel and the public to the lowest practicable level.

C. REGULATORY POSITION

The safety-oriented considerations from which technical specifications for experiments should be developed include (1) the physical conditions of the design and conduct of experiments, (2) the materials content of experiments, and (3) the administrative controls employed to evaluate, authorize, and carry out experiments. The material that follows is organized according to the above three considerations, but it is not intended that this be the only format acceptable for use for proposed technical specifications. The definitions of certain terms used in this section are given in Appendix A.

1. Physical Conditions

a. Reactivity Effects

From a safety standpoint, the principal concern is that associated with a net positive reactivity effect, whether it is caused by the insertion of an experiment having a positive reactivity effect or by the removal of an experiment having a negative reactivity effect. Credit may be taken for the operation of the reactor safety system and engineered safeguards systems provided (1) they have been designed to standards and criteria establishing very high reliability, such as ANSI N42.7 (IEEE-279), (2) adequate quality assurance was provided in their construction and is provided during operation, and (3) it can be shown that they can function independently of the assumed experiment failure mode. All proposed transients should be analyzed to assure that a safety limit would not be exceeded.

(1) Every experiment should be evaluated for its static reactivity worth and its potential reactivity worth.

(2) The potential reactivity worth of each secured removable experiment should be less than that value of reactivity which, if introduced as a positive step change, could result in a transient that would be likely to lead to doses in any restricted or unrestricted area in excess of the limits set forth in 10 CFR Part 20.

(3) The magnitude of the potential reactivity worth of each unsecured experiment should be less than that value which, if introduced as a positive step change in reactivity, would cause a violation of a safety limit or of the minimum shutdown margin.

(4) The rate of change of reactivity of any unsecured experiment, any movable experiment, or any combination of such experiments introduced by intentionally setting the experiment(s) in motion relative to the reactor should not exceed the capacity of the control system to provide compensation.

(5) The sum of the magnitudes of the static reactivity worths of all unsecured experiments which coexist should not exceed the maximum value of potential reactivity worth authorized for a single secured removable experiment or the minimum shutdown margin, whichever is less.

b. Thermal-Hydraulic Effects

(1) Every experiment should be evaluated for its actual and potential thermal effects on reactor components and coolant. Normally, this evaluation should be made for the reactor at the extremes of its operating margin, as defined by limiting safety system settings.

(2) Experiments should be designed to prevent the negation of any flux peaking or reactor coolant flow considerations that have been used to define or are implicit in the safety limits for the reactor. Coolant flow considerations should include potential blockage or redistribution and potential phase changes in liquid coolant.

(3) The surface temperature of the material which bounds or supports any experiment should not exceed the lowest of the following, where applicable:

(a) the saturation temperature of liquid reactor coolant at any point of mutual contact.

(b) a temperature conservatively below that at which the corrosion rate of the boundary material at any surface would lead to its failure, or,

(c) a temperature conservatively below that at which the strength of the boundary material would be reduced to a point predictably leading to failure.

c. Mechanical Stress Effects

(1) Every experiment should be evaluated with respect to the storage and possible uncontrolled release of any mechanical energy.

(2) Experiments involving a potential for creating objects with substantial momentum (missiles) should be oriented in such a way as to minimize the probability of damage to the reactor system.

(3) Materials of construction and fabrication and assembly techniques utilized in experiments should be so specified and used that assurance is provided that no stress failure can occur at stresses twice those anticipated in the manipulation and conduct of the experiment or twice those which could occur as a result of unintended but credible changes of, or within, the experiment.

(4) Prototype testing under experiment conditions should be employed to demonstrate the ability to withstand failure.

2. **Material Content of Experiments**

Certain kinds of materials which may be used in experiments possess properties with significant safety implications. Limitations on the amounts of such materials can limit the consequences of experiment failures. The material content of every experiment should be analyzed and limited according to the classifications given below.

a. **Radioactive materials**

(1) The radioactive material content, including fission products, of any singly encapsulated experiment should be limited so that the complete release of all gaseous, particulate, or volatile components from the encapsulation will not result in doses in excess of 10% of the equivalent annual doses stated in 10 CFR Part 20. This dose limit applies to persons occupying (1) unrestricted areas continuously for two hours starting at time of release or (2) restricted areas during the length of time required to evacuate the restricted area.

(2) The radioactive material content, including fission products, of any doubly encapsulated or vented experiment should be limited so that the complete release of all gaseous, particulate, or volatile components from the encapsulation or confining boundary of the experiment could not result in (1) a dose to any person occupying an unrestricted area continuously for a period of two hours starting at the time of release in excess of 0.5 rem to the whole body or 1.5 rem to the thyroid or (2) a dose to any person occupying a restricted area during the length of time required to evacuate the restricted area in excess of 5 rem to the whole body or 30 rem to the thyroid.

(3) For purposes of applying the above considerations, a single-mode nonviolent failure of the encapsulation boundary that releases all radioactive material into the immediate environment of the experiment or to the reactor building, as appropriate, should be assumed. The analysis should establish the most probable trajectory of the material, if any, into restricted and unrestricted areas. Credit for natural consequence-limiting features such as solubility, absorption, and dilution and for installed features such as filters may be taken provided each such feature is specifically identified and conservatively justified by specific test or physical data or well-established physical mechanisms. In addition, with respect to installed features, credit taken for their effectiveness should depend on the adequacy of the related quality assurance procedures undertaken, including the extent to which surveillance tests simulate the conditions to be met in practice. If assumptions regarding atmospheric dilution are involved, they should not be less conservative than those used in the analysis of Design Basis Accidents.

Irradiation of fissionable materials, excluding the fissionable material content of fuel element assemblies described in the technical specifications, should be deemed an unreviewed safety question unless a specification meeting the above criteria and its related safety analysis have been approved by the Commission. With respect to other radioactive materials, specifications and safety analyses should be submitted that are representative of experiments with either the highest inventory of radioactive materials or the highest probability for failure that could result in the escape of such material into restricted and unrestricted areas. In addition, records should be generated and maintained to allow for review to demonstrate that the radioactive material content of each individual experiment does not exceed that allowed by the stated criteria.

These considerations should not be interpreted (1) to permit or encourage any unnecessary intentional releases of radioactive materials to unrestricted areas, or (2) to relieve the obligation to minimize and control radiation doses in restricted areas.

b. **Trace Elements and Impurities**

A reasonable effort should be made to identify in advance of an experiment trace elements or impurities whose activation products may represent the dominant radiological hazard.

c. **High-Cross-Section Materials**

Nuclides possessing high thermal neutron absorption cross sections should be identified and limited with respect to their quantity or method of inclusion in individual experiments in order to control reactivity or thermal effects within the limitations specified.

d. **Highly Reactive Chemicals**

The inclusion of explosive materials in experiments constitutes an unreviewed safety question unless such usage has been reviewed and approved by the Commission, except that amounts up to 25 milligrams of TNT equivalent may be irradiated or stored inside the reactor confinement system in accordance with regulatory position C.1.c.

e. **Corrosive Chemicals**

A list should be prepared identifying materials which are chemically incompatible with the reactor system from the viewpoint of corrosion and which should be excluded from any experiments or the use of which is subject to special scrutiny and control. This list should be provided to all who use the reactor.

f. **Radiation-Sensitive Materials**

The evaluation of each experiment should include an assessment of the consequences of physical or chemical changes in the material content as a result of its presence in a radiation environment, particularly for nonmetallic materials.

Effects to be considered include the alteration or degradation of mechanical properties due to radiation-induced decomposition, e.g., of plastics or polymers, and radiolytic generation of excessive gas pressure or explosive gas mixtures.

g. Flammable or Toxic Materials

Procedures control should incorporate mechanisms for handling and limiting the quantities of highly flammable or toxic materials used in experimental programs or used in the reactor room.

h. Cryogenic Liquids

The inclusion of cryogenic liquids within the biological shield of a research reactor would constitute an unreviewed safety question unless such usage has been reviewed and approved by the Commission.

i. Unknown Materials

No experiments should be performed unless the material content, with the exception of trace constituents, is known.

3. Administrative Controls of Experiments

a. Internal Authorization

(1) Evaluation by Safety Review Group

(a) No experiment should be performed without review and approval by a technically competent Safety Review Group or Committee. Repetitive experiments with safety considerations in common may be reviewed and approved as a class.

(b) Criteria for review of an experiment or class of experiments should include (1) applicable regulatory criteria, including those in 10 CFR Part 20 and the technical specifications and (2) in-house safety criteria and rules which have been established for facility operations, including those which govern requirements for encapsulation, venting, filtration, shielding, and similar experiment design considerations, as well as those which govern the quality assurance program required under § 50.34.

(c) Records should be kept of the Safety Review Group's review and authorization for each experiment or class of experiments.

(2) Operations Approval

(a) Every experiment should have the prior explicit written approval of the Licensed Senior Operator in charge of reactor operations.

(b) Every person who is to carry out an experiment should be certified by the Licensed Senior Operator in charge of reactor operations as to the sufficiency of his knowledge and training in procedures required for the safe conduct of the experiment.

b. Procedures for Active Conduct of Experiments

(1) Detailed written procedures should be provided for the use or operation of each experimental facility.

(2) The Licensed Operator at the console should be notified just prior to moving any experiment within the reactor area and should authorize such movement.

(3) Each experiment removed from the reactor or reactor system should be subject to a radiation monitoring procedure which anticipates exposure rates greater than those predicted. The results of such monitoring should be documented.

c. Procedures Relating to Personnel Access to Experiments

(1) There should be a documented procedure for the control of visitor access to the reactor area to minimize the likelihood of unnecessary exposure to radiation as a result of experimental activities and to minimize the possibility of intentional or unintentional obstruction of safety.

(2) There should be a written training procedure for the purpose of qualifying experimenters in the reactor and safety-related aspects of their activities, including their expected responses to alarms.

d. Quality Assurance Program

There should be a Quality Assurance Program covering the design, fabrication, and testing of experiments, including procedures for verification of kinds and amounts of their material contents such as those described in regulatory position C.2.

APPENDIX A

DEFINITIONS

1. **Experiment**--An experiment, as used herein, is any of the following:
   a. An activity utilizing the reactor system or its components or the neutrons or radiation generated therein;
   b. An evaluation or test of a reactor system operational, surveillance, or maintenance technique;
   c. An experimental or testing activity which is conducted within the confinement or containment system of the reactor; or
   d. The material content of any of the foregoing, including structural components, encapsulation or confining boundaries, and contained fluids or solids.

2. **Experimental Facility**–An experimental facility is any structure or device which is intended to guide, orient, position, manipulate, or otherwise facilitate a multiplicity of experiments of similar character.

3. **Explosive Material**–Explosive material is any solid or liquid which is categorized as a Severe, Dangerous, or Very Dangerous Explosion Hazard in "Dangerous Properties of Industrial Materials" by N. I. Sax, Third Ed. (1968), or is given an Identification of Reactivity (Stability) index of 2, 3, or 4 by the National Fire Protection Association in its publication 704-M, 1966, "Identification System for Fire Hazards of Materials," also enumerated in the "Handbook for Laboratory Safety" 2nd Ed. (1971) published by The Chemical Rubber Co.

4. **Movable Experiment**–A movable experiment is one which may be inserted, removed, or manipulated while the reactor is critical.

5. **Potential Reactivity Worth**–The potential reactivity worth of an experiment is the maximum absolute value of the reactivity change that would occur as a result of intended or anticipated changes or credible malfunctions that alter experiment position or configuration.

   The evaluation must consider possible trajectories of the experiment in motion relative to the reactor, its orientation along each trajectory, and circumstances which can cause internal changes such as creating or filling of void spaces or motion of mechanical components. For removable experiments, the potential reactivity worth is equal to or greater than the static reactivity worth.

6. **Removable Experiment**–A removable experiment is any experiment, experimental facility, or component of an experiment, other than a permanently attached appurtenance to the reactor system, which can reasonably be anticipated to be moved one or more times during the life of the reactor.

7. **Secured Experiment**–Any experiment, experimental facility, or component of an experiment is deemed to be secured, or in a secured position, if it is held in a stationary position relative to the reactor by mechanical means. The restraining forces must be substantially greater than those to which the experiment might be subjected by hydraulic, pneumatic, buoyant, or other forces which are normal to the operating environment of the experiment, or by forces which can arise as a result of credible malfunctions.

8. **Static Reactivity Worth**–As used herein, the static reactivity worth of an experiment is the absolute value of the reactivity change which is measurable by calibrated control or regulating rod comparison methods between two defined terminal positions or configurations of the experiment. For removable experiments, the terminal positions are fully removed from the reactor and fully inserted or installed in the normal functioning or intended position.

9. **Unsecured Experiment**–Any experiment, experimental facility, or component of an experiment is deemed to be unsecured if it is not and when it is not secured as defined in 7. above. Moving parts of experiments are deemed to be unsecured when they are in motion.

Appendix 10.2

Regulatory Guide 2.4

Review of Experiments for Research Reactors

U.S. NUCLEAR REGULATORY COMMISSION

July 1976

REGULATORY GUIDE

OFFICE OF STANDARDS DEVELOPMENT

REGULATORY GUIDE 2.4

REVIEW OF EXPERIMENTS FOR RESEARCH REACTORS

A. INTRODUCTION

Section 50.36, "Technical Specifications," of 10 CFR Part 50, "Licensing of Production and Utilization Facilities," requires that each applicant for a license authorizing operation of a production or utilization facility include in his application proposed technical specifications. If acceptable, these technical specifications, along with any other such specifications that the Commission finds appropriate, are incorporated into the facility license that is issued by the Commission and are conditions of the license.

Paragraph (c)(5), "Administrative controls," of § 50.36 of 10 CFR Part 50 requires that technical specifications for nuclear reactors include provisions relating to the organization and management procedures, recordkeeping, review and audit, and reporting necessary to ensure operation of the facility in a safe manner. Section 50.59, "Changes, tests and experiments," of 10 CFR Part 50 permits each holder of a license authorizing operation of a production or utilization facility to make changes in the facility and procedures as described in the safety analysis report (SAR) and to conduct tests or experiments not described in the SAR, without prior Commission approval, unless the proposed change, test, or experiment involves a change in the technical specification incorporated in the license or an unreviewed safety question.

This guide describes procedures acceptable to the NRC staff for the licensee's review and approval of experiments performed at research reactor facilities.

B. DISCUSSION

Standard ANSI N401-1974 (ANS-15.6), "Review of Experiments for Research Reactors,"* was prepared by Work Group ANS-15.6 and sponsored by

*Copies may be obtained from the American Nuclear Society, 244 East Ogden Avenue, Hinsdale, Illinois 60521.

Subcommittee ANS-15 (Research Reactors) of the American Nuclear Society (ANS). This standard was approved by the American National Standards Committee N17, Research Reactors, Reactor Physics and Radiation Shielding, and its Secretariat in March 1974. It was subsequently approved and designated ANSI N401-1974 by the American National Standards Institute (ANSI) on November 19, 1974. The standard provides guidance for the licensee's review and approval of experiments performed at research reactor facilities by identifying substantive areas for each experiment that should be reviewed to provide assurance that the experiment (1) falls within the limits delineated in the technical specifications, (2) does not present an unreviewed safety question as defined in §50.59, "Changes, tests and experiments," of 10 CFR Part 50, (3) does not constitute a threat to the health and safety of any individuals, and (4) does not constitute a hazard to the reactor facility or other equipment. In addition, this standard recommends a system for classifying experiments to establish levels of licensee review and approval commensurate with the level of risk inherent in the experiment. Both the requirements and the recommendations of the standard have been evaluated by the staff in evaluating the acceptability of this standard.

C. REGULATORY POSITION

The requirements and recommendations provided in ANSI N401-1974, "Review of Experiments for Research Reactors," are generally acceptable to the NRC staff. The guidance provides an adequate basis for the review and approval of research reactor experiments performed in accordance with §§50.36 and 50.59 of 10 CFR Part 50, subject to the following:

1. The last sentence of the paragraph defining, "shall, should and may," as given in Section 3, "Definitions," of ANSI N401-1974 should be modified to read as follows: "To conform to this standard, experiment review shall be performed in accordance with the standard's requirements and recommendations."

2. The definition of non-secured experiment, as given in Section 3, "Definitions," should be modified to read as follows: "Any experiment, experimental facility, or component of an experiment is considered to be unsecured when it is not secured as defined under secured experiment in Section 3."

3. Subsection 4.1, "Classification System," should be modified by adding the following sentence: "The experiment classification system to determine level of approval for the experiments should be reviewed and approved by the Reactor Safety Committee designated in the Technical Specifications."

4. In addition to the experiment plan (Section 5, "The Experimental Plan"), there should also exist detailed procedures for carrying out an

experiment, and these procedures should be reviewed as required by the facility's technical specifications. A single experimental procedure may be used for more than one exposure or more than one identical experiment, but such a procedure should expire after a specified interval.

5. Subsection 6.1, "Review Procedure," should be modified by adding the following sentence: "The experiment review procedure should be reviewed and approved by the Reactor Safety Committee designated in the Technical Specifications."

6. Paragraph (3) of Subsection 6.2, "Considerations," should be replaced with the following: "Does the experiment meet all criteria regarding reactivity effects? These criteria include assurance that (1) the potential reactivity worth of each secured experiment would be less than that value of reactivity which, if introduced as a positive step change, could result in a transient that would be likely to lead to doses in any restricted or unrestricted area in excess of the limits set forth in 10 CFR Part 20; (2) the magnitude of the potential reactivity worth of each non-secured experiment would be less than that value which, if introduced as a positive step change in reactivity, would cause a violation of a safety limit or of the minimum shutdown margin; and (3) the rate of change and magnitude of reactivity of any moveable experiment, moveable parts of experiments, or any combination of such experiments introduced by intentionally setting the experiments in motion relative to the reactor would not exceed the capacity of the control system to provide compensation."

7. In Subsection 6.3, "Review Personnel," the last paragraph should be replaced with the following: "Members of the Committee should disqualify themselves from the review of experiments in which they are directly involved. They may act as consultants to the review group but should not be involved with the final decision for approval or disapproval of the experiment."

8. The specific applicability or acceptability of items 1, 3, 4, and 5 of Section 9, "References," of ANSI N401-1974 will be covered separately in other regulatory guides, where appropriate.

D. IMPLEMENTATION

The purpose of this section is to provide guidance to applicants regarding the NRC staff's plans for using this regulatory guide in the review of research reactor facility applications. The staff will use this guide in evaluating applications submitted after the date shown below. However, all or part of this guide may be used by the staff to the extent reasonable and practicable for evaluating prior applications. Such use is usually reflected in the staff review questions and subsequent evaluations for specific cases. Backfitting action, if required, will be considered separately pursuant to Section 50.109 of 10 CFR Part 50.

Except in those cases in which the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the method described herein will be used by the staff in evaluating applications in connection with research reactor facility construction permits, operating licenses, or proposed amendments thereto submitted for approval after March 1, 1977.

NUCLEAR ENGINEERING TEACHING LABORATORY

PROCEDURE HP 1

RADIATION MONITORING - PERSONNEL

Approvals:

Health Physicist	Date 1/15/93
Reactor Supervisor	Date 1/15/93
Director, NETL	Date 1/15/93
Chairperson, Reactor Committee	Date 1/15/93
Chairperson, Radiation Safety Committee	Date 1/27/93

List of Pages: 1 2 3 4 5 6

Attachments:
- A Daily Exposure Record
- B Visitor Dosimeter Record

BALCONES RESEARCH CENTER
THE UNIVERSITY OF TEXAS AT AUSTIN

Record of Procedure Changes

Page	*Date	*Initial	*Change
2	11/1/93		Page 2 of 6, Section II, paragraph 1
			sentence #1 - change
			old: "... any area, access to which is controlled
			by the licensee for purposes of protection of individ-
			uals from exposure to radiation and radioactive mater-
			ials."
			new: "... an area, access to which is limited by the
			licensee for the purpose of protecting individuals
			against undue risks from exposure to radiation and
			radioactive materials."
3	11/1/93		Page 3 of 6, Section IV
			A2. sentence #2 - replace
			old: The whole body is defined as the head and trunk
			down to the knees, and upper arms down to the elbow.
			new: Whole body means, for purposes of external ex-
			posure, head, trunk (including male gonads), arms
			above the elbow, or legs above the knee.
			B1. sentence #2 change
			old: .... dosimetry for the individual.
			new: ... dosimetry to be assigned to the individual.

Record of Procedure Changes

Page	*Date	*Initial	*Change
	*	*	* C2. sentence #2 - change
	*	*	* old: ... accumulated dose per quarter....
	*	*	* new: ... accumulated monthly dose....
4	* 11/1/93	*	* Page 4 of 6
	*	*	* C2.a sentence #1 - change
	*	*	* old: ...record the reading in the PD INITIAL column
	*	*	* of the logsheet.
	*	*	* new: ... record the dosimeter serial # in the DOSIMETER
	*	*	* ID column, and the reading in the INITIAL reading
	*	*	* column of the Daily Exposure Logsheet.
	*	*	* C2.b sentence #1 - change
	*	*	* old: ...in the PD FINAL column of the logsheet.
	*	*	* the DAILY DOSE.
	*	*	* new: ...in the FINAL READING column of the logsheet.
	*	*	* C2.c sentence #1 - replace
	*	*	* old: Add ... entry.
	*	*	* new: In the DOSE column, record the value obtained by
	*	*	* subtracting the dosimeters initial reading from the
	*	*	* final reading, and initial the entry. At the end of
	*	*	* each month, the summation of the daily doses is re-

Record of Procedure Changes

Page	Date	Initial	Change
			corded in the MONTH TOTAL box.
			C2.c sentence #2 - change
		[initials]	old: ...THAT THEIR QUARTER TOTAL DOES NOT ...
		[initials]	new: ...THAT THEIR MONTH TOTAL DOES NOT...
			C.2.d. sentence #1 - change
		[initials]	old: ...adjust the QUARTER TOTAL based on the results of the permanent dosimetry readings.
		[initials]	new: ...adjust the YEAR TO DATE total from data obtained from permanent dosimetry reports.
6	11/1/93		Page 6 of 6, Paragraph V, B.2.c. sentence #1 - replace
		[initials]	old: Asterisk the DOSIMETER IN column on the Daily Exposure Logsheet and record estimated dose.
		[initials]	new: Mark the ~~CHECK~~ check column and record the estimated dose in the DOSE column.

I. PURPOSE

To describe the requirements and methods for dose assessment of personnel working at or visiting the Nuclear Engineering Teaching Laboratory (NETL).

II. DISCUSSION

Title 10, CFR Part 20 defines a Restricted Area as "...any area, access to which is controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials." This procedure outlines the personnel monitoring requirements for individuals who enter any Restricted Area within the NETL.

Accurate assessment of personnel exposure is necessary not only to comply with Federal Regulations, but to evaluate the licensee's ALARA (As Low As Reasonably Achievable) program effectiveness. Therefore, it is incumbent upon all personnel who work at or visit the NETL to be cognizant of, and ensure compliance with, the requirements of this procedure.

III. REFERENCES

A. Title 10, Chapter 1, Code of Federal Regulations, Part 20 (10 CFR 20), "Standards for Protection Against Radiation."

B. Texas Regulations for Control of Radiation, Part 21 (TRCR 21),"Standards for Protection Against Radiation."

C. ANSI/ANS - 15.11, 1987, "Radiation Protection at Research Reactor Facilities."

D. University of Texas, July 1988, "Manual of Radiation Safety."

IV. PROCEDURE

A. Dosimetry Requirements

1. Any person who enters a Restricted Area of the NETL is required to wear dosimetry. The type of dosimetry required is determined by the Health Physicist, or in his absence, the NETL Director or Reactor Supervisor.

2. Personnel dosimetry is to be worn on the portion of the whole body that is expected to receive the highest dose. The whole body is defined as the head and trunk down to the knees, and the upper arms down to the elbow. For most applications, the dosimetry should be worn in the chest or belt area. For special applications, the dosimetry should be adjusted to be worn in the area receiving the highest dose. For example, when working in a radiation field emanating from the floor, the dosimetry should be worn just above the knee of one leg.

3. Special dosimetry (i.e. finger rings, neutron badges, etc.) shall be worn at the direction of the Health Physicist. The Health Physicist is responsible for periodic review of all activities in the NETL to ensure that the proper dosimetry is provided; however, it is the ultimate responsibility of each person who enters a Restricted Area to ensure that the proper dosimetry is worn for the activity performed.

B. Permanent Dosimetry

1. Permanent dosimetry for NETL is requested by completing Form USO 1-15, "Request for Film Badge Service". The NETL Health Physicist reviews this form and approves the need for, and type of dosimetry for the individual.

2. Personnel assigned permanent dosimetry are required to wear a pocket dosimeter at all times, in addition to their permanent dosimetry.

C. Pocket Dosimeters

1. Any person who enters a Restricted Area of the NETL is required to wear a pocket dosimeter. This requirement is in addition to any permanent or special dosimetry that is issued to the person. The requirement does not apply to visitors who are covered under section D of this procedure. During work in a Restricted Area, the pocket dosimeter shall be checked periodically to monitor dose. When a pocket dosimeter reads three-fourths of scale, the wearer shall exit the area, record the dose, and rezero the pocket dosimeter.

2. All personnel who are not classified as visitors shall have a Daily Exposure Logsheet (HP1 Form A) issued to them. This logsheet tracks accumulated dose per quarter as indicated by pocket dosimeter readings. Each person is responsible for completing the logsheet as follows:

a. Prior to entering a restricted area, obtain a pocket dosimeter and zero it to between 0 and 10% of scale, and record the reading in the PD INITIAL column of the logsheet.

b. At the end of the day, record the pocket dosimeter reading in the PD FINAL column of the logsheet. the DAILY DOSE.

c. Add the recorded DAILY DOSE to previous entry QUARTER TOTAL, record it in the proper column, and initial the entry.

NOTE: IT IS THE RESPONSIBILITY OF EACH INDIVIDUAL TO ENSURE THAT THEIR QUARTER TOTAL DOES NOT EXCEED THEIR ASSIGNED LIMIT.

d. For personnel assigned permanent dosimetry, the Health Physicist will periodically adjust the QUARTER TOTAL based on the results of the permanent dosimetry readings.

D. VISITORS

1. Escorts

a. Personnel who are authorized to escort visitors into restricted areas are listed in the front of the visitors log book. Additions to the escort list can only be granted by the NETL Director, Reactor Supervisor, or Health Physicist.

b. Escorts of visitors are responsible for their visitors at all times. Visitors should remain within the escort's line of sight at all times. The escort is responsible for the visitor's adherence to established radiological procedures, and response to emergency signals.

c. Escorts are responsible for completing the information in the visitor card (HP 1 Form B).

d. Escorts are responsible for ensuring that their visitor(s) have the proper dosimetry in compliance with this procedure.

e. Authorization for visitor access to the reactor floor must be obtained from the Health Physicist or, in his absence, the NETL Director or Reactor Supervisor.

Step	Action and Response	Comment or Correction

2. Dosimetry

   a. Each visitor or group shall wear a pocket dosimeter to enter any building restricted area.

   b. Visitors film badges will be maintained and issued by the Health Physicist on an as-needed basis.

   c. Tour groups may be issued a dosimeter at the discretion of the Health Physicist. For tour groups, at least one pocket dosimeter should be issued for every ten visitors.

V. ABNORMAL CONDITIONS

A. Lost Permanent/Pocket Dosimeter

1. Immediate Actions

   a. Initiate a quick check of the immediate area to determine if the dosimeter has fallen in the vicinity.

   b. Exit the restricted area and contact the Health Physicist.

2. Supplementary Actions

   a. Assist the Health Physicist in estimating dose by recalling activities performed, materials used, time in restricted areas, etc.

   b. Procure replacement dosimeter, and initiate a search for the lost dosimeter.

B. Pocket Dosimeter Anomalies

1. Immediate Actions

   a. Exit the restricted area and contact the Health Physicist.

2. Supplementary Actions

   a. Assist the Health Physicist in determining the cause by recalling activities performed, materials used, time in restricted areas, etc., and whether the pocket dosimeter has been dropped or bumped.

Step	Action and Response	Comment or Correction

b. Health Physicist shall perform surveys of the area and estimate true exposure.

c. Asterisk the DOSIMETER IN column on the Daily Exposure Logsheet and record estimated dose.

d. Remove the suspect dosimeter from service until a calibration is performed.

Number	Title	Rev. 1
HP-1A	Radiation Monitoring Personnel	Date 1/93

DAILY EXPOSURE LOGSHEET

NAME: ____________________ LIMIT: ____________

SS#: ____________________ DOB: ____________

DATE	PD INITIAL	PD FINAL	DAILY DOSE	QUARTER TOTAL	INITIALS

ORIGINAL

THE UNIVERSITY OF TEXAS
NUCLEAR ENGINEERING TEACHING LABORATORY

DATE:_______________

NAME:____
PRINT

____
SIGNATURE

SS.#:______________________ D.O.B.:__________________

DOSIMETER #:________________ DOSE:__________________

HPI Form B

NUCLEAR ENGINEERING TEACHING LABORATORY

PROCEDURE HP 2

RADIATION MONITORING - FACILITY

Approvals:

Health Physicist — Date 1-7-93

Reactor Supervisor — Date 1-7-93

Director, NETL — Date 1-15-93

Chairperson, Reactor Committee — Date 1/15/93

Chairperson, Radiation Safety Committee — Date 1/27/93

List of Pages: 1 2 3 4 5

Attachments:

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ORIGINAL

Number	Title	
ADMN-1	Procedure Outline and Control	Rev. A Date 5/90

Record of Procedure Changes

Page	*Date	*Initial	*Change
	*	*	*
2	*	*	* Page 2 of 5, Section I - change
	*	*	*
	*	*	* old: "[redacted] the requirements and [redacted]
	*	*	*
	*	*	* [redacted] radiation..."
	*	*	*
	*	*	* new: "[redacted] the requirements and [redacted]
	*	*	*
	*	*	* [redacted] radiation..."
	*	*	*
	*	*	* Section II, line 5 - change
	*	*	*
	*	*	* old: "*[redacted] personnel of [redacted] conditions."
	*	*	*
	*	*	* new: "[redacted] personnel to [redacted] conditions."
	*	*	*
	*	*	* Section II, line 8 - change
	*	*	*
	*	*	* old: "Ensures no spread of...in excess of the [redacted]
	*	*	*
	*	*	* limits"
	*	*	*
	*	*	* new: "Ensures no spread of...in excess of [redacted]
	*	*	*
	*	*	* limits"
	*	*	*
	*	*	* Section II, second paragraph, second sentence - change
	*	*	*
	*	*	* old: "For example, when an operation is being
	*	*	*
	*	*	* performed and where...operation.
	*	*	*
	*	*	* new: "For example, when an operation is being
	*	*	*
	*	*	* performed where [redacted]...surveys should be
	*	*	*
	*	*	* performed and the results [redacted] before, during, and
	*	*	*
	*	*	* [redacted] the completion..."

Number	Title	
ADMN-1	Procedure Outline and Control	Rev. A Date 5/90

Record of Procedure Changes

Page	*Date	*Initial	*Change
3	*	*	Page 3 of 5, Section IV, Paragraph A(1.)(a.), second
	*	*	sentence - change
	*	*	old: "In addition, the walls and roof..."
	*	*	new: "In addition, the [redacted] walls and roof..."
	*	*	~~Section IV, Paragraph A(1.)(a.), third sentence -~~
	*	*	~~change~~
	*	*	old: "These surveys should be performed [redacted]
	*	*	[redacted] operating."
	*	*	new: "These surveys should be performed during
	*	*	reactor operation."
	*	*	Section IV, Paragraph A(1.)(b.), first sentence-
	*	*	change
	*	*	old: "Landauer type K (x8) dosimeters..."
	*	*	new: "Landauer dosimeters, type X8,..."
	*	*	Section IV, Paragraph A(2.)(b.), second sentence -
	*	*	change
	*	*	old: "This survey should be conducted with the
	*	*	reactor operating."
	*	*	new: "This survey should be conducted during reactor
	*	*	operation.

Number	Title	Rev. A
ADMN-1	Procedure Outline and Control	Date 5/90

Record of Procedure Changes

Page	*Date	*Initial	*Change
4	* *	* *	* * Page 4 of 5, Section IV, Paragraph(3.), first sentence -
	* *	* *	* * change
	* *	* *	* * old: "The instrument used for performance of radiation
	* *	* *	* * surveys shall be a [redacted]iger-[redacted]eller (G-M) type...to a
	* *	* *	* * minimum level of 0.1 mr/hour.
	* *	* *	* * new: "The instrument used to perform radiation surveys
	* *	* *	* * shall be a [redacted]iger-[redacted]eller (G-M) type or...
	* *	* *	* * [redacted]
	* *	* *	* * ~~Detection~~ to a minimum detection level of 0.1 mrem/hour.
	* *	* *	* * Section IV, Paragraph B(2.)(d.) - change
	* *	* *	* * old: " Each area designated as a Controlled Surface
	* *	* *	* * Contamination/Area (CSCA) shall be swiped for beta-
	* *	* *	* * gamma contamination upon the first entry of the day into
	* *	* *	* * the CSCA. The number of swipes taken should be based
	* *	* *	* * on the size of the CSCA, with approximately one (1)
	* *	* *	* * swipe per twenty-five (25) ft^2 of CSCA.
	* *	* *	* * new: "Each designated Controlled Surface Contamination
	* *	* *	* * Area (CSCA) See attached
	* *	* *	* *
	* *	* *	* *

Each designated CSCA occupied for the purpose(s) stated in the associated RWP shall be swiped for beta-gamma contamination prior to personnel exiting the CSCA for the day. The person(s) working in the CSCA are responsible for conducting swipes prior to exiting the CSCA for that work day. The swipes shall be taken to the health physics (HP) laboratory for analysis. If the health physicist or technician is not in the laboratory, the swipes should be slid under the door of the Health Physics laboratory. The swipes should be clearly labeled on the area map and swipe envelope. All personnel who have been in a CSCA at any time during the day MUST, in addition to the usual hand and foot frisk required prior to exiting the CSCA, utilize the hand and foot monitor prior to leaving the building.

[taken to]

HP2

Record of Procedure Changes

Page	*Date	*Initial	*Change
5	* *	* *	* * Page 5 of 5, Section IV, Paragraph D
	* *	* *	* * delete 1. Logs, move sentence under D.1. under 2.,
	* *	* *	* * renumber 2. to 1.
	* *	* *	* * old: 1. [redacted] All radiation and contamination...
	* *	* *	* * of the NETL.
	* *	* *	* * new: 1. [redacted] (a). All radiation
	* *	* *	* * and contamination surveys will be recorded using
	* *	* *	* * building maps and floor plans of the NETL. [redacted]
	* *	* *	* * [redacted] noted on the survey records, gamma measure-
	* *	* *	* * ments should be made with the instrument at waist
	* *	* *	* * height (approx. 1 meter).
	* *	* *	* * Section IV, Paragraph D 2.c. -delete c.
	* *	* *	* * old: Gamma/neutron readings below .1 mr/hr shall be
	* *	* *	* * recorded...nearest 0.1 mr/hr.
	* *	* *	* * new: deleted
	* *	* *	* * Section IV, Paragraph D 3. renumber to 2., change
	* *	* *	* * paragraph a. value to centimeters, and b., last sen-
	* *	* *	* * tence
	* *	* *	* * old: 3. Contamination Surveys
	* *	* *	* * new: 2. Contamination Surveys

Number	Title	Rev. A
ADMN-1	Procedure Outline and Control	Date 5/90

Record of Procedure Changes

Page	*Date	*Initial	*Change
	*	*	*
	*	*	* IV D 3. cont'd
	*	*	*
	*	*	* 3.a. old: Contamination surveys should be taken using
	*	*	*
	*	*	* a [redacted] filter paper......100cm^2.
	*	*	*
	*	*	*new:2.a.Contamination surveys should be taken using a
	*	*	*
	*	*	* [redacted] cm filter paper swipe....
	*	*	*
	*	*	* 3.b. old: When the swipe is counted, the result is
	*	*	*
	*	*	* logged by number...floor plan.
	*	*	*
	*	*	* new: 2.b. When the swipes are counted, the results
	*	*	*
	*	*	* obtained shall be attached to the survey record.
	*	*	*
	*	*	*
	*	*	*
	*	*	*
	*	*	*
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	*	*	*
	*	*	*
	*	*	*

I. PURPOSE

To describe the requirements and methods for periodic radiation and contamination surveys of the Nuclear Engineering Teaching Laboratory (NETL).

II. DISCUSSION

Periodic monitoring of the NETL for radiation and contamination is an important component of the Health Physics program, and serves several functions:

* Assists in keeping personnel exposures ALARA
* Warns personnel of abnormal conditions
* Ensures compliance with the proper posting requirements
* Ensures no spread of contamination to, or exposure of, persons outside of the NETL in excess of the federal limits

Radiation and contamination surveys should be performed in keeping with good radiological practices. For example, when an operation is being performed and where a change in radiation or contamination levels is expected, surveys should be performed and recorded before, during, and at the completion of the operation. Additional surveys may be specified by the Health Physicist on an "as needed" basis for each operation or on equipment.

This procedure specifies the routine survey requirements that are performed at the NETL.

III. REFERENCES

A. Title 10, Chapter 1, Code of Federal Regulations, Part 20 (10 CFR 20), "Standards for Protection Against Radiation."

B. Texas Regulations for Control of Radiation, Part 21 "Standards for Protection Against Radiation."

C. ANSI/ANS 15.11 1987 "Radiation Protection at Research Reactor Facilities."

D. University of Texas, July 1988 "Manual of Radiation Safety."

Step	Action and Response	Comment or Correction

IV. PROCEDURE

A. Radiation Surveys

1. Building Exterior

a. The exterior walls and roof of the NETL shall be surveyed monthly for gamma radiation. In addition, the walls and roof of the reactor section of the building shall be surveyed for neutron radiation. These surveys should be performed with the reactor operating.

b. Landauer type K (x8) dosimeters (or equivalent) shall be placed in the following exterior locations:
- Front walkway light pole
- Reactor building east wall
- Reactor building west wall
- NETL facility transformer
- Rear service entry driveway
- Reactor building exhaust stack

These dosimeters shall be changed out and read quarterly.

2. Building interior

a. A gamma survey shall be performed weekly in all Restricted Areas.

b. A neutron survey shall be performed weekly in the reactor room for any week (Sunday through Saturday) that the reactor operates. This survey should be conducted with the reactor operating.

c. A gamma survey shall be performed quarterly in all non-restricted areas.

d. Landauer type C dosimeters (or equivalent) shall be placed in the following interior locations.
- Reactor bay, north
- Reactor bay, east
- Reactor bay, west
- Reactor bay, pool area, roof level
- Reactor bay, water treatment room
- Shield area entry, room 1.102

These dosimeters shall be changed out and read monthly.

e. Landauer type G dosimeters (or equivalent) shall be placed in the following interior locations:
- Reception center, room 2.102
- Sample processing, room 3.102
- Radioactive experiment, room 3.106
- Gamma Spectroscopy, room 3.112

These dosimeters shall be changed out and read monthly.

Step	Action and Response	Comment or Correction

3. Survey Instruments

   The instrument used for performance of radiation surveys shall be a geiger-mueller (G-M) type or scintillation type detector capable of gamma radiation detection to a minimum level of 0.1 mr/hour.

B. Contamination Surveys

1. Building Exterior

   a. The walkways, driveways, and parking lots immediately surrounding the NETL shall be swiped quarterly for beta-gamma contamination. This survey should consist of a minimum of twenty (20) swipes.
   b. The roof of the NETL reactor building shall be swiped monthly for beta-gamma contamination. This survey should consist of a minimum of five (5) swipes.

2. Building Interior

   a. All Radioactive Materials areas shall be swiped weekly for beta-gamma contamination. This survey should consist of a minimum of two (2) swipes per area.
   b. All Restricted Areas shall be swiped monthly for beta-gamma contamination. This survey should consist of a minimum of two (2) swipes per area in addition to any other survey requirements.
   c. All non-restricted areas shall be swiped on a rotating basis such that the NETL is completely surveyed quarterly for beta-gamma contamination. This survey should consist of a minimum of one (1) swipe per area (room, hallway, staircase, etc.)
   d. Each area designated as a Controlled Surface Contamination/Area (CSCA) shall be swiped for beta-gamma contamination upon the first entry of the day into the CSCA. The number of swipes taken should be based on the size of the CSCA, with approximately one (1) swipe per twenty-five (25) ft^2 of CSCA.

3. Alpha Surveys

   Swipe surveys for alpha particles are at the direction of the Health Physicist. The Health Physicist shall be notified prior to commencement of any activity that has the potential to result in loose alpha activity.

C. Water

1. Reactor Shield Foundation

A sample shall be obtained and counted quarterly as part of the routine environmental monitoring.

2. Reactor Shield Tank

A sample shall be obtained (20ml), and counted quarterly.

D. Records

1. Logs

All radiation and contamination surveys will be logged using building maps and floor plans of the NETL.

2. Radiation Surveys

a. Radiation surveys should normally be taken by holding the instrument at approximately three feet from the ground (waist level). Any deviation from this level shall be noted on the survey log.

b. Gamma/neutron readings shall be recorded on the floor plans at the location where the measurement was made. Neutron readings can be recorded on the same plan as gamma surveys; neutron readings shall have a triangle drawn around them to differentiate them from beta-gamma readings.

c. Gamma/neutron readings below .1mr/hr shall be recorded as "<0.1" on the floor plans. Readings above 0.1mr/hr shall be recorded as actual reading rounded to the nearest 0.1mr/hr.

3. Contamination Surveys

a. Contamination surveys should be taken using a two-inch filter paper swipe, and covering an area of approximately $100cm^2$.

b. Swipes shall be numbered, and the number written on the floor plan at the location where the swipe was taken. When the swipe is counted, the result is logged by number on the swipe counting log, and the log is attached to the floor plan.

NUCLEAR ENGINEERING TEACHING LABORATORY

PROCEDURE HP 3

NETL ALARA PROGRAM

Approvals:

Health Physicist, NETL	Date 1-7-93
Reactor Supervisor	Date 1-7-93
Director, NETL	Date 1/15/93
Chairperson, Reactor Committee	Date 1/15/93
Chairperson, Radiation Safety Committee	Date 1/27/93

List of Pages: 1 2 3 4 5 6 7

Attachments:

BALCONES RESEARCH CENTER
THE UNIVERSITY OF TEXAS AT AUSTIN

Record of Procedure Changes
HP-3, NETL ALARA PROGRAM

Page	*Date	*Initial	*Change
	*	*	* Page 2 of 7, paragraph I., change from "To promulgate
	*	*	* specific radiological practices.....(ALARA).,to
	*	*	* "The objectives of the ALARA program are to maintain
	*	*	* exposures to radiation and releases of radioactive
	*	*	* effluents at levels that are ALARA within the established
	*	*	* dose equivalent and effluent release limits of the
	*	*	* appropriate regulatory authority. This procedure is
	*	*	* intended to establish specific guidelines to insure
	*	*	* that operations at NETL are conducted with ALARA
	*	*	* principles in mind.
	*	*	* Page 2 of 7, paragraph II., change "Requirements placed
	*	*	* on the conduct of ......, for safe operation of the
	*	*	* reactor facility." paragraph to " U.S. regulations
	*	*	* limit occupational exposure to 5 rem/yr (50 mSv/yr) and
	*	*	* public doses to 100 mrem/yr (1 mSv/yr). The recommended
	*	*	* total effective dose equivalent for occupational
	*	*	* exposure, as currently given in NCRP Report No. 91,
	*	*	* "Recommendations on Limits for Exposure to Ionizing
	*	*	* Radiations," is 5 rem/yr (50 mSv/yr), with a 1 rem
	*	*	* (10 mSv) per year lifetime average. ICRP Report No. 60,

Record of Procedure Changes

Page *Date *Initial *Change "Recommendations of the International Commission on Radiological Protection" recommends, with additional conditions, 10 rem (0.1 Sv) in 5 years. Both NCRP 91 and ICRP 60 recommend that the public dose not exceed 100 mrem/yr (1 mSv/yr). NCRP has the added limitation that infrequent public exposures not exceed 500 mrem/yr (5 mSv/yr), while ICRP allows unquantified excursions above 100 mrem/yr (1 mSv/yr) as long as the 5-yr annual average does not exceed recommended limits. Delete second paragraph which begins, "This procedure is intended to establish specific guidelines for.....ALARA."

Page 2 of 7, Paragraph III. REFERENCES - change ANSI/ANS 15.11 1987 to 1993. Change 1988 date on University of Texas "Manual of Radiation Safety" to the current manual. Add NCRP Publication No. 107.

Page 3 of 7, Paragraph IV.PROCEDURE, A. ALARA Program Commitment.

(3)

Record of Procedure Changes

HP-3, NETL ALARA PROGRAM

Page	*Date	*Initial	*Change
	*	*	* Page 3 of 7, paragraph IV. B., change "The NETL facility
	*	*	* was designed with consideration and implementation of the
	*	*	* design objectives and features specified in reference
	*	*	* C, section 8.1." to ...reference C, section 8.2.
	*	*	* Page 3 of 7, paragrapg IV. C., change "Procedures are
	*	*	* established that.......minimize exposure." to Procedure
	*	*	* HP-2 establishes the requirements for radiation and
	*	*	* contamination surveys. HP-7 details the requirements
	*	*	* for issurance and administration of radiation work
	*	*	* permits (RWPs). Together these procedures assist in
	*	*	* keeping personnel exposures ALARA and to uphold safe
	*	*	* radiological practices at the NETL. Change the sentence: section beginning
	*	*	* "References A and B specify the allowable quarterly
	*	*	* exposure limits..."to References A and B specify the
	*	*	* allowable occupational dose limits. In support of
	*	*	* ALARA, local occupational dose limits for the NETL have
	*	*	* been established as follows: An annual limit, which is
	*	*	* the more limiting of: (a) the total effective dose
	*	*	* equivalent being equal to 1 rem (0.01 sievert); or
	*	*	* (b) the sum of the deep dose equivalent and the committed

Record of Procedure Changes
HP-3, NETL ALARA PROGRAM

Page	*Date	*Initial	*Change
	*	*	* dose equivalent to any individual organ or tissue other
	*	*	* than the lens of the eye being equal to 1 rem (0.01
	*	*	* sievert). The annual limits to the lens of the eye, to
	*	*	* the skin, and to the extremities, which are: (a) an
	*	*	* eye dose equivalent of 1.5 rem (0.015 sievert), and
	*	*	* (b) a shallow dose equivalent of 5 rem (0.05 sievert)
	*	*	* to the skin or to any extremity.
	*	*	* Page 4 of 7, Paragraph IV. D., change "Procedures are
	*	*	* established that...extend to unrestricted areas." to
	*	*	* HP-2 and HP-7 establish procedures for contamination
	*	*	* surveys. These procedures assist in maintaining
	*	*	* exposures ALARA, and provide assurance that contamination
	*	*	* does not spread to unrestricted areas of the facility.
	*	*	* Page 4 of 7, Paragraph IV., C., change "Reference C
	*	*	* specifies the recommended....established." to The
	*	*	* recommended acceptable surface contamination levels
	*	*	* for unconditional release of an area are given in
	*	*	* Reference C. In support of Alara principles, the
	*	*	* NETL has established the following Acceptable Surface
	*	*	* Contamination Levels for Unconditional Release:

Record of Procedure Changes
HP-3, NETL ALARA PROGRAM

Page	*Date	*Initial	*Change
	*	*	*
	*	*	* Page 5 of 7, Paragraph IV. E., change "Procedures have
	*	*	*
	*	*	* been established that....radioactive materials within
	*	*	*
	*	*	* the NETL. These procedures ensure ...., section 5.
	*	*	*
	*	*	* to HP-6 and the University Manual of Radiation Safety
	*	*	*
	*	*	* establish procedures for the identification, storage,
	*	*	*
	*	*	* transfer, and inventory of radioactive materials
	*	*	*
	*	*	* with the confines of the NETL facility, in accordance
	*	*	*
	*	*	* with the guidance criteria in Reference c, section 5,
	*	*	*
	*	*	* and applicable Federal and State regulations.
	*	*	*
	*	*	* Page 6 of 7, Paragraph IV., F., change "Procedures
	*	*	*
	*	*	* shall provide...radiological considerations. The
	*	*	*
	*	*	* criteria used ...in Reference C, 8.2.1. to ADMN-6 and
	*	*	*
	*	*	* HP-7 procedures provide for a review of all experiments
	*	*	*
	*	*	* and reactor operation/maintenance activities by the
	*	*	*
	*	*	* Health Physicist. The review criteria of Reference
	*	*	*
	*	*	* C, Section 8.4 should be used.
	*	*	*
	*	*	* Page 6 of 7, Paragraph IV. H., change "Procedures
	*	*	*
	*	*	* have been established that....unescorted access.)" to
	*	*	*
	*	*	* Procedure HP-4 provides for initial and requalification
	*	*	*
	*	*	* radiological training for all personnel entering any

Record of Procedure Changes

Page	*Date	*Initial	*Change
	*	*	* restricted areas of the NETL facility.
	*	*	* Page 7 of 7, change " 5. All persons exiting the
	*	*	* NETL should frisk....leaving the building." to
	*	*	* 5. All personnel who have been in a CSCA at any time
	*	*	* during the day MUST, in addition to the usual frisks
	*	*	* required prior to exiting the CSCS, utilize the hand
	*	*	* and foot monitor prior to leaving the building.
	*	*	* Additionally, personnel who have been in any of the
	*	*	* restricted areas in the building should, as a matter
	*	*	* of good radiological operating practice, frisk on the
	*	*	* hand and foot monitor prior to leaving the building.
	*	*	*
	*	*	*
	*	*	*
	*	*	*
	*	*	*
	*	*	*
	*	*	*
	*	*	*

I. PURPOSE

To promulgate specific radiological practices and policies applicable to the Nuclear Engineering Teaching Laboratory, in order to maintain exposures and releases as low as reasonably achievable (ALARA).

II. DISCUSSION

Requirements placed on the conduct of operations at the NETL come from several sources. Two licenses, one federal and one state, grant permission to operate in accordance with the applicable regulations. The Manual of Radiation Safety further identifies methods for the control of radiation, and defines the responsibilities of the Radiation Safety Committee and the Radiation Safety Officer. A Reactor Operations Manual maintains procedures and operations developed by the Reactor Supervisor, with review by the Nuclear Reactor Committee, for safe operation of the reactor facility.

This procedure is intended to establish specific guidelines for operations at the NETL. The intent is to augment other documents to ensure safe, efficient operation while maintaining exposure and releases ALARA.

III. REFERENCES

A. Title 10, Chapter 1, Code of Federal Regulations, Part 20, (10 CFR 20), "Standards for Protection Against Radiation."

B. Texas Regulations for the Control of Radiation, Part 21, (TRCR 21), "Standards for Protection Against Radiation."

C. ANSI/ANS 15.11 1987, "Radiation Protection at Research Reactor Facilities."

D. University of Texas, July 1988, "Manual of Radiation Safety."

E. UT TRIGA Safety Analysis Report.

F. UT TRIGA Operations Manual.

G. Docket 50-602 Technical Specifications.

IV. PROCEDURE

A. ALARA Program Commitment

1. The NETL is a research and teaching facility consisting of a TRIGA Mark II reactor and various support laboratories. The mission of the facility is to further research and educational objectives within the limits of the licenses granted by Federal and State agencies. Exposure of personnel to various types of radiation, and release of effluents to the environment are inherent risks in the pursuit of these objectives. A careful balance must be maintained between the quest for knowledge and the risks involved in the quest.

The management of the NETL does not desire to limit the ability of researchers to perform experiments and participate in reactor operations. However, the management is firmly and unequivocally committed to keeping exposures to personnel and the general public as low as reasonably achievable (ALARA).

2. The NETL Health Physicist is the individual given explicit responsibility and authority for implementation of the radiation protection program. The responsibilities and organizational relationships of the Health Physicist follow the guidelines in the applicable sections of References E, F, and G.

B. Facility Design

The NETL facility was designed with consideration and implementation of the design objectives and features specified in reference C, section 8.1. Any change to the facility design shall incorporate ALARA considerations.

C. Radiation Control

Procedures are established that specify the requirements for radiation surveys; these surveys assist in evaluating allowable time for personnel to spend in certain areas, and therefore minimize exposure.

References A and B specify the allowable quarterly exposure limits. In order to support the ALARA principles, local exposure limits for the NETL have been established.

Step	Action and Response	Comment or Correction

1. NETL Local Quarterly Dose Limits

   a. Whole body; head and trunk; active blood forming organs; lens of eyes; or gonads — 0.25 REM

   b. Hands and forearms; feet and ankles — 3.75 REM

   c. Skin of whole body — 1.5 REM

These dose limits may only be exceeded by written permission of the NETL director, who will assign a new individual local dose limit for the person.

D. Contamination Control

Procedures are established that specify the requirements for contamination surveys; these surveys assist in maintaining exposures low and provide assurance that the contamination does not extend to unrestricted areas.

Reference C specifies the recommended acceptable surface contamination levels for unconditional release of an area. In order to support the ALARA principles, local control levels for the NETL have been established.

NETL
Acceptable Surface Contamination Levels
for Unconditional Release

Nuclide[a]	Average fixed[b c]	Maximum fixed[b d]	Removable [b e]
U-nat, U-235, U-238, and associated decay products	2,500 dpm α/100 cm^2	7,500 dpm α/100 cm^2	500 dpm α/100 cm^2
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	50 dpm/100 cm^2	150 dpm/100 cm^2	10 dpm/100 cm^2

ORIGINAL

Step	Action and Response	Comment or Correction

Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	500 dpm/100 cm^2	1,500 dpm/100 cm^2	100 dpm/100 cm^2
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	2,500 dpm β-γ/100cm^2	7,500 dpm β-γ/100cm^2	500 dpm β-γ/100cm^2

[a] Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta-gamma-emitting nuclides should apply independently.

[b] As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[c] Measurements of average contaminant should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each such object.

[d] The maximum contamination level applies to an area of not more than 100 cm^2.

[e] The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination or objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

E. Radioactive Material Control

Procedures have been established that provide for identification, storage, transfer, and inventory of radioactive materials within the NETL. These procedures ensure compliance with all Federal and State regulations and the criteria in Reference C, section 5.

Step Action and Response Comment or Correction

F. Radioactive Effluent Monitoring

The TRIGA reactor is designed and operated such that no radioactive liquid effluent is expected. Liquid effluents from laboratory sinks are routed to radwaste storage tanks, where they are diluted, processed or stored prior to release in accordance with the limits of References A and B.

A gaseous air monitor is installed in the reactor room exhaust; a particulate air monitor constantly samples the reactor room air. Both monitors ensure compliance with the limits of Reference A.

Procedural mechanisms are in place that require the Health Physicist to review all experiments. During this review, the appropriate controls and monitoring will be stipulated for any activities that could result in airborne radioactivity.

G. Planning

Procedures shall provide for the Health Physicist to review all experiments and reactor operation/maintenance activities for radiological considerations. The criteria used for this review is listed in Reference C, 8.2.1.

H. Training

Procedures have been established that provide for initial and requalification training of all personnel who enter restricted areas (i.e. allowed unescorted access).

I. Review and Audit

1. The Health Physicist shall review all occupational exposures monthly.

2. The NETL ALARA program shall be reviewed annually by an ALARA committee consisting of the NETL Director, Reactor Supervisor, NETL Health Physicist, and the Radiation Safety Officer. The facility radiation protection program shall also be reviewed at this meeting.

J. Miscellaneous Requirements

1. Mandatory frisking boundaries are established on each level by Radiation Work Permits (RWP).

2. An RWP shall control frisking requirements for entry to and egress from any location with potential surface contamination.

Step	Action and Response	Comment or Correction

3. The Health Physicist may, at his discretion, establish temporary "Potential Contamination Areas (PCA)".

4. Persons entering a PCA shall frisk upon exiting the PCA. The frisk shall be consistent with the task done while in the PCA. Examples: Hand only, foot only, both, whole body, or equipment.

5. All persons exiting the NETL should frisk on the Hand and Foot Monitor prior to leaving the building.

NUCLEAR ENGINEERING TEACHING LABORATORY

PROCEDURE HP 4

RADIATION PROTECTION TRAINING

Approvals:

[signature]	4/20/90
Health Physicist, NETL	Date
Thomas L. Bauer	4/20/90
Reactor Supervisor	Date
Bernard W. Wehring	4/20/90
Director, NETL	Date
Harris L. Marcus	4/25/90
Chairperson, Reactor Committee	Date
[signature]	5/29/90
Chairperson, Radiation Safety Committee	Date

List of Pages: 1 2 3

Attachments: A - Personnel Training Record

BALCONES RESEARCH CENTER
THE UNIVERSITY OF TEXAS AT AUSTIN

ORIGINAL

Step	Action and Response	Comment or Correction

I. PURPOSE

To specify the radiological protection training requirements for personnel and visitors at the NETL.

II. DISCUSSION

One of the most important components of any ALARA program is the radiological protection training that is provided to facility personnel. A well trained staff contributes significantly to the safe, efficient operation of the facility during normal and emergency situations.

This procedure establishes the requirements for initial and requalification training for personnel granted unescorted access to restricted areas. Other requirements include the training for visitors and provisions for specialized training for experiments and maintenance activities.

III. REFERENCES

A. Title 10, Chapter 1, Code of Federal Regulations, Part 20, (10 CFR 20), "Standards for Protection Against Radiation."

B. Title 10, Chapter 1, Code of Federal Regulations, Part 19, (10 CFR 19), "Notices, Instructions, and Reports to Workers; Inspections."

C. Texas Regulations for the Control of Radiation, Part 21, (TRCR 21), "Standards for Protection Against Radiation."

D. ANSI/ANS 15.11, 1987 "Radiation Protection at Research Reactor Facilities."

IV. PROCEDURE

A. Initial Training

Step	Action and Response	Comment or Correction

1. All personnel shall attend the NETL Radiological Safety course given by the NETL Health Physicist prior to unrestricted access to restricted areas in the NETL. This course includes the requirements of 10 CFR 19.12 and incorporates NRC Regulatory Guide 8.13 concerning prenatal exosure.

B. Requalification Training

All personnel granted unrestricted access to restricted areas of the NETL shall attend the NETL Radiological Safety Requalification course given by the NETL Health Physicist once every two years, not to exceed thirty (30) months..

C. Visitors

Prior to entry into any restricted area of the NETL, all visitors should be briefed by their escort. This briefing should contain the following as a minimum:

* ALARA and exposure
* wearing of personnel dosimetry
* attention to postings and signs
* how to perform a hand/foot frisk
* emergency response

D. Other Training

Specialized radiological controls training may be required prior to the performance of experiments or maintenance procedures. This training shall be determined by the Health Physicist as part of the experiment/maintenance review. If it is determined that specialized training is required, all personnel involved in the performance of the activity shall attend the training prior to participation in the activity.

E. Records

The Health Physicist shall maintain records of all training required by this procedure.

PERSONNEL TRAINING RECORD

NAME: ______________________ SS#: ______________________

POSITION: ______________________ DOB: ______________________

NETL RADIOLOGICAL SAFETY COURSE

I certify that I have attended the NETL Radiological Safety Course, and have been instructed pursuant to 10 CFR 19.12 "Instructions to Workers". I further certify that I have been instructed pursuant to NRC Regulatory Guide 8.13 concerning prenatal exposure.

____
Signature   Date

____
Health Physicist   Date

REQUALIFICATION RECORD

______________ Date	______________________ Health Physicist
______________ Date	______________________ Health Physicist
______________ Date	______________________ Health Physicist
______________ Date	______________________ Health Physicist
______________ Date	______________________ Health Physicist
______________ Date	______________________ Health Physicist
______________ Date	______________________ Health Physicist
______________ Date	______________________ Health Physicist
______________ Date	______________________ Health Physicist

ORIGINAL

NUCLEAR ENGINEERING TEACHING LABORATORY

PROCEDURE HP 5

PORTABLE RADIATION MONITORING EQUIPMENT

Approvals:

Health Physicist, NETL — Date 1/15/93

Reactor Supervisor — Date 1/15/93

Director, NETL — Date 1/15/93

Chairperson, Reactor Committee — Date 1/15/93

Chairperson
Radiation Safety Committee — Date 1/27/93

Pages: 1 2 3 4

Attachments:

A - Bicron Frisk-Tech Calibration
B - Bicron Micro-Rem Calibration
C - Eberline RO-2A Calibration
D - Eberline RM-14S Calibration
E - Pocket Dosimeter Calibration
F - PRS2/PNR4 Calibration
G - Victoreen 440 and others
H - Berthold LB 1043 Hand and Foot Monitor

BALCONES RESEARCH CENTER
THE UNIVERSITY OF TEXAS AT AUSTIN

I. PURPOSE

This procedure prescribes the periodic checks and calibrations performed on the portable radiation monitoring equipment used at the NETL.

II. DESCRIPTION

Portable radiation and contamination detection devices are used extensively throughout the NETL. They are used to set entry requirements in restricted areas, to determine protective clothing, and to monitor radiation levels outside of the facility. A large part of the ALARA program depends on accurate measurements of radiation and contamination levels by portable instruments. The instruments governed by this procedure are:

* Bicron Frisk-Tech (2)
* Bicron Micro-Rem
* Eberline RO-2A
* Eberline PRS2
* Pocket Dosimeters
* Eberline PNR-4
* Eberline RM-14S (7)

III. REFERENCES

* ANSI N323-1978
* Bicron Frisk-Tech Technical Manual
* Bicron Micro-Rem Technical Manual
* Eberline RO-2 Technical Manual
* Eberline PRS2 Technical Manual
* Eberline PNR-4 Technical Manual
* Eberline RM-14S Technical Manual

IV. MATERIALS, EQUIPMENT, OTHER PROCEDURES

* Cs-137 Calibration Source S.N. 2447
* Pulse generator
* Calibrated Beta source set
* Am-241 source
* D_2O Sphere
* Cf-252 Source SCRF 202 Z

V. PROCEDURE

A. Instrument Checks

All instruments should be checked prior to use, to ensure that the instrument is functioning properly. The actual checks performed depend on the instrument being used, but should consist of the following:

1. Check calibration sticker to ensure that the instrument has been calibrated within the previous six months (one year for PRS-2/Lin-Log). Instruments found with expired calibration shall be delivered to the Health Physics Laboratory.

2. Check the "Response Check" tag to ensure that the instrument has been response checked for that day. If not, perform the response check, and initial and date the response check tag.

3. If the instrument will be operated on battery power, perform a battery check. If the battery check fails, recharge the batteries or bring the instrument to the Health Physics laboratory for battery replacement by a facility staff member.

4. Zero the instrument, if equipped with a zero knob.

5. Perform a visual inspection of the instrument, looking for obvious signs of damage. Pay particular attention to the thin windows of probes. Do not use the instrument if it appears damaged, but return it to the Health Physics laboratory.

B. Calibration Requirements

1. Bicron Frisk-Tech - shall be calibrated every six months, not to exceed seven and one-half months (Form A), or following repair/maintenance.

2. Bicron Micro-Rem - shall be calibrated every six months, not to exceed seven and one-half months (Form B), or following repair/maintenance.

3. Eberline RO-2A - shall be calibrated every six months, not to exceed seven and one-half months (Form C) or following repair/maintenance.

4. Eberline PRS-2 and PNR-4 shall be calibrated annually, not to exceed fifteen months, by D_2O moderated CF252 source.

5. Eberline RM-14S - shall be calibrated every six months not to exceed seven and one half months (Form D) or following maintenance.

6. Pocket Dosimeters (0-200 mr only) - shall be calibrated every three months (Form E), not to exceed four months.

C. Response Checks

1. All instruments except the PRS2 and PNR4 shall be checked prior to the first use of any day. The source used, and instructions for the check are on the equipment response check tag. Each person shall date and initial the tag whenever a response check is performed. One response check per calender day is sufficient to meet this requirement.

D. Records

1. The NETL Health Physicist shall maintain all instrument calibration records required by this procedure.

BICRON FRISK-TECH CALIBRATION

NOTE: Calibration should be performed using battery power. Ensure batteries are charged prior to calibration.

1. Connect the pulse generator to the probe connector. Set the response control midway between fast and slow. Turn the audio switch to "off".

2. Turn the ratemeter control to x1000. Set the pulse generator to 400, and the select switch to x1000. Observe the instrument meter reading; acceptable results are ±20%. If the meter reads outside of this range, adjust R52 until the meter reads 400. Record the results.

3. Set the pulse generator to 100, and the select switch to x1000. Record the results.

4. Calibrate the x100(R50), x10(R48), and x1(R46) ranges as per steps 2 and 3.

5. Disconnect the pulser and connect the probe normally used with the frisker. Ensure that the HV is set to 900.

6. Obtain the beta source set and calculate the current dpm, for each of the six sources (C14, Pm147, Tc99, Sr90, Pb210, C136).

7. Place a source in the swipe counting well and cover with the probe. Take two 1-minute counts using the scalar option, and record. Repeat for each of the sources.

8. Calculate detector efficiency for each source and plot a curve of beta energy vs efficiency. Attach a copy of the plot to the frisker, and the original to HP-5A.

Note: Steps 9-11 apply only to Frisker #A972 with Probe #A215R

9. Set the HV to 680. Obtain the swipe counting well from the probe holder and place the Am241 source in the well. Center the probe on top of the well, and use the scalar option to record two 2-minute counts.

10. Calculate the efficiency and post it on the frisker.

ORIGINAL

11. Sign and date the calibration sheet. Attach a calibration sticker to the frisker.

RANGE	PULSE CPM	READING	PULSE CPM	READING
x1000	400,000	______	100,000	______
x100	40,000	______	10,000	______
x10	4,000	______	1,000	______
x1	400	______	100	______

Probe Number: ____________________

Source	First Count	Second Count	Efficiency
C-14	__________	__________	__________
Pm-147	__________	__________	__________
Tc-99	__________	__________	__________
Sr-90	__________	__________	__________
Cl-36	__________	__________	__________
Pb-210	__________	__________	__________
Am-241	__________	__________	__________

______________________________ ____________________

CALIBRATED BY DATE

ORIGINAL

BICRON MICRO-REM CALIBRATION

NOTE: Perform a battery check prior to calibration, and replace if necessary.

1. Use the Cs 137 calibrating source table to determine the distance and attenuation factor (AF) to achieve the desired dose rate. The instrument should be placed so that the centerline of the detector is directly in line with the source beam.

2. Turn the control switch to the "x1000" position. Expose the unit to 150 mR/h. Adjust R6 (5 kohm potentiometer) until the meter reads 1.5 mSv/hr if original reading is off by greater than ±20%.

3. Leave the control switch set at "x1000". Expose the unit to 50 mR/h. The meter should read 0.5 mSv/hr, ±20%.

4. Turn the control switch set at "x100" position. Expose the unit to 15 mR/h. Adjust R9 (5 kohm potentiometer) until the meter reads 150 μSv/hr if original reading is off by greater than ±20%.

5. Leave the control switch set at "x100". Expose the unit to 5 mR/h. The meter should read 50 μSv/hr, ±20%.

6. Turn the control switch to the "x10" position. Expose the unit to 1.5 mR/h. Adjust R12 (5 kohm potentiometer) until the meter reads 15 μSv/hr if original reading is off by greater than ±20%.

7. Leave the control switch set at "x10" position. Expose the unit to 0.4 mR/h. The meter should read 5 μSv/hr, ±20%.

8. Turn the control switch to the "x1" position. Expose the unit to .15 mR/h. Adjust R15 (5 kohm potentiometer) until the meter reads 1.5 μSv/hr if original reading is off by greater than ±20%.

9. Leave the control switch set at "x1". Expose the unit to .05 mR/h. The meter should read .5 Sv/hr, ±20%.

NOTE: The x0.1 scale is NOT calibrated on this instrument.

10. Record the results, sign and date the calibration sheet, and attach a calibration sticker to the instrument.

BICRON MICRO-REM CALIBRATION

RANGE	SOURCE	INSTRUMENT	SOURCE	INSTRUMENT
x1000	150 mr/hr	________	50 mr/hr	________
x100	150 mr/hr	________	5 mr/hr	________
x10	1.5 mr/hr	________	.5 mr/hr	________
x1	15 mr/hr	________	.05 mr/hr	________

CALIBRATED BY ______________________ DATE ______________

ORIGINAL

EBERLINE RO-2A CALIBRATION

NOTE: Perform a battery check prior to calibration, and replace if necessary.

1. Use the Cs 137 calibration source table to determine the distance and attenuation factor (AF) to achieve the desired dose rate. The instrument should be placed so that the centerline of the detector is directly in line with the source beam.

2. Turn the control switch to the 50 R/hr scale. Expose the unit to 10 R/hr. Adjust the 50 R/hr calibration screw to read 10 R/hr if original reading is off by greater than ±20%.

   NOTE: The calibration source is not strong enough to obtain a reading of 40 R/hr. Only one point is done on this scale.

3. Turn the control switch to the 5 R/hr scale. Expose the unit to 4 R/hr. Adjust the 5 R/hr calibration screw to read 4 R/hr if original reading is off by greater than ±20%.

4. Expose the unit to 1 R/hr. The meter should read 1 R/hr ±20%.

5. Turn the control switch to the 500 mr/hr scale. Expose the unit to 400 mr/hr. Adjust the 500 mr/hr calibration screw to read 400 mr/hr if original reading is off by greater than ±20%.

6. Expose the unit to 100 mr/hr. The meter should read 100 mr/hr ±20%.

7. Turn the control switch to the 50 mr/hr scale. Expose the unit to 40 mr/hr. Adjust the 50 mr/hr calibration screw to read 40 mr/hr if original reading is off by greater than ±20%.

8. Expose the unit to 10 mr/hr. The meter should read 10 mr/hr ±20%.

9. Record the results, sign and date the calibration sheet, and attach a calibration sticker to the instrument.

EBERLINE RO-2A CALIBRATION

RANGE	SOURCE	INSTRUMENT	SOURCE	INSTRUMENT
50 R/hr	N/A	N/A	10 R/hr	________
5 R/hr	4 R/hr	________	1 R/hr	________
500 mr/hr	400 mr/hr	________	100 mr/hr	________
50 mr/hr	40 mr/hr	________	10 mr/hr	________

CALIBRATED BY ______________________________ DATE ______________

ORIGINAL

EBERLINE RM-14S CALIBRATION

Note: Calibration should be performed using battery power. Ensure batteries are charged prior to calibration.

1. Turn on the RM-14S and verify the following settings:
   a. High Voltage - 900 V + 50
   b. Dead time - 50μsec
   c. Response - 15 sec

2. Connect the pulse generator to the probe connector.
   Turn the RM-14S ratemeter control to x1M. x1k
   Set the pulse generator to 400, and select switch to x1M.
   Observe the meter reading; acceptable results are + 20%.
   If the meter reads outside of this range, adjust the meter calibration pot until the meter reads 400.
   Record the results.

3. Set the pulse generator to 100. Observe the meter reading and record results.

4. Calibrate the other ranges (x100K, x10K, x1K, x100, x10) as per steps 2 and 3.

5. Disconnect the pulser, and connect the probe normally used with the frisker.

6. Obtain the beta source set and calculate the correct dpm for each of the six sources. (C-14, Pm-147, Tc99, Sr90, Pb210, C136)

7. Place a source in the swipe counting well and cover with the probe. Allow approximately one minute for the count rate to stabilize, and record the reading. Repeat for each of the sources.

8. Calculate detector efficiency for each source, and plot a curve of beta energy vs. efficiency. Attach a copy of the plot to the frisker, and the original to HP-5D.

Range	Pulse CPM	Reading	Pulse CPM	Reading
x1M	4,000,000	______	1,000,000	______
x100K	400,000	______	100,000	______
x10K	40,000	______	10,000	______
x1K	4,000	______	1,000	______
x100	400	______	100	______
x10	40	______	10	______

Probe Number: ____________________

Source	First Count	Second Count	Efficiency
C-14	________	________	________
Pm-147	________	________	________
Tc-99	________	________	________
Sr-90	________	________	________
Cl-36	________	________	________
Pb-210	________	________	________

______________________________ ____________

Calibrated By Date

ORIGINAL

POCKET DOSIMETER CALIBRATION

1. Zero each of the pocket dosimeters to be calibrated. Reject any dosimeter that cannot be zeroed.

2. Place the dosimeter in a location where background is < 1 μSv/hr for 24 hours.

3. Check each dosimeter for drift. If the dosimeter reading is ±2% of scale off of zero, reject the dosimeter.

4. Rezero all dosimeters that passed the drift check.

5. Place the dosimeters in the dosimeter calibrator outer ring or inner ring. The outer ring results in 50mr in 24.1 hours; the inner ring results in 50mr in 6.2 hours. Do not use both rings simultaneously as the inner ring dosimeters shield the outer ring from exposure.

6. Allow the dosimeter to accumulate between 50mr and 150mr. Calculate the expected exposure based on the ring used and time exposed. Reject any dosimeters that are off by plus or minus 20%.

7. Perform steps 1 - 6 for the 0 - 1.5R dosimeters except allow the dosimeters to accumulate between 500mr and 1R.

8. Attach a calibration sticker to each dosimeter that passes.

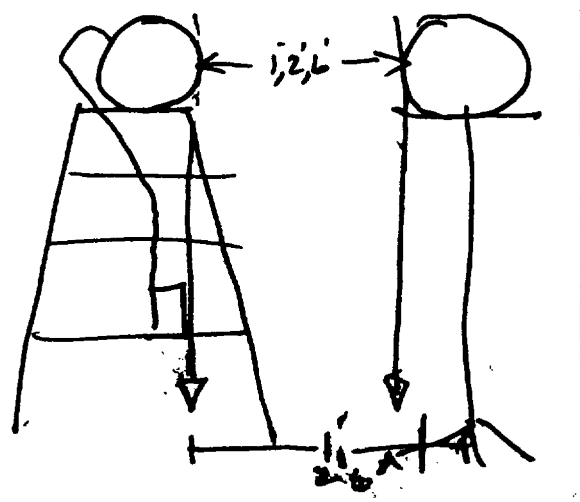
Eberline PRS2/PNR4 Calibration

Note: Ensure that the PRS2 is recharged prior to calibration, and the PNR4 has new batteries.

1. Setup

   a. Establish the calibration setup as per the drawing, or a similar configuration.

TAKE DRAWING FROM D_2O SPHERE LAB NOTEBOOK



   b. Obtain a printout of the expected calculated mr.hr and Counts per Minute for the Cf-252 source # SCRF 202-Z. Attach the printout to the Calibration Record.

   c. Using the following Room Return Multiplication Factors (RRMF), determine the expected mr/hr and Counts per Minuter for the unit undergoing calibration, and record on the Calibration Record.

Distance:	RRMF
One foot:	1.062
Two feet:	1.095
Six feet:	1.435

Note: Distances are measured from D_2O sphere surface to detector sphere surface.

2. PRS2 Calibration

   a. Turn the selector switch to HV and record the high voltage reading.
   b. Place the detector at one foot from the D_2O sphere.
   c. Turn the selector switch to position A and record the readings.
   d. Repeat step C for positions B, C, and D.
   e. Ensure the "reset rate" knob is turned fully counter-clockwise. Turn the selector switch to 5 minutes. Press the "reset" button. Record the total counts and repeat the 5 minute count.
   f. Turn the selector switch to 1 minute, and perform two one-minute counts, and record.
   g. Repeat steps c - f at distances of 2 feet and six feet.

3. PNR4 Calibration

   a. Turn the selector switch to ON.
   b. Place the detector at one foot from the D_2O sphere. Record the reading.
   c. Repeat step b at two feet and six feet.

PRS2 Calibration Record

High Voltage: ______________________________(1750-2050)

Calibration Data

One foot	________mr/hr	________cpm
Two feet	________mr/hr	________cpm
Six feet	________mr/hr	________cpm

Scale	Distance	mr/hr	cpm
A	One foot	________	________(5)
B	" "	________	________(1)
C	" "	________	
D	" "	________	
A	Two feet	________	________(5)
B	" "	________	________(1)
C	" "	________	
D	" "	________	
A	Six feet	________	________(5)
B	" "	________	________(1)
C	" "	________	
D	" "	________	

Readings should agree ± 20% with calibration data

______________________________ ______________________________
Calibrated by Date

PNR4 Calibration Record

Distance	Expected	Actual
One foot	______ mr/hr	______ mr/hr
Two feet	______ mr/hr	______ mr/hr
Six feet	______ mr/hr	______ mr/hr

Readings should agree ± 20% with calibration data.

______________________ Calibrated by

______________________ Date

ORIGINAL

VICTOREEN 440 CALIBRATION

NOTE: Perform a battery check prior to calibration, and replace if necessary.

1. Use the Cs 137 calibrating source table to determine the distance and attenuation factor (AF) to achieve the desired dose rate. The instrument should be placed so that the centerline of the detector is directly in line with the source beam.

2. Turn the control switch to the "300" position. Expose the unit to 200 mR/h. The meter should read 200 mr/hr, ±20%.

3. Leave the control switch set at "300". Expose the unit to 100 mR/h. The meter should read 100mr/hr, ±20%.

4. Turn the control switch to the "100" position. Expose the unit to 75 mR/h. The meter should read 75 mr/hr, ±20%.

5. Leave the control switch set at "100". Expose the unit to 25 mR/h. The meter should read 25 mr/hr, ±20%.

6. Turn the control switch to the "30" position. Expose the unit to 20 mR/h. The meter should read 20 mr/hr, ±20%.

7. Leave the control switch set at "30" position. Expose the unit to 10 mR/h. The meter should read 10 mr/hr, ±20%.

8. Turn the control switch to the "10" position. Expose the unit to 7.5 mR/h. The meter should read 7.5 mR/hr, ±20%.

9. Leave the control switch set at "10". Expose the unit to 2.5 mR/h. The meter should read 2.5 mR/hr, ±20%.

10. Turn the control switch to the "3" position. Expose the unit to 2.0 mR/hr. The meter should read 2.0 mr/hr, ± 20%.

11. Leave the control switch set at "3". Expose the unit to 1.0 mR/hr. the meter should read 1.0 mr/hr, ± 20%.

12. If any reading is greater than ± 20%, refer to the 440 manual for calibration adjustments, and repeat this procedure.

13. Record the results, sign and date the calibration sheet, and attach a calibration sticker to the instrument.

VICTOREEN THYAC III CALIBRATION

NOTE: Perform a battery check prior to calibration, and replace if necessary.

1. Use the Cs 137 calibrating source table to determine the distance and attenuation factor (AF) to achieve the desired dose rate. The instrument should be placed so that the centerline of the detector is directly in line with the source beam.

2. Turn the control switch to the "x1000" position. Expose the unit to 150 mR/h. Adjust calibration potentiometer until the meter reads 1.5 mSv/hr (150 mR/h) if original reading is off by greater than ±20%.

3. Leave the control switch set at "x1000". Expose the unit to 50 mR/h. The meter should read 0.5 mSv/hr (50 mR/h), ±20%.

4. Turn the control switch set at "x100" position. Expose the unit to 15 mR/h. Adjust calibration potentiometer until the meter reads 150 μSv/hr (15 mR/h) if original reading is off by greater than ±20%.

5. Leave the control switch set at "x100". Expose the unit to 5 mR/h. The meter should read 50 μSv/hr (5 mR/h), ±20%.

6. Turn the control switch to the "x10" position. Expose the unit to 1.5 mR/h. Adjust calibration potentiometer until the meter reads 15 μSv/hr calibration (1.5 mR/h) if original reading is off by greater than ±20%.

7. Leave the control switch set at "x10" position. Expose the unit to 0.4 mR/h. The meter should read 5 μSv/hr (.5 mR/h), ±20%.

8. Turn the control switch to the "x1" position. Expose the unit to .15 mR/h. Adjust calibration potentiometer until the meter reads 1.5 μSv/hr (.15 mR/h) if original reading is off by greater than ±20%.

9. Leave the control switch set at "x1". Expose the unit to .05 mR/h. The meter should read .5 μSv/hr (.05 mR/h), ±20%.

10. Record the results, sign and date the calibration sheet, and attach a calibration sticker to the instrument.

TECHNICAL ASSOCIATES PUG1AB

NOTE: Perform a battery check prior to calibration, and replace if necessary.

1. Use the Cs 137 calibrating source table to determine the distance and attenuation factor (AF) to achieve the desired dose rate. The instrument should be placed so that the centerline of the detector is directly in line with the source beam.

2. Turn the control switch to the "x1000" position. Expose the unit to 150 mR/h. Adjust calibration potentiometer until the meter reads 1.5 mSv/hr (150 mR/h) if original reading is off by greater than ±20%.

3. Leave the control switch set at "x1000". Expose the unit to 50 mR/h. The meter should read 0.5 mSv/hr (50 mR/h), ±20%.

4. Turn the control switch set at "x100" position. Expose the unit to 15 mR/h. Adjust calibration potentiometer until the meter reads 150 μSv/hr (15 mR/h) if original reading is off by greater than ±20%.

5. Leave the control switch set at "x100". Expose the unit to 5 mR/h. The meter should read 50 μSv/hr (5 mR/h), ±20%.

6. Turn the control switch to the "x10" position. Expose the unit to 1.5 mR/h. Adjust calibration potentiometer until the meter reads 15 μSv/hr calibration (1.5 mR/h) if original reading is off by greater than ±20%.

7. Leave the control switch set at "x10" position. Expose the unit to 0.4 mR/h. The meter should read 5 μSv/hr (.5 mR/h), ±20%.

8. Turn the control switch to the "x1" position. Expose the unit to .15 mR/h. Adjust calibration potentiometer until the meter reads 1.5 μSv/hr (.15 mR/h) if original reading is off by greater than ±20%.

9. Leave the control switch set at "x1". Expose the unit to .05 mR/h. The meter should read .5 μSv/hr (.05 mR/h), ±20%.

10. Record the results, sign and date the calibration sheet, and attach a calibration sticker to the instrument.

Victoreeen 440 Calibration

Range	Source	Instrument	Source	Instrument
300	200mr/hr	________	100mr/hr	________
100	75mr/hr	________	25mr/hr	________
30	20mr/hr	________	10mr/hr	________
10	7.5mr/hr	________	2.5mr/hr	________
3	2.0mr/hr	________	1.0mr/hr	________

Calibrated by ____________________ Date ____________________

ORIGINAL

VICTOREEN THYAC III CALIBRATION

RANGE	SOURCE	INSTRUMENT	SOURCE	INSTRUMENT
x1000	150 mr/hr	________	50 mr/hr	________
x100	150 mr/hr	________	5 mr/hr	________
x10	1.5 mr/hr	________	.5 mr/hr	________
x1	15 mr/hr	________	.05 mr/hr	________

________________________________ CALIBRATED BY

________________ DATE

ORIGINAL

TECHNICAL ASSOCIATES PUG1AB

RANGE	SOURCE	INSTRUMENT	SOURCE	INSTRUMENT
x1000	150 mr/hr	________	50 mr/hr	________
x100	150 mr/hr	________	5 mr/hr	________
x10	1.5 mr/hr	________	.5 mr/hr	________
x1	15 mr/hr	________	.05 mr/hr	________

CALIBRATED BY ____________________ DATE ____________

BERTHOLD LB-1043 BX HAND AND FOOT MONITOR CALIBRATION

1. Retrieve the Beta Source Set and the Plexiglass Calibration Template (PCT) from the Health Physics laboratory. For this calibration, use the Carbon-14 source # 343-43-D3, Strontium-90 source # 205-58-5, and the Technetium-99 source # 363-04-1.

2. Calculate the current activity of each of the sources in disintegrations per minute (DPM).

3. Place the Sr-90 source in position # 1 in the PCT.

4. Step on the footplate of the H&F monitor to actuate the sensing switch and terminate the background reading.

5. Place the PCT in the left hand detector slot with the source active surface facing left. Push the PCT inward to actuate the hand sensing switch.

6. Place right hand in the right hand detector slot and push inward to actuate hand sensing switch. The display will count down from 10, and will show CONTAMINATION-POSITION L1. Following a brief display of this message, the display will show the number of counts. Record this number on the calibration form. This measurement corresponds to position L1-#1.

7. Remove the PCT from the left hand slot, remove right hand from the right hand slot, and, holding the PCT with source away from the H&F monitor, step off of the footplate.

8. Maintain the source at least four feet from the H&F monitor. Repeat the procedure for PCT positions 2,3,4 and 5, which correspond to calibration positions L1-2,3,4 and 5, respectively.

9. Place the source in PCT position #1, turn the source active surface facing right, and repeat the procedure. The message will read CONTAMINATION-L2. The calibration positions will be L2, 1-5.

10. Repeat the procedure for the right hand detector slot. The messages will read CONTAMINATION-R1 and R2. The calibration positions will be R1 and R2, 1-5.

11. Repeat the procedure for the two footplates, F1 and F2.
When stepping on the footplates, step on the edge only to actuate the sensing switch. Place both hands into the hand detector slots to start the count.

12. When all measurements have been recorded, use the calculated DPM of the source to determine the efficiency of each detector by dividing the measured counts by the calculated DPM.

NUCLEAR ENGINEERING TEACHING LABORATORY

PROCEDURE HP 6

RADIOACTIVE MATERIAL CONTROL

Approvals:

[signature]	4/26/90
Health Physicist, NETL	Date
Thomas L. Bauer	4/26/90
Reactor Supervisor	Date
Bernard W. Wehring	4-26-90
Director, NETL	Date
[signature]	5-7-90
Chairperson, Reactor Committee	Date
[signature]	5/29/90
Chairperson, Radiation Safety Committee	Date

List of Pages: 1 2 3 4 5 6

Attachments:

- A Sample Log (In Core)
- B Exposure Log (Ex Core)
- C Radioactive Material Storage Log
- D Radioactive Material Transfer Record

BALCONES RESEARCH CENTER
THE UNIVERSITY OF TEXAS AT AUSTIN

ORIGINAL

I. PURPOSE

This procedure prescribes the controls instituted concerning the control of radioactive materials in the NETL.

II. DESCRIPTION

Strict control over radioactive materials helps to achieve the goals of the ALARA program. Ensuring that materials are segregated helps to minimize the amount of radioactive waste generated by activities in the facility. This procedure describes the controls placed on areas where radioactive materials are used with respect to material tagging, area entry requirements, and required postings.

III. REFERENCES

* Title 10, Code of Federal Regulations, Part 20 (10 CFR 20)
* ANSI 15.11 -1987

IV. MATERIALS, EQUIPMENT, OTHER PROCEDURES

* Radiation Safety Manual, University of Texas at Austin

V. PROCEDURE

A. Controlled Surface Contamination Areas (CSCA)

1. Definition - A Controlled Surface Contamination Area is any accessible area where contamination levels exceed, or due to activities in progress could exceed, 500 dpm/100 cm^2 β-γ, or any detectable alpha.

2. Posting Requirements

    a. All CSCA's shall be distinguished by a physical boundary such that no access is possible without compromising the boundary.

Step	Action and Response	Correction or Comment

b. All CSCA's shall be clearly posted with signs/maps that indicate the following:

* Controlled Surface Contamination Area

* Requirements for entry, i.e. clothing, dosimetry, etc.

* Most recent swipe and radiation survey results.

* Type of frisk to be performed upon exiting.

3. General Requirements

* Each CSCA shall have only one entry/exit point. The entry/exit shall be equipped with a step-off pad and a frisker.

* All personnel must perform a frisk upon leaving a CSCA. The type of frisk is determined by conditions in the CSCA.

* Unless specifically exempted by an RWP, no materials, tools, equipment, etc., shall be taken out of a CSCA. If it is necessary to remove items from a CSCA, contact the Health Physicist.

* A CSCA can only be released for unrestricted use by the Health Physicist or designee.

B. Radioactive Material Storage Areas

Any room where radioactive materials are stored shall be posted as a Radioactive Material Storage area. If only a section of a room is used for storage, then that section shall be cordoned off and posted as such.

C. Radioactive Waste

1. It is the responsibility of all personnel who use the NETL to limit the amount of radioactive waste generated to the minimum amount possible, consistent with the work or experiment being performed.

ORIGINAL

Step	Action and Response	Correction or Comment

2. In all cases where radioactive waste will be generated, radioactive canisters will be placed for use. These canisters shall be labeled as to the type of waste allowed in each canister, in order to provide for waste segregation. Segregation categories include, but are not limited to, the following:

   a. solids (gloves, absorbents)
   b. liquids
   c. Beta-gamma emitters
   d. Alpha emitters
   e. Irradiated samples
   f. Specific isotopes

3. All radioactive waste will be bagged and tagged for disposal by the Health Physicist in accordance with the Radiation Safety Manual.

D. Radioactive Material Control

1. All radioactive materials shall be marked by use of yellow and magenta tape, paint, tags, or other similar method. Materials possessed under the State of Texas broad license are further identified by a 1/4" silver dot placed on the object near the radioactive marking or on the tag.

2. Materials that exceed 500 dpm/100 cm^2 β-γ or any alpha loose surface contamination shall be sealed in a poly bag when not in use, or remain inside a posted CSCA.

3. Irradiated Experiment Materials

   a. Any material placed inside the boundary of the shield tank due to an experiment shall be logged using HP6 Form A (in-core) or HP6 Form B (ex-core). For purposes of this procedure, in-core refers to placement within the outside diameter of the reflector (horizontal or vertical insertion), or within the core region. These forms are maintained in a logbook in the Control Room.

Step	Action and Response	Correction or Comment

b. Transfer and Accountability

1) Radioactive experiment materials shall be marked in accordance with D.1 above. These materials are under the jurisdiction of the Federal licence until such time as they are moved to a location outside of the Reactor Bay. Movement to a location outside of the Reactor Bay is normally considered a transfer of the material to the State licence, and therefore requires completion of HP6 Form D, Radioactive Material Transfer Record.

2) Encapsulation devices are defined as Federal license materials regardless of their location within the NETL.

3) Radioactive experimental materials that need to be moved in and out of the reactor bay several times (for example to the machine shop to be worked) can remain on the Federal license until such time as they are permanently moved out of the reactor bay for storage, release, or disposal. Federal materials moved out under this provision must remain under the direct control of the user until returned to the reactor bay.

4) Radioactive Material Transfer Record (HP 6 Form D) shall be completed for each transfer. These forms shall be sequentially numbered and maintained by the Health Physicist as the formal record of transfer between licences. Material transfers require approval of the Health Physicist or a Senior Reactor Operator only after receiving telephone permission from the Radiation Safety Office. Following the transfer, the form is sent to the Radiation Safety Officer for signature, and returned to the Health Physicist for filing.

4. Release of Radioactive Materials

a. Items to be released for unrestricted use shall have a direct radiation survey performed using a thin window pancake style GM probe or another appropriate type of survey meter when a GM does not provide the requisite sensitivity of detection capability. This survey shall be performed in a location where the background counts are less than 100 counts per minute.

b. The direct survey must ensure that all surfaces of the object are accessible to the probe. If there is no detected activity, the item may be released for unrestricted use.

Step	Action and Response	Correction or Comment

c. If the item shows radioactivity above background (>2 times normal background) the item shall be swiped to determine if the radioactivity is due to loose surface contamination. If removable, the item should be decontaminated and completely resurveyed. If not removeable, the item shall be stored as radioative material.

d. All surveys performed for the purpose of material release shall be recorded and stored by the Health Physicist.

5. Radioactive Material Storage

a. Radioactive materials that are being stored for future use, decay, disposal, or decontamination are the responsibility of the Health Physicist.

b. These materials shall be tagged and logged in the Radioactive Material Storage log. This log shall be updated whenever any materials are removed from the storage area for any reason. The log shall be maintained in the Health Physics Laboratory.

SAMPLE LOG (IN-CORE)

Reference: Experiment/Irradiation — Exp. No._____ Req. No._____

Irradiation: — Time_______________(KWHR's)

Loaded by ________________________ — Batch Identification:______

Unloaded by ______________________

Date/Time Inserted	Date/Time Removed	Location	Sample ID	Max Dose dose rate@30cm	Comments: Swipe Results

Sample Tracking:

Transfer To: __________________ Auth.user/license — __________________ Auth.no./license no. — ________ Date

Place in Storage: __________________ HP — __________________ Location — ________ Date

To RSO for Disposal: or Release __________________ HP — __________________ Reference # — ________ Date

ORIGINAL

Number	Title	Rev. 1
HP-6B	Radioactive Material Control	Date 4/90

EXPOSURE LOG (EX-CORE)

Reference: Experiment/Irradiation — Exp. No._____ Req. No._____

Irradiation: — Time_______________(KWHR's)

Loaded by ________________________ — Batch Identification:______

Unloaded by ______________________

Date/Time Inserted	Date/Time Removed	Location	Sample ID	Max DPM at contact	Comments removeable act.

Sample Tracking:

Transfer To: ________________ ________________ ________
Auth.user/license — Auth.no./license no. — Date

Place in Storage: ________________ ________________ ________
HP — Location — Date

To RSO for Disposal: ________________ ________________ ________
or Release — HP — Reference # — Date

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RADIOACTIVE MATERIAL STORAGE LOG

DATE IN	ITEM DESCRIPTION	STATUS*	DISPENSATION	DATE	INITIALS

* Storage, Decontamination, Disposal, Decay

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RADIOACTIVE MATERIAL TRANSFER RECORD

Serial#________________ Date________

From: NETL License # R-

Transfer Approval Signature HP/SRO

Off Campus Transfer

Institution,License#,Exp.Date

Radiation Safety Officer

On Campus Transfer

Authorized User and #

Transfer Receipt Signature

Material Description	Primary Isotope	Primary Compound	Activity

Survey Results: Contact________mr/hr 30cm________mr/hr

Swipe #	α β-γ	dpm	location

Precautions/Notes:

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Step	Action and Response	Correction or Comment

NUCLEAR ENGINEERING TEACHING LABORATORY

PROCEDURE HP 7

RADIATION WORK PERMITS (RWP)

Approvals:

[signature] 4/26/90
Health Physicist, NETL — Date

Thomas J. Bauer 4/26/90
Reactor Supervisor — Date

Bernard W. Wehring 4-26-90
Director, NETL — Date

[signature] 5-7-90
Chairperson, Reactor Committee — Date

[signature] 5/29/90
Chairperson,
Radiation Safety Committee — Date

List of Pages: 1 2 3 4 5

Attachments:

A Radiation Work Permit
B RWP Briefing Log
C RWP Entry Log

THE UNIVERSITY OF TEXAS AT AUSTIN
BALCONES RESEARCH CENTER

ORIGINAL

I. PURPOSE

To describe the requirements for, and administration of, Radiation Work Permits (RWP) for the Nuclear Engineering Teaching Laboratory (NETL).

II. DISCUSSION

The Radiation Work Permit is an administrative control used at the NETL for the protection of faculty, staff, students, and visitors. An RWP is issued for situations where there is a potential for a radiological hazard. The RWP ensures effective exposure control in that radiation workers and supervisors are required to evaluate the proposed task with respect to radiological hazards. This evaluation, with assistance from the NETL Health Physicist, results in identification of the personnel protection practices applicable to the task. In addition, the RWP provides a permanent record of task performance and exposure that is helpful in preparing for future tasks.

III. REFERENCES

A. Title 10, Chapter 1, Code of Federal Regulations, Part 20 (10 CFR 20), "Standards for Protection Against Radiation."

B. Texas Regulations for Control of Radiation, Part 21 (TRCR 21), "Standards for Protection Against Radiation."

IV. MATERIALS, EQUIPMENT, OTHER PROCEDURES

A. NETL HP Procedures as required.

B. Procedure ADMN 5, Experiment Authorization

V. PROCEDURE

A. Requirements for Issue

An RWP must be completed prior to work under conditions that follow:

1. Opening and closing of reactor beam tubes or other changes in reactor shielding.
2. Entry into a known High Radiation Area.
3. Establishment of a Controlled Surface Contamination Area.
4. Entry into a known High Airborne Radioactivity Area.
5. At the discretion of the Health Physicist based on review of proposed experiments.

B. RWP's for Experiments

Procedure ADMN 5 describes the process for experiment authorization. If an experiment requires an RWP, it should be filled out and submitted along with the experiment request. Approval of an RWP does not constitute permission to conduct an experiment unless the experiment authorization is also signed.

C. Administration

1. The individual in charge of the activity or task is responsible for completing sections 1 - 7 of the RWP. Discussion of the task with the Health Physicist concerning the radiological implications of the task should occur during this phase.

2. The RWP is submitted to the Health Physicist for review and approval. If the potential for personnel exposure could exceed 100 mrem, the RWP must be approved by the ALARA committee.

3. The Health Physicist assigns an RWP number, logs the RWP, and completes the appropriate sections of the RWP.

4. The Health Physicist returns the RWP to the initiator who signs the RWP to indicate acknowledgement of the work conditions and requirements. The Reactor Supervisor (or designee) must also sign the RWP prior to commencement of the work or task.

5. The person in charge of the work (RWP initiator) is responsible for the following:

   a. Ensuring that all personnel who will be working under the RWP have read and signed the RWP.

   b. Notifying personnel in adjacent areas of potential hazards of the work and possible impact.

   c. Enforcing the requirements of the RWP.

   d. Closing out and completing the RWP when the task is finished, and returning the RWP to the Health Physicist.

6. All personnel who work under an RWP shall read the RWP and indicate acceptance and understanding of the conditions by signing the RWP.

Step	Action and Response	Correction or Comment

7. Each person who works under an RWP shall record their pocket dosimeter reading before commencing and after completing work. If an individual starts and stops work several times on the same RWP, the pocket dosimeter readings shall be recorded for each time period.

8. RWP's are normally issued for a specific time period. If an RWP will expire prior to completion of work, the supervisor shall contact the Health Physicist for RWP extension approval prior to expiration of the RWP.

9. The RWP for a task shall be located near, but not necessarily inside, the work area.

10. The Health Physics staff will perform any confirmatory surveys after the RWP has been returned. The Health Physics staff will also perform any surveys as required by other NETL HP Procedures.

11. Additions to the list of persons authorized to work under an RWP can only be made by the work supervisor. If a visitor requires entry to an area under an RWP, the Health Physicist's approval is required in addition to the work supervisor. Visitors will not normally be allowed into areas governed by an RWP.

D. Fixed Radiation Work Permits

1. A Fixed RWP is one that is written for an area that is permanently established or a task that is routinely performed.

2. A request for a Fixed RWP shall be submitted to the Health Physicist, and must be approved by the ALARA committee.

3. Fixed RWP's shall have attached to them a list of personnel authorized to use the RWP. Authorization is granted by the Health Physicist.

4. The Health Physicist shall review each active Fixed RWP monthly to ensure that the conditions of the RWP are sufficient for the area or task. The Health Physicist may make any necessary changes to account for area or task changes; however, any substantive changes must be reviewed in a timely manner by the ALARA committee.

Step	Action and Response	Correction or Comment

E. Records

1. The Health Physicist shall maintain a file of all completed RWP's.

2. All expired RWP's (unless granted an extension) shall be returned to the Health Physicist even if the RWP was never used.

RADIATION WORK PERMIT

Date Requested:______________ RWP No.______________

Date of Work/Task:______________

Expiration Date:______________

Extension Date and Approval:______________________________

1. Person in Charge of Work:______________________________
   (Must be faculty or staff)

2. Description of Work (Be specific - attach additional sheets as necessary):______________________________
   ____
   ____

3. Persons Authorized to Work Under this RWP:

Name	Position (Faculty, Student, etc.)	HP Approval (Additions)

4. Work Location:______________________________
   ____

5. Radiological Hazard Assessment (Be Specific - Attach Additional Sheets as Necessary):______________________________
   ____
   ____

6. MAN.REM Estimate:______________________________

7. Expected Contamination Levels:______________________________
   a. Nuclide(s):______________________________
   b. Form (Gas, solid, liquid):______________________________

8. The task or work as described cannot be performed; contact the Health Physicist for further discussion.

   NETL Health Physicist:______________________________

   Date:______________________________

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9. Radiological Instructions/Requirements

A. ____________ HP Monitoring Required

____________ Prior to Start
____________ Intermittent
____________ Continuous
____________ Prior to Close-Out

B. ____________ Swipe Survey at End of Work

C. ____________ Personnel Frisking Required

____________ Hand and Foot
____________ Whole Body

D. ____________ Work Alone Not Allowed - Observer Required

E. ____________ Survey Instruments Required

____________ Low Range Dose Rate
____________ High Range Dose Rate
____________ Neutron
____________ Frisker

F. ____________ Special Dosimetry (Specify Below)

____
____
____
____
____

G. ____________ Protective Clothing

____________ Gloves (Specify Type)
____
____

____________ Shoe Covers
____________ Lab Coat
____________ Coveralls
____________ Full Anti-C's
____________ Face Shield
____________ Safety Glasses

H. ____________ Respiratory Equipment (Specify)

____
____

I. Additional Special Instructions ____________________

10. Approvals Prior to Work:

NETL Health Physicist ____________ Date ________

Person in Charge of Work ____________ Date ________

Reactor Supervisor ____________ Date ________

11. RWP Close-Out

A. Work Completed, RWP Briefing and Entry Log Attached, RWP Closed Out

Person in Charge of Work ____________ Date ________

B. Required Surveys Complete and Attached

Health Physics Staff ____________ Date ________

C. RWP Reviewed and Filed

NETL Health Physicist ____________ Date ________

ORIGINAL

RWP BRIEFING LOG

RWP NO.____________

By signing this log, the person indicates that they have read and understand the requirements imposed on the work by this RWP, and shall comply while working under this RWP.

Printed Name	Signature	Date

ORIGINAL

RWP ENTRY LOG

RWP NO. ________________

		TIME			DOSIMETER			MAN.REM
Name	Date	Out	In	Total	Out	In	Total	TOTAL

ORIGINAL

NUCLEAR ENGINEERING TEACHING LABORATORY

MAIN 1 - REV. 2

CALIBRATION AND FUNCTION
CHECKS OF THE ICS SYSTEM
Interlock and SCRAM Features

Approvals:

Thomas J. Bauer — 4/8/93
Reactor Supervisor — Date

Bernard W. Wehring — 4/8/93
Director, NETL — Date

Randall J. Charbeneau — 4/8/93
Chairperson,
Nuclear Reactor Committee — Date

Pages: 1 thru 30

Attachments:	ICS Interlocks	2 pages
	ICS SCRAMS	1 page
	Acceptance	1 page

BALCONES RESEARCH CENTER
THE UNIVERSITY OF TEXAS AT AUSTIN
CALIBRATION AND FUNCTION

Summary of Changes

7/28/96

Docket 50-602 Procedures

Procedure: Main1

Description: The following changes have been made to MAIN1 to update the procedures. Changes include minor editorial changes, revision of the data recording forms, improvements to cross reference TS requirements, and additions necessary to meet the automatic mode amendment. Clarification of the TS for automatic mode identified several interlock tests that were implicitly tested or inadequately tested. These have been added to directly test each condition.

* Update table of contents on page 3.
* Revise tables on pages 4 to 6, to include the new step numbers and references to Technical Specification requirements.
* Page 8 - Revise message in step 13.
* Page 14 - Revise step 16, revise and renumber to step 20.
  Renumber step 17, 18, 19, 20 to 16, 17, 18, 19.
  Revise reference in step 18 (new) from 16 to 14.
* Page 16 - Renumber steps 7 - 13 to 14 - 26.
  Add new steps 7 - 13.
  Add new step 27 & 28.
  Revise references #'s in step 18 (new).
* Page 20 - Remove step 19. Renumber steps 17 - 20 to 21 - 24.
  Step 19 will be added to SURV-6.
  Add new steps 17 - 20.
  Add (e) to step 14.
* Page 22 - Renumber steps 16 - 18 to 20 - 22.
  Add new steps 16 - 19
  Revise (e) in step 14.
* Revise attachment pages to add records for new steps.

Page 8

message > Reactor Active, Can not log out!

Page 14

(20) Activate the NM1000 Rod Withdrawal Prohibit signal, "RWP1", by pulling the neutron source

(a) Verify that the Reg rod, Shim 1, Shim 2 and Transient rod cannot be withdrawn from the core by pressing the rod "UP" buttons.
(b) A warning message should appear in the AW and the WAW.

message > Minimum Source Interlock

Page 16

(7) Set Auto mode demand power thumbwheel to "000E00". Press the "AUTO" mode pushbutton to invoke the Auto Mode.

(8) Activate the NM1000 Rod Withdrawal Prohibit signal, "RWP1", by pulling the neutron source

(a) Verify that the Reg rod, Shim 1, Shim 2 and transient rod cannot be withdrawn from the core by pressing the rod "UP" buttons.
(b) A warning message should appear in the AW and the WAW.

message > Minimum Source Interlock

(9) Restore neutron source.

(10) Apply Tmasient rod air. Press and hold the transient rod "UP" button to test the simultaneous withdrawal logic.

(a) The drive and animation should move up.
(b) Now press any of the other rod "UP" buttons except the Reg rod.
(c) The transient rod drive and animation should stop and the other drive should not start up.
(d) Movement can not be restarted until both buttons have been released and the drive "UP" button is pressed again.
(e) Repeat this test for other rod "UP" buttons except the Reg rod.

(11) Repeat step 10 for each Shim rod.

(12) Return all rods to full down position. Remove air from transient rod by depressing "AIR" button.

(a) Verify system is still in AUTO mode.
(b) Raise transient drive eylinder to about 50 units
(c) Attmpt to fire transient rod by pressing "FIRE" button
(d) Verify rod does not fire and "AIR" light does not come on
(e) Return transient drive to full down position

(13) Repeat step (6).

(27) Move Shim1 to approximately 50 % withdrawn.

(28) Move Shim2 to approximately 50 % withdrawn.

Page 20

(14) (e) Position Reg and Shim rods at about 50 units.

(17) Move Transient rod drive to about 50 units. Air must be OFF.

(18) Activate the NM1000 Rod Withdrawal Prohibit signal, "RWP1", by pulling the neutron source.

(19) Press the "FIRE" button to apply air to Transient rod drive mechanism
- (a) The Transient rod should not move
- (b) The "AIR" light should not come ON
- (c) A warning message should appear in the AW and the WAW.
  message > Minimum Source Interlock

(20) Restore the neutron source.

Page 22

(14) (e) The Reg rod and both Shim rods are positioned at about 50 units.

(16) Move Transient rod drive to about 50 units. Air must be OFF.

(17) Activate the NM1000 Rod Withdrawal Prohibit signal, "RWP1", by pulling the neutron source.

(18) Press the "FIRE" button to apply air to Transient Rod Drive Mechanism
- (a) The transient rod should not move
- (b) The "AIR" light should not come ON
- (c) A warning message should appear in the AW and the WAW.
  message > Minimum Source Interlock

(19) Restore the neutron source.

>>>>>>>>>>>>THIS TABLE TO BE REDONE IN FINAL!!!!

CONTENTS: Page

Interlock Check Conditions

This section of the ICS system procedures tests the following interlocks. The function of each of these interlocks is a function of the digital control program.

Section	Steps	Description	TS requirement
	Prerequisite Conditions:		
1.0	2-6	A correct password is a requirement for operation of the magnet key switch.	
1.0	8-10	Log on allows replacement of an active operator.	
1.0	11-15	Log off requires system to be in the SCRAM mode.	
	Manual Mode Conditions:		
2.3	2-5	Change from scram to manual mode requires operator log on.	
2.3	6-9	Acknowledgement of scram condition to restore magnet key switch action and enter manual mode.	
2.4	14	Release of rod by magnet or air switch will interrupt power to each control rod unit.	
2.4	10-13, 15	Simultaneous withdrawal limits up motion to one rod and allows down motion of any combination.	4.2.2.b
2.4	16-18	Transient rod function as a normal rod.	4.2.2.b
2.4	19	"Fire" button for transient rod applies air to drive only if drive is down.	4.2.2.c
2.4	20	Rod withdrawal prohibit signal prevents operation of rods if minimum neutron source level is not present.	4.2.2.a
	Auto Mode Conditions:		
3.3	3	No operator prevents entry into auto mode.	
3.3	5	Do not prevent auto mode if shim rods are at the down limit.	
3.3	8	Rod withdrawal prohibit signal prevents operation of rods if minimum neutron source level is not present.	4.2.2.a
3.3	10, 11	Simultaneous withdrawal limits up motion to one rod excluding reg rod.	4.2.2.b
3.3	12	"Fire" button for transient rod applies air to drive only if drive is down.	4.2.2.c
3.4	1-5	Power demand switches determine regulating rod motion with a limit of 3-5 secs. for the reactor period.	
3.4	6	Rod magnet switch changes auto mode to manual mode.	
3.4	11	Manual scram button changes auto to scram mode.	

	Pulse Mode Conditions:		
4.1	1-3	Prevent entry into pulse ready mode.	
4.1	4-7	Transient rod air off requirement.	
4.1	8-10	Reactor power level less than 1 kw.	4.2.2.e
4.1	11-12	1 DPM limit for pulse mode.	
4.1	18-19	Rod withdrawal prohibit signal prevents operation of transient rod if minimum neutron source level is not present.	4.2.2.a
4.1	21-22	Pulse withdrawal Interlock, no standard rod motion.	4.2.2.d

	Square Wave Mode Conditions:		
5.1	1-3	Prevent entry into square ready mode.	
5.1	4-7	Transient rod air off requirement.	
5.1	8-10	Reactor power level less than 1 kw.	4.2.2.e
5.1	11-12	1 DPM limit for pulse mode.	
5.1	17, 18	Rod withdrawal prohibit signal prevents operation of transient rod if minimum neutron source level is not present.	4.2.2.a
5.1	20, 21	Pulse withdrawal interlock, no standard rod motion	4.2.2.d

Note: Two types of annunciator conditions will occur. One condition presents an audible alarm and the other does not. The first is a detection of a failure condition. The second is a discovery of an incorrect condition.

Scram Functions

This section of the ICS system procedures tests the safety circuit functions. The scram functions are independent of the digital control program. Annunciation features of the system are a function of the digital program. Several scram conditions and other key system checks and tests are also functions of the control program.

Section	Steps	Description	TS requirements
		Digital Control Program	
6.0	1-18	Scram for data base timeout and network fault if both low and high networks fail.	
7.1	2	Scram for CSC digital scanner timeout.	
7.1	3-8	Scram for CSC watchdog timeout.	4.2.3.f
7.2	2	Scram for DAC digital scanner timeout.	
7.2	3-8	Scram for DAC watchdog timeout.	4.2.3.f
7.4	2	NPP1000 pulse mode gain change relay function	
7.4	2	NP1000 pulse mode bypass relay function	
7.4	2	NM1000 pulse mode bypass relay function	
		Fuel Temperature	
7.0	2	FT #1 scram at 550 deg. C	4.2.3.a
7.0	3	FT #2 scram at 550 deg. C	4.2.3.a
		Power Safety Channels	
7.0	4	NPP1000 set point for high percent power	4.2.3.b
7.0	4	NPP1000 set point for pulse peak power	4.2.3.b
7.0	5	NP1000 set point for high percent power	4.2.3.b
7.0	9-10	NM1000 Hi percent power or Lo high voltage	4.2.3.b
		Operable Systems	
7.0	6	Scram for manual pushbutton	4.2.3.d
7.0	7	Scram for magnet key switch	4.2.3.e
7.0	8	Magnet supply voltage and ground detection	
7.0	11-12	NM1000 Hi percent power or Lo high voltage	4.2.3.c
7.0	13	NPP1000 set point for high voltage loss	4.2.3.c
7.0	14	NP1000 set point for high voltage loss	4.2.3.c
7.0	17	Scram for low pool level condition sensors	
7.3	2	Scram for NM1000 communication fault.	
7.3	4	Scram for NM1000 data base timeout.	

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Interlock Checks

Operator Functions:

Valid Password		
Incorrect password fails		____yes
Correct password successful		____yes
Operator change:		____okay
Operator logout:	**SCRAM** mode	____yes
Operator logout:	**NON SCRAM** mode	____no

Manual Mode:

No operator:	prevents change to **manual** mode ___yes
Failure to acknowledge annunciator:	prevents magnet **key switch** function___yes

Simultaneous withdrawal interlock: stops motion of **two rods** in **up** direction

Move rod	Stops on movement of:		
Reg rod	Shim 1 ___	Shim 2 ___	Trans ___
Shim 1	Reg ___	Trans ___	Shim 2 ___
Shim 2	Reg ___	Trans ___	Shim 1 ___
Trans	Shim 1 ___	Shim 2 ___	Reg ___

Rod release by magnet or air switch: returns magnet power indication

Drop rod		Magnet indication returns		
Shim 1	___	_____yes	**Reg** ___	_____yes
Shim 2	___	_____yes	**Trans** ___	_____air remains off !

Fire button function	(**transient** rod only):	
Drive **down**	- air turns *on* ________ units	_____yes
Drive **up**	- air stays *off* ________ units	_____yes

Rod withdrawal prohibit: stops rod movements (all rods):
RWP (NM1000): **Reg** ___ **Shim1** ___ **Shim2** ___ **Trans** ___

Interlock Checks

Auto Mode

No operator prevents entry into auto mode ___yes
Auto mode does not intitiate from SCRAM mode ___yes

Rod withdrawal prohibit: stops rod movements (all rods):
RWP (NM1000) **Reg** ___ **Shim1**___ **Shim2** ___ **Trans**___

Simultaneous withdrawal interlock stops motion of **two rods** in **up** direction

Move	Stops on movement of;	
Trans	Shim 1___	Shim 2___
Shim 1	Trans ___	Shim 2___
Shim 2	Trans ___	Shim 2___

Fire button function: (transient rod only)
Drive **up** - air stays *off*________ units ______yes

Rod position: Maintain Auto Mode

Reg Down	_____yes
Shim1-10%, Shim2 Down	_____yes
Shim2 10%, Shim1 Down	_____yes

Demand power
set indication, above (high)_____ **reg** rod moves to _____%(0)
set indication, below (low)_____ **reg** rod moves to _____%(100)

auto mode variation: ______ % in 20 minutes

Magnet switch Mode change auto to manual

Reg Down	_____yes
Shim 1 rod	_____yes
Shim 2 rod	_____yes

All rods up; **reg** 50% **Scram mode** _____yes

Interlock Checks

Pulse Mode

Condition	Enter pulse mode
scram mode	______no
auto mode	______no
square wave; ready mode	______no
manual mode; transient rod air on	______no
manual mode; power > 1 kw	______no
manual mode; period < 1 DPM	______no
manual mode	______*yes*

Rod withdrawal Prohibit:	(transient rod only)			
RWP (NM1000)	trans rod does not fire			______yes
Rod motion:				
No **UP** motion		Reg ____	Shim1 ____	Shim2 ____
Down motion		Reg ____	Shim1 ____	Shim2 ____
Withdrawal Time:	transient rod withdrawn			__________sec

Square Wave Mode

Condition	Enter pulse mode
scram mode	______no
auto mode	______no
pulse mode	______no
manual mode; transient rod air on	______no
manual mode; power > 1 kw	______no
manual mode; period < 1 DPM	______no
manual mode	______*yes*

Rod withdrawal Prohibit:	(transient rod only)			
RWP (NM1000)	trans rod does not fire			______yes
Rod motion:				
No **UP** motion		Reg ____	Shim1 ____	Shim2 ____
Down motion		Reg ____	Shim1 ____	Shim2 ____
Withdrawal Time:	transient rod withdrawn			_see above_sec

SCRAM Checks

Network Functions:

IC Network LO Fault		yes_____	no____
IC Network HI Fault		yes_____	no____
Loss of both communication lines:	SCRAM:	yes_____	no____

Limiting Safety System Setting:

Fuel Temp #1 _______deg.C	Trips okay	_______
Fuel Temp #2 _______deg.C	Trips okay	_______
NPP1000(#1) _______%	Trips okay	_______
NP1000 (#2) _______%	Trips okay	_______

System Operable Conditions:

Key Switch			Trips okay	_______
Manual SCRAM Switch			Trips okay	_______
Magent Power Grounded		____HI ____LO		
NM1000	Hi pwr	_______%	Trips okay	_______
NM1000	HV___________volts dc		Trips okay	_______
NPP1000	HV _____	AC____	Trips okay	_______
NP1000	HV _____	AC____	Trips okay	_______
Pool Water LO1	_______meters		Trips okay	_______
Pool Water LO2	_______meters		Trips okay	_______
External (#1)	____________________		Trips okay	_______
External (#2)	____________________		Trips okay	_______

CSC System:

Scanner	DIS064___	Trips okay	_______
Watchdog trip test		Trips okay	_______
Kill sc	Enter PID#______	Trips okay	_______

DAC System:

Scanner	DIS064___	Trips okay	_______
Watchdog trip test		Trips okay	_______
Kill scanner	Enter PID#______	Trips okay	_______

NM1000 System:

Stack Fault	_______	Trips okay	_______
Communication	_______	Trips okay	_______

Interlock Checks and Scram Functions

Acceptance Documentation

Comments:

Date: ____/____/____ Approval:____________________

Interlock and SCRAM Features

I. PURPOSE

The purpose of this procedure is the calibration and functional check of the instrument, control and safety system for the TRIGA reactor. Systems subject to this procedure are the control console programs, the operation control interlocks and the control rod safety system.

II. DESCRIPTION

The instrument control and safety system is a digital processing system that monitors analog and digital signals, displays information for the operator and logs data. Operator interactions with the system determine control of operation modes and rod positions. Safety system function is independent of the ICS system programs. This procedure systematically examines key program features that determine system interlocks and that implement system SCRAM functions.

III. REFERENCES

1.) UT TRIGA ICS Manual
 Parts 1,2,3, and 4
2.) UT TRIGA Mechanical System Manual
 Parts 1,2,3, and 4
3.) Acceptance test data

IV. EQUIPMENT AND MATERIALS

1.) ICS system keys
2.) Multimeter - Fluke 87
3.) Multisource - Keithley 263
4.) Test instrument cables, probes

V. PROCEDURE

<u>Note</u>: Log all console operation for diagnostic work, maintenance,

surveillance, calibration and test with the password MIRAGE.

(1) Review calibration and functional check requirements. Follow the instructions of each of the following sections.

(2) Discontinue operation if any procedure is not successful. Correction of all failures is necessary to continue routine operation.

(3) Run prestart checks to verify operable conditions. Review surveillance results. Approval of the data by the reactor supervisor is necessary to continue operation.

(4) File procedure records and prestart checklist. Initial and date calibration check tag. Tag location should be on key ring with the magnet key.

(5) Return to normal operation.

CONTENTS: Page

Interlock Check Conditions

This section of the ICS system procedures tests the following interlocks. The function of each of these interlocks is a function of the digital control program.

Section	Steps	Description
		Operator Conditions:
1.0	2-6	a.) A correct password is a requirement for operation of magnet key switch.
1.0	8-10	b.) Log on allows replacement of an active operator.
1.0	11-15	c.) Log off requires system to be in SCRAM mode.
		Manual Conditions:
2.3	2-5	a.) Change from scram to manual mode requires operator log on.
2.3	6-9	b.) Acknowledgement of scram condition necessary to restore magnet key switch action and enter manual mode.
2.4	10-13	c.) Simultaneous withdrawal limits up motion to one rod and allows down motion of any combination.
2.4	14	d.) Release of rod by magnet or air switch will momentarily interrupt power to each control rod unit.
2.4	16	e.) Rod withdrawal prohibit signal prevents operation of rods if minimum neutron source level is not present.
2.4	17-19	f.) Transient rod function as a normal rod.
2.4	20	g.) "Fire" button for transient rod applies air to drive only if drive is down.

Step		Action and Response	Comment or Correction
		<u>Auto Mode Conditions</u>:	
3.3	3	a.) No operator prevents entry into auto mode.	
3.3	5	b.) Prevent auto mode if shim 1 and shim 2 are at the down limit.	
3.4	1-5	c.) Power demand switches determine regulating rod motion and with a limit of 15 secs. for the reactor period.	
3.4	6	d.) Rod magnet switch changes auto mode to manual mode.	
3.4	11	e.) Manual scram button changes auto to scram mode.	
		<u>Pulse Mode Conditions</u>:	
4.1	1-3	a.) Prevent entry into pulse ready mode.	
4.1	4-7	b.) Transient rod air off requirement.	
4.1	8-10	c.) Reactor power level less than 1 kW.	
4.1	11-12	d.) 1 DPM limit for pulse mode.	
4.1	17-18	e.) Pulse Withdrawal Interlock	
		<u>Square Mode Conditions</u>:	
5.1	1-3	a.) Prevent entry into square ready mode.	
5.1	4-7	b.) Transient rod air off requirement.	
5.1	8-10	c.) Reactor power level less than 1 kw.	
5.1	11-12	d.) 1 DPM limit for pulse mode.	

Note: Two types of annunciator conditions will occur. One condition presents an audible alarm and the other does not. The first is a detection of a failure condition. The second is a discovery of an incorrect condition.

Scram Functions

This section of the ICS system procedures tests the safety circuit functions. The scram functions are independent of the digital control program. Annunciation features of the system are a function of the digital program. Several scram conditions and other key system checks and tests are also functions of the control program.

Section	Steps	Description
		Digital Control Program
6.0	1-18	Scram for network fault if both low and high networks fail.
6.0	17	Scram for data base timeout.
7.1	2	Scram for CSC digital scanner timeout.
7.1	3-8	Scram for CSC watchdog timeout.
7.2	2	Scram for DAC digital scanner timeout.
7.2	3-8	Scram for DAC watchdog timeout.
7.4	2	NP1000 pulse mode bypass relay function
7.4	2	NPP1000 gain change relay function
7.4	2	NM1000 pulse mode bypass relay function
		Fuel Temperature
7.0	2	FT #1 scram at 550 deg. C
7.0	3	FT #2 scram at 550 deg. C
		Power Safety Channels
7.0	4	NPP1000 set point for high percent power
7.0	5	NP1000 set point for high percent power
7.0	9-12	NM1000 Hi percent power or Lo high voltage
7.0	13	NPP1000 set point for high voltage loss
7.0	14	NP1000 set point for high voltage loss
7.4	1	NPP1000 set point for pulse mode power
		Operable Systems
7.0	6	Scram for magnet key switch
7.0	7	Scram for manual pushbutton
7.0	8	Magnet supply voltage and ground detection
7.0	17	Scram for low pool level condition sensors
7.3	2	Scram for NM1000 communication fault.
7.3	4	Scram for NM1000 data base timeout.

Interlock Check Procedures

1.0 OPERATOR LOG ON/OFF

(1) Complete successful power up sequence. Refer to Acceptance Test Procedures, section 1.0 steps (1)-(3).

(2) Initiate the operator log in sequence by pressing the "F5" function key. A menu should appear.

menu > Reactor Operator Log On/Off Utility ...

(3) Select item 1, "Operator Log In," by pressing the "1" key. A prompt should appear below the menu.

prompt > Please enter your password --> _

(4) Enter an invalid password "ABCDEF". A message should momentarily appear below the menu.

message > Invalid Password ... Permission Denied!

(5) Initiate the operator log in sequence by pressing the "F5" function key. A menu should appear.

menu > Reactor Operator Log On/Off Utility ...

(6) Select item 1, "Operator Log In," by pressing the "1" key. A prompt should appear below the menu.

prompt > Please enter your password --> _

(7) Enter a valid password "MIRAGE". A message should momentarily appear below the menu.

message > Accepted - Welcome to the Triga Control System

(8) Initiate the operator log in sequence by pressing the "F5" function key. A menu should appear.

menu > Reactor Operator Log On/Off Utility ...

(9) Select item 1, "Operator Log In," by pressing the "1" key. A prompt should appear below the menu.

message > Replace Operator #__? (Y/N)

Step	Action and Response	Comment or Correction

(10) Respond "N" to prompt to continue.

(11) Press switch to start the Prestart Checks sequence. Verify the Prestart Checks completes successfully.

(12) Switch Magnet Key Switch to "Reset", then "ON". The system will enter the Manual mode.

(13) Select item 2, "Operator Log Off", by pressing the "2" key. A message should momentarily appear below the menu.

message > Invalid request Reactor Active!

(14) Return system to SCRAM mode by switching Magnet Key Switch "off".

(15) Select item 2, "Operator Log Off", by pressing the "2" key. A message should momentarily appear below the menu.

message > Operator Log off ... Goodbye!

(16) Access the operator log display by pressing the "F6" function key. Verify the display items.

Maintain a record of the operator, hours and energy.
Note that a correction is needed for any "pseudo" data present if any calibration or testing activities generate power level data.
This data should always be the total for the password applicable to this procedure.

Press the <spacebar> to return to the Standard Display, STW.

2.0 MANUAL MODE

Complete the checks of section 1.0.

2.1 ENTERING THE MANUAL MODE

The Manual mode will be entered when all the following conditions exist:

(a) No SCRAM conditions are present.
(b) An operator is logged in.
(c) Key switch for magnet current is in the "ON" position.
(d) Auto Pretest mode is completed successfully.

Consult Acceptance Test Procedures, System Startup (section 1.0), Operator Log On/Off (section 2.0), and SCRAM Conditions (section 4.0) for these items.

2.2 EXITING THE MANUAL MODE

The Manual mode will be exited when any of the following conditions exist:

(a) A SCRAM condition occurs.
(b) The Pulse mode is invoked.
(c) The Auto mode is invoked.
(d) The Square Wave mode is invoked.

Consult Acceptance Test Procedures, SCRAM (section 4.0), Pulse (section 6.0), Auto (section 7.0) and Square Wave (section 8.0) mode for these items.

2.3 INITIATION AND TERMINATION OF MANUAL MODE

(1) Power up the system and allow the system to complete its start up sequence indicated by the reactor animation and STW screens being displayed.

(a) The Reactor Display mode should be "SCRAM".
(b) All the Reactor Mode pushbutton lights should be Off.
(c) Auto-winddown of all rod drives is invoked in the SCRAM mode.
(d) Magnet Power - Air Supply to the rod drives should be Off. Off indicated by the corresponding indicator boxes below the animated rod drives being black on the Reactor Display.

(2) Clear all SCRAM conditions and acknowledge any SCRAM or warning messages in the AW by pressing the "ACK" button.

(3) Operate the "MAGNET POWER" key switch from "ON" to "RESET" to "ON". The Reactor Control Console should beep indicating an invalid operation has been attempted. A message should appear in the AW and the SCW.

message > SCRAM - Please Log In

(4) Acknowledge the SCRAM message by pressing the "ACK" button. The message "SCRAM - Please Log In" should be cleared from both the AW and the SCW.

(5) Initiate the operator login sequence by pressing the "F5" function key. A menu and prompt should appear.

menu > Reactor Operator Log On/Off Utility
prompt > Please enter the password -->

(6) Press the "Manual SCRAM" button. A message should appear in the AW and the SCW. Do not acknowledge the error condition.

message > SCRAM - Console Pushbutton

(7) Attempt to invoke the Manual mode by operating the "MAGNET POWER" key switch from "ON" to RSET" to "ON".

(a) Do not acknowledge scram message.
(b) The system should re-enter the "SCRAM" mode.
(c) The SCRAM condition message will still exist.

Step	Action and Response	Comment or Correction

(8) Acknowledge the SCRAM message by pressing the "ACK" button. The message "SCRAM - Console Pushbutton" should be cleared from both the AW and the SCW.

(9) Attempt to invoke the manual mode by operating the "MAGNET POWER" key switch again. This time, the Manual mode should be invoked.

- (a) The Manual mode will be indicated by the "MANUAL" pushbutton light coming on.
- (b) Reactor Display mode will indicate "Manual".
- (c) Magnet Power indicator boxes on animated rod drives turn yellow.
- (d) Rod magnet power will indicate on the Reactor Display.
- (e) Air Supply to the Transient rod drive will not be applied by entering the Manual mode so its Air Supply status box below its animated rod drive will remain black.

(10) Complete the procedures of the next section then terminate operation by operation of the "MAGNET POWER" key switch to the "OFF" position. Verify the conditions of step (1) exist.

2.4 <u>OPERATION WITHIN THE MANUAL MODE</u>

(1) Invoke the Manual mode as described above.

- (a) The display animation includes a representation of the Drive, Magnet, and the Rod. All should move in unison.
- (b) The rod position is represented by a number between 0 and 999.
- (c) A specific rod position should be attainable via the "UP" and "DOWN" buttons.

(2) Press and hold the Reg Rod "UP" button.

- (a) The Reg rod and the animated Reg rod should begin to withdraw out from the reactor core.
- (b) The numeric rod position below the animated rod drive should increase in value.

(3) Release the Reg rod "UP" button.

- (a) The Reg rod and the animated rod drive should stop moving.
- (b) The numeric readout should stop increasing.
- (c) The actual position of the rod drive and the animated representation should correspond.

Step	Action and Response	Comment or Correction

(4) Press and release the "UP" button. There should be no appreciable delay between

(a) activation/release of the "UP" button
(b) and the start/stop movement of the rod drive
(c) and the animated representation.

(5) Press and hold the Reg rod "DOWN" button.

(a) The Reg rod and the animated Reg rod should begin to insert back into the reactor core.
(b) The numeric rod position below the animated rod drive should decrease in value.

(6) Release the Reg rod "DOWN" button.

(a) The Reg rod and the animated rod drive should stop moving.
(b) The numeric readout should stop decreasing.
(c) The actual position of the rod drive and the animated representation should correspond.

(7) Press and release the "DOWN" button. There should be no appreciable delay between

(a) activation/release of the "DOWN" button
(b) and the start/stop movement of the rod drive
(c) and the animated representation.

(8) Press and hold the Reg rod "UP" button.

(a) The drive and animation should move up.
(b) Now press the Reg rod "DOWN" button.
(c) The drive and animation should stop.
(d) Movement can not be restarted until both buttons have been released and one or the other activated again.

(9) Press and hold the Reg rod "DOWN" button.

(a) The drive and animation should move down.
(b) Now press the Reg rod "UP" button.
(c) The drive and animation should stop.
(d) Movement can not be restarted until both buttons have been released and one or the other activated again.

(10) Press and hold the Reg rod "UP" button to test the simultaneous withdrawal logic.

(a) The drive and animation should move up.
(b) Now press any of the other rod "UP" buttons.
(c) The Reg rod drive and animation should stop and the other drive should not start up.
(d) Movement can not be restarted until both buttons have been released and the drive "UP" button is pressed again.
(e) Repeat this test for other rod "UP" buttons.

(11) Move the Shim rods off the bottom so there will be room to move down. The animated display should reflect their new positions.

(12) Press and hold the Reg rod "UP" button.

(a) The Reg rod drive and animation should move up.
(b) Now press any or all of the other rod "DOWN" buttons.
(c) The Reg rod drive and animation should continue moving up while the other rod(s) moves down.
(d) Release the buttons.
(e) All rods should stop.

(13) Press and hold the Reg rod "DOWN" button.

(a) The Reg rod drive and animation should move down.
(b) Now press any or all of the other rod "DOWN" buttons.
(c) The Reg rod drive and animation should continue moving down while the other rod(s) moves down.
(d) Release the buttons.
(e) All rods should stop.

(14) Press the Reg rod "MAGNET" current button to SCRAM rod. If the "MAGNET" button is held down long enough, say longer than 1 second, the yellow box representing the Reg rod's magnet current will go black as long as the button is held depressed. When the button is released, the magnet current is restored and the Reg rod magnet box is filled once again with yellow.

(a) Verify that the Reg rod and its animated representation drop to the fully inserted position.
(b) Verify the Auto-winddown of the Reg Rod Drive Mechanism is initiated.

(15) Repeat steps (2) through (14) for each Shim rod.

Step	Action and Response	Comment or Correction

(16) Activate the NM1000 Rod Withdrawal Prohibit signal, "RWP1",by pulling the neutron source and verify that the Reg rod, Shim 1, and Shim 2 cannot be (further) withdrawn from the core by pressing the rod "UP" buttons.

(17) At this point, the Transient Rod and Drive Mechanism should be fully down and the Air Supply Off. The Air Supply status box below the animated Transient Rod Drive Mechanism should be black indicating Air is not applied.

(18) Press the "FIRE" button to apply air to the Transient Rod Drive Mechanism.

(a) The Transient rod should move up approximately 1/2".
(b) The Air Supply status box should change to yellow indicating Air is applied.

(19) Repeat steps (2) through (16) for the Transient rod. For the Transient rod, however, the "MAGNET" button is replaced by an "AIR" button. It operates in a manner similar to the "MAGNET" button except the Air stays Off even after the "AIR" button is released.

(20) To reapply Air, the "FIRE" button must be pressed with the rod drive at the bottom.

(a) Attempt to turn the Air back On while the Transient rod drive is in Auto-wind down operation.
(b) Verify the "FIRE" button will turn the Air back On, only after the rod drive reaches the bottom limit.

3.0 AUTO MODE

The Auto Mode automatically controls the reactor power to be equal to the Demand Power set into the "Demand Power" thumbwheel switches. Control is accomplished by a PID algorithm controlling the position and speed of the Reg rod.

If the reactor power is at some value above or below the demand power and the auto mode is invoked, the auto mode algorithms will move the Reg rod to bring reactor power equal to the demand power setting.

The Reg rod control is always by computer in the Auto mode.

The checks in this section require the operation of the reactor at power. Exclude these checks until completion of all startup processes and basic acceptance for power operation.

3.1 ENTERING THE AUTO MODE

The Auto mode is entered if:

(a) The mode is manual and
(b) either the "AUTO" mode button is pressed manually, or
(c) the Square Wave ramp up sequence is completed successfully.

3.2 EXITING THE AUTO MODE

The Auto mode is exited if:

(a) the Manual mode is selected, or
(b) any rod is SCRAMMED, or
(c) any SCRAM condition exists.

3.3 INITIATION AND TERMINATION OF THE AUTO MODE

(1) Power up the system and allow the system to complete its start up sequence indicated by the reactor animation and STW screens being displayed.

(a) The Reactor Display mode should be "SCRAM".
(b) All the Reactor Mode pushbutton lights should be Off.
(c) Auto-winddown of all rod drives is invoked in the SCRAM mode.
(d) Magnet Power - Air Supply to the rod drives should be Off. Off indicated by the corresponding indicator boxes below the animated rod drives being black on the Reactor Display.

(2) Clear all SCRAM conditions and acknowledge any SCRAM or warning messages in the AW by pressing the "ACK" button.

(3) Press the "AUTO" mode pushbutton to invoke the Auto mode. Verify that the system does not change modes and the system beeps once indicating an invalid operation is being attempted.

(4) Initiate the operator login sequence by pressing the "F5" function key. A menu and prompt should appear.

menu > Reactor Operator Log On/Off Utility
prompt > Please enter the password -->

(5) Repeat step (3).

(6) Turn the MAGNET power key switch to the RESET position. Clear all SCRAM and Warning messages and place the system into the Manual Operate mode.

(7) Startup the reactor to a power level of about 50 watts. Move the Reg and all Shim rods by manual operation off the bottom to their 50% withdrawn position. Rod position is approximate. The Transient rod should be left at the bottom.

(8) Set the "Demand Power" thumbwheel switches to match the current power being produced by the reactor.

(9) Press the "AUTO" mode pushbutton to invoke the auto mode.

(a) The "AUTO" mode light should come on.
(b) The "MAN" light should go off.
(c) The Reactor Display should indicate Auto mode.

(10) Press the "MAN" pushbutton to invoke the Manual mode.

(a) The "MAN" mode light should come on.
(b) The "AUTO" light should go off.
(c) The Reactor Display should indicate Manual mode.

(11) Move the Reg Rod Drive Mechanism to full insertion with the remaining rods and thumbwheels set per items (7) and (8) above.

(a) Invoke the auto mode.
(b) The system should stay in the AUTO mode.

(12) Press the "MAN" pushbutton to invoke the Manual mode.

(13) Move the Shim 1 rod to its 10% withdrawn position. The Shim 2 and the Reg rod should be at their 50% withdrawn position.

(14) Press the "AUTO" mode pushbutton to invoke the Auto mode.

(15) Move the Shim 2 rod manually to the bottom. The system should stay in the auto mode.

(16) Press the "MAN" pushbutton to invoke the Manual mode.

(17) Move the Shim 2 rod to its 10% withdrawn position. The Shim 1 and the Reg rod should be at their 50% withdrawn position.

(18) Press the "AUTO" mode pushbutton to invoke the Auto mode.

(19) Move the Shim 1 rod manually to the bottom. The system should stay in the auto mode.

3.4 OPERATION WITHIN THE AUTO MODE

(1) Set the "Demand Power" thumbwheel above the current power level.

(a) Verify the reactor power changes to the demand level.
(b) Confirm a 3 to 5 second period limit of the power response.

(2) Vary the setting of the "Demand Power" thumbwheel above and below the current power level.

(a) Verify that the Reg rod servos down to 0% position.
(b) Verify that the Reg rod servos up to 100% position.

(3) Set the "Demand Power" setting below power level.

(a) Verify the reactor power changes to the demand power.
(b) Verify period is negative.

(4) Operate in the Auto mode for about 20 minutes.

(a) Observe Auto mode drift.
(b) Verify ability to maintain power to within +/ - 10 percent.

(5) Switch between Auto mode and Manual mode under constant and varying power conditions.

(a) Verify system response
(b) Verify status of mode lights.

(6) Press magnet power switch of a control rod. Repeat for each rod.

(a) Verify system starts in Auto mode.
(b) verify mode changes to manual mode.

(7) Invoke the Auto mode. Move transient rod drive to bottom limit and fire transient rod.

(8) Change position of transient rod manually.

(a) Observe the up movement of the Reg rod to compensate for the power change.
(b) Observe the down movement of the Reg rod to compensate for the power change.

(9) Adjust the positions of the Shim 1, Shim 2 and the transient rod to balance the power (rod) profile of the reactor, maintaining the Reg rod within its 0% to 100% boundary.

(10) Adjust the balance of the non-servoed rods until the Reg rod position is finalized at the 50% point for optimum control.

(11) Press the "MANUAL SCRAM" button.

(a) System should change to the "SCRAM" mode.
(b) All mode lights will go off.

4.0 PULSE MODE

The Pulse Ready Mode is initiated from the Manual mode by pressing the "PULSE" mode button and entering a pulse ID string. The pulse is initiated from the Pulse Ready mode by pressing the "FIRE" button. 5000 power readings are taken during the 1/2 second pulse period. Peak fuel temperature readings are acquired during the next 4 seconds and then calculations are made from the pulse data and presented on the standard resolution screen. Interlocks which prevent entry into Pulse Ready mode are tested in procedures (1) through (13).

4.1 ENTERING THE PULSE READY MODE

(1) Place the system in SCRAM mode. Press the "PULSE" button on the control console. You should hear a beep; the system should remain in SCRAM mode.

(2) Place the system into AUTO mode. Press the "PULSE" button. You should hear a beep; the system should remain in AUTO mode. Return system to MANUAL mode.

(3) Place the system in SQUARE WAVE READY mode. Press the "PULSE" button. You should hear a beep; the system should remain in SQUARE WAVE READY mode.

(4) Place the system in MANUAL mode.

(5) Press the "AIR" button on the control console. If the transient rod air supply was on, it will turn off and the transient rod will fall to the bottom of the reactor core. The rod drive will then wind down automatically to its bottom position.

(6) Press the "FIRE" button to turn on the air pressure to the transient rod.

(7) Press the "PULSE" button. You should hear a beep and the system should remain in MANUAL mode. A warning message should appear in the AW and the WAW.

message > Trans Rod Air must be off!

(8) Remove the air supply to the transient rod by pressing the "AIR" button.

(9) Acknowledge the warning message by pressing the "ACK" button. The warning message on the AW and the WAW should disappear.

(10) Raise the reactor power above 1 kW. Press the "PULSE" button. You should hear a beep and the system should remain in MANUAL mode. A warning message should appear in the AW and the WAW.

message > Power too high to pulse

(11) Lower the reactor power below 1 kW. Acknowledge the warning message by pressing the "ACK" button. The warning message on the AW and the WAW should disappear.

(12) Introduce a positive period of about 15 seconds to the reactor. While the 15 second period is occurring, press the "PULSE" button. You should hear a beep. The system should remain in MANUAL mode. A warning message should appear in the AW and the WAW.

message > Period too short to pulse

(13) Acknowledge the warning message by pressing the "ACK" button. The warning message on the AW and the WAW should disappear.

(14) Prepare the system to enter the PULSE READY mode by creating the following conditions:

(a) System is in the MANUAL mode.
(b) Reactor power is less than 1 kW.
(c) The rate of change of reactor power is less then 1 DPM.
(d) The transient rod air pressure is off and the transient rod is down.

(15) Press the "PULSE" button.

(a) The mode should change to "PULSE - READY" on the reactor animation display.
(b) The PULSE button should illuminate on the control console.
(c) The STW should be replaced by

message > Enter Pulse ID String -->

(16) Enter a string of characters to identify the pulse followed by a carriage return. MAIN 1-MM/YY (MM-month, YY-year) The STW should reappear.

(17) With system in PULSE mode, attempt to drive Reg rod out using "UP" button on console. Verify the Reg rod does not move up but will move down.

(18) Repeat step (17) for each Shim rod.

(19) Fire Pulse with all rods down and measure time that pulse rod remains withdrawn (shall be less than 15 seconds).

(20) Return to MANUAL mode.

5.0 SQUARE WAVE MODE

The Square Wave mode is initiated from the MANUAL mode by pressing the "Square Wave" button. The mode combines the reactor control features of both pulse and auto mode. A pulse is performed with sufficient reactivity to reach the demand power for the auto control of the reactor power level. The PID algorithm controls the duration of the operation until a manual SCRAM shutdown terminates the mode.

Interlocks which prevent entry into Square Wave Ready mode are tested in steps (1) through (13) of section 5.1.

5.1 ENTERING THE SQUARE WAVE READY MODE

(1) Place the system in SCRAM mode. Press the "SQUARE WAVE" button on the control console. You should hear a beep; the system should remain in SCRAM mode.

(2) Place the system into AUTO mode. Press the "SQUARE WAVE" button. You should hear a beep; the system should remain in AUTO mode. Return system to MANUAL mode.

(3) Place the system in PULSE READY mode. Press the "SQUARE WAVE" button. You should hear a beep; the system should remain in PULSE READY mode.

(4) Place the system in MANUAL mode.

(5) Press the "AIR" button on the control console. If the transient rod air supply was on, it will turn off and the transient rod will fall to the bottom of the reactor core. The rod drive will then wind down automatically to its bottom-most position.

(6) Press the "FIRE" button to turn on the air pressure to the transient rod.

(7) Press the "SQUARE WAVE" button. You should hear a beep and the system should remain in MANUAL mode. A warning message should appear in the AW and the WAW.

message > Trans Rod Air must be off!

(8) Remove the air supply to the transient rod by pressing the "AIR button.

(9) Acknowledge the warning message by pressing the "ACK" button. The warning message on the AW and the WAW should disappear.

(10) Raise the reactor power above 1 kW. Press the "SQUARE WAVE" button. You should hear a beep and a warning message should appear in the AW and the WAW

message > Power too high to pulse

(11) Lower the reactor power below 1 kW. Acknowledge the warning message by pressing the "ACK" button. The warning message on the AW and the WAW should disappear.

(12) Introduce a positive period of about 15 seconds to the reactor. While the 15 second period is occurring, press the "SQUARE WAVE" button. You should hear a beep. The system should remain in MANUAL mode. A warning message should appear in the AW and the WAW.

message > Period too short to pulse

(13) Acknowledge the warning message by pressing the "ACK" button. The warning message on the AW and the WAW should disappear.

(14) Prepare the system to enter the SQUARE WAVE mode by creating the following conditions:

(a) System is in the MANUAL mode.
(b) Reactor power is less than 1 KW.
(c) The rate of change of reactor power is less than 1 DPM.
(d) The transient rod air pressure is off and the transient rod is all the way down.
(e) The Reg rod and all Shim rods are off the bottom.

(15) Press the "SQUARE WAVE" button.

(a) The mode should change to "SQUARE - READY" on the reactor animation display.
(b) The SQUARE WAVE button should illuminate on the control console.

(16) With the system in the square wave ready mode, attempt to drive the Reg rod out. Verify the Reg rod does not move up but will move down.

(17) Repeat step (16) for each Shim rod.

(18) Return to MANUAL mode.

Step	Action and Response	Comment or Correction

6.0 REDUNDANT NETWORK

(1) Verify both networks (boards, cables and terminators) are installed in the CSC and the DAC and that both the CSC and DAC power is off. The CSC instrument power switch initiates power to the CSC and DAC. The DAC power switch controls power to the DAC rack only.

(2) Power up the CSC. Observe that the CSC memory test and operating system boot up properly, and that the application bootup sequence starts. Verify that during the application bootup sequence, the CSC bootup fails the network test.

message > Network Test Cycle ##: Network looks dead

(3) Verify the test number increments every 20 seconds indicating the test is being repeated.

(4) Power up the DAC. Allow sufficient time for the DAC to complete its memory test, boot its operating system, and start its application bootup sequence (maximum of 3 minutes). At this point the CSC network test cycle should complete successfully.

message > Network Test Cycle ##: Network looks OK

(5) Verify the CSC completes its boot by observing the Reactor Display and Standard Display screens being displayed.

(6) Verify that none of the following network failure messages appear in the AW, WAW or SCW:

(a) Hi IC-NET Comm Fault
(b) Lo IC-NET Comm Fault
(c) SCRAM - NET Fault, Please Reboot

(7) Verify the network is operating by changing some DAC input such as reactor room door status. Observe the change on the AW and STW.

(8) Locate the CSC network plugs. The terminators are accessed from the rear of the CSC control console computer (or expansion chassis).

(9) Remove the terminator plug from the CSC High Network board. Verify that a message is generated in the AW and the WAW.

message > Hi IC-NET Comm Fault

Step	Action and Response	Comment or Correction

(10) Repeat step (7). Verify that the network continues to update the CSC even though the "Hi" network is inoperable.

(11) Restore the terminator to the CSC high network board.

(12) Press the "ACK" button. Verify the error messages disappear from both the AW and the WAW.

(13) Remove the terminator plug from the CSC Low Network board.
Verify that a message is generated in the AW and the WAW.

message > Lo IC-NET Comm Fault

(14) Repeat step (7). Verify that the network continues to update the CSC even though the "Lo" network is inoperable.

(15) Restore the terminator to the CSC low-network board.

(16) Press the "ACK" button. Verify the error messages disappear from both the AW and the WAW.

(17) Place the system in Manual (Steady State) mode and remove the terminator plug from both the CSC High and Low Network boards.
Wait 60 seconds between removal time of high and low network terminator. Verify the following:

(a) A "Hi IC-NET Comm Fault" message is queued in the AW.
(b) A "Lo IC-NET Comm Fault" message is queued in the AW.
(c) A "SCRAM - NET Fault, Please Reboot" message is queued in AW.
(d) A "SCRAM - Database Timeout" message is queued in AW.
(e) A "Hi IC-NET Comm Fault" message is displayed in the WAW.
(f) A "Lo IC-NET Comm Fault" message is displayed in the WAW.
(g) A "SCRAM - NET Fault, Please Reboot" message is displayed in SCW.
(h) A "SCRAM - Database Time out" message is displayed in SCW.
(i) The reactor is SCRAMMED.
(j) The Reactor Display mode is SCRAMMED.
(k) The "MAN" pushbutton light is extinguished.

(18) Restore both terminator plugs to the CSC network boards and reboot both the CSC and DAC by turning the power off on both units for 10 seconds and then repowering the units. Verify that the system successfully reboots and the network is totally operational as outlined above.

7.0 SCRAM MODE

(1) Clear all SCRAM and Warning messages and place the system into the Manual Operate mode (use KEY RESET to clear any SCRAMS not cleared by ACK).

(2) Simulate a Fuel Temp #1 SCRAM by using the CSC SCRAM test switch. Verify that the following conditions occur, including SCRAM at indication of 550°C.

(a) A message appears in the AW and the SCW.

message > SCRAM - Fuel Temp #1 Hi
(mode changes to SCRAM, magnet currents and air are turned off and rod drives are auto wound-down).

(b) The reactor to be SCRAMMED.
(c) The Reactor Display to be SCRAMMED
(d) The MAN pushbutton light to be extinguished.

(3) Repeat step (1). Repeat step (2) for Fuel Temp #2 TC.

(4) Repeat step (1). Simulate an NPP1000 #1 % Power Hi SCRAM condition to the DAC by using the CSC Scram Test Switch. Verify this causes:

(a) A message appears in the AW and the SCW.

message > SCRAM - NPP1000 Power "Hi"

(b) The reactor to be SCRAMMED.
(c) The Reactor Display to be SCRAMMED.
(d) The MAN pushbutton light to be extinguished.

(5) Repeat step (1). Repeat step (4) for NP1000 % Power Hi SCRAM.

(6) Repeat step (1). Switch the Magnet Power key switch to "OFF". Verify that the following conditions occur:

(a) The message "SCRAM - Key Switch Off" to appear in the AW and SCW.
(b) The reactor to be SCRAMMED.
(c) The Reactor Display to be SCRAMMED.
(d) The MAN pushbutton light to be extinguished.

(7) Repeat step (1). Press manual SCRAM switch. Verify that the following conditions occur:

(a) The message "SCRAM - Console Pushbutton" to appear in the AW and SCW.
(b) The reactor to be SCRAMMED.
(c) The Reactor Display to be SCRAMMED.
(d) The MAN pushbutton light to be extinguished.

(8) Test the ground fault detect circuit by a momentary ground of the supply and return lines of the scram circuit. Ground each circuit one at a time. A message appears in AW.

message > Mag Power Grounded - Hi Side
message > Mag Power Grounded - Lo Side

(9) Repeat step (1). Simulate an NM1000 % Power Hi SCRAM condition to the DAC using the Operation Mode 5 by pressing "F5 0 F8 5 ENTER". Verify this causes:

(a) A message appears in the AW and the SCW.

message > SCRAM - NM1000 Power Hi

(b) The reactor to be SCRAMMED.
(c) The Reactor Display to be SCRAMMED.
(d) The MAN pushbutton light to be extinguished.

(10) Reset F5 pressing "F5 0 F8 0 ENTER".

(11) Repeat step (1). Simulate an NM1000 HV loss condition to the DAC by removing connector J1 from the HV distribution and monitoring module in the NM1000 preamp cabinet. Verify this causes the following:

(a) A message appears in the AW, SCW and WAW.

message > SCRAM - NM1000 Power Hi

(b) The reactor to be SCRAMMED.
(c) The Reactor Display to be SCRAMMED.
(d) The MAN pushbutton light to be extinguished.

(12) Reconnect J1 and press "F7 90 ENTER".

(13) Repeat step (1). Simulate high voltage scram conditions in the NPP1000 by using the Scram Test Switches. Verify the following conditions occur:

(a) A message appears in the AW and the SCW.

message > SCRAM - NPP1000 HV Lo

(b) The reactor to be SCRAMMED.
(c) The Reactor Display to be SCRAMMED.
(d) The MAN pushbutton light to be extinguished.

(14) Repeat step (1). Repeat step (13) for the NP1000.

(15) Repeat step (1). Momentarily disconnect AC power from the NPP1000 and NP1000. Verify the following conditions occur:

(a) A message appears in the AW and the SCW.

message > SCRAM - NPP1000 HV Lo
> SCRAM - NPP1000 Power Hi
> SCRAM - NP1000 HV Lo
> SCRAM - NP1000 Power Hi

(b) The reactor to be SCRAMMED.
(c) The Reactor Display to be SCRAMMED.
(d) The MAN pushbutton light to be extinguished.

(16) Repeat step (1). Move each switch float to the DAC "Pool Water Lo" input. Verify that the following conditions occur:

(a) A message appears in the AW and the SCW.

message > SCRAM - Pool Water Lo

(b) The reactor to be SCRAMMED.
(c) The Reactor Display to be SCRAMMED.
(d) The MAN pushbutton light to be extinguished.

(17) Test operation of external scrams (positive scram bus).

(18) Test operation of external scrams (negative scram bus).

7.1 CSC PROGRAM LOGIC FAILURE

(1) Repeat step (1) of Section 7.0.

(2) Momentarily disconnect the communication cable at the IBM7532 (H5) to disrupt the CSC DIS064 Digital Scanner board: Wait for at least 10 seconds. Verify this causes the following, then reconnect H5:

(a) A message appears in the AW and SCW.

message > SCRAM - CSC Watchdog Timeout
> SCRAM - CSC DIS64 Timeout

(b) The reactor to be SCRAMMED.
(c) The reactor display to be SCRAMMED.
(d) The MAN pushbutton light to be extinguished.

(3) Repeat step (1) of Section 7.0. Test CSC Watchdog trip relay with console test switch. Verify the following:

(a) A message appears in the AW and the SCW.

message > SCRAM - CSC Watchdog Timeout.

(b) The reactor to be SCRAMMED.
(c) The Reactor Display to be SCRAMMED.
(d) The MAN pushbutton light to be extinguished.

(4) Repeat step (1) of Section 7.0. Enter "ALT-4" on the keyboard to switch the display to window 4. The CSC prompt should be visible.

prompt > CSC #

(5) Enter the command "ps" followed by a <return>. The CSC operating system should list the current process table.

(6) Enter the command "kill -9 ##" where ## is the sc PID obtained from the process table. This should kill the scanner process and trigger the CSC Watchdogs.

(7) Verify the following:

(a) Red SCRAM button illuminates.
(b) The reactor SCRAMs as the control rods drop.
(c) The Reactor Display does not change to SCRAM.
(d) The MAN pushbutton light does not extinguish.

(8) Re-boot.

Step	Action and Response	Comment or Correction

7.2 DAC PROGRAM LOGIC FAILURE

(1) Repeat step (1) of Section 7.0.

(2) Momentarily disconnect the communication cable at the IBM7532 (H26) to disrupt the DAC DIS064 Digital Scanner board: Wait for at least 10 seconds. Verify this causes the following, then reconnect H26.

(a) A message appears in the AW and SCW.

message > SCRAM - DAC DIS64 Timeout

(b) The reactor to be SCRAMMED.
(c) The reactor display to be SCRAMMED.
(d) The MAN pushbutton light to be extinguished.

(3) Repeat step (1) of Section 7.0. Test DAC Watchdog trip relay with console test switch. Verify the following:

(a) A message appears in the AW and the SCW.

message > SCRAM - DAC Watchdog Timeout.

(b) The reactor to be SCRAMMED.
(c) The Reactor Display to be SCRAMMED.
(d) The MAN pushbutton light to be extinguished.

(4) Repeat step (1) of Section 7.0. Install or activate local control keyboard and monitor at the DAC. Enter "ALT-1" on the keyboard to switch the display to window 1 at the DAC. The DAC prompt should be visible.

prompt > DAC #

(5) Enter the command "ps" followed by a <return>. The DAC operating system should list the current process table.

(6) Enter the command "kill -9 ##" when ## is the scanner PID number obtained from the process table. This should kill the scanner process and trigger the DAC Watchdogs.

(7) Verify the following:

(a) A message appears in the AW and the SCW.

message > SCRAM - DAC Database Timeout.

(b) The reactor to be SCRAMMED.
(c) The Reactor Display to be SCRAMMED.
(d) The MAN pushbutton light to be extinguished.

(8) Re-boot.

7.3 NM1000 PROGRAM LOGIC FAILURE

Check and test NM1000 System by simulation of NM1000 Fault conditions to the DAC.

(1) Repeat step (1) of section 7.0.

(2) Disconnect the communication cable at the NM1000. Cable designation is A5-P2 on circuit board in NM1000 Processor Cabinet. Verify that a message appears in the AW:

message > SCRAM NM1000 Comm Fault

Clear the fault condition using "F7 90 Enter".

(3) Repeat section 7.0 step (1).

(4) Change the value of a stack constant in the NM1000. Press "F4 3", then enter new value of 3 or 4 (whichever is not current value) by pressing "F8 # ENTER". Verify that a message appears in the AW:

message > NM1000 Stack Fault

Clear the fault condition using "F7 90 Enter".

7.4 Pulse Mode Functions
(No actions necessary)

(1) Operational test of the NPP1000 scram in step 7.0 (5) verifies circuit performance for peak pulse power trip. Check of the circuit gain change occurs in step 7.4 (2). Measurement of the gain change is done by the calibration procedure (MAIN2).

(2) The pulse mode scram circuit relays for NPP1000 gain change, NP1000 bypass and NM1000 bypass are subject to functional test as part of the prestart check sequence. Successful completion of the sequence requires the NPP1000, NP1000, and NM1000 to actuate scram trips with a preset input signal. A Hi Power trip for the NPP1000 will occur only if the gain change relay is in the non-pulse configuration. A Hi Power trip of the NP1000 will occur only if the bypass is in the non-pulse mode. A Hi Power trip of the NM1000 will occur only if the bypass relay is in the non-pulse mode.

Interlock Checks

Operator Functions: Valid Password

1.) Incorrect password fails ___yes

2.) Correct password successful ___yes

Replace operator ___okay

Logout:

Non SCRAM mode_____ SCRAM mode_____

Manual Mode:

No operator prevents change to manual mode ___yes

Failure to acknowledge annunciator prevents magnet key switch function ___yes

Simultaneous withdrawal interlock stops motion of rods in up direction

Move	Stops on movement of:		
Reg Rod	Shim 1___	Shim 2___	Trans ___
Shim 1	Reg ___	Trans ___	Shim 2___
Shim 2	Reg ___	Trans ___	Shim 1___
Trans	Shim 1___	Shim 2___	Reg ___

Rod withdrawal prohibit stops rod movements: all rods

RWP (NM1000) Reg Rod__ Shim1__ Shim2__ Trans ___

Rod release by magnet or air switch

Rod Drops:	Magnet Indication Returns
Shim 1___	_____yes
Shim 2___	_____yes
Reg ___	_____yes
Trans ___	_____air remains off

Fire button function:

Transient rod drive down - air turns on
________ units _____yes

Transient rod drive up - air stays off
________ units _____yes

Auto Mode

No operator prevents entry into auto mode ___yes
Auto mode does not initiate from SCRAM mode ___yes

Demand power

high____ reg rod moves to ____%(0)
low ____ reg rod moves to ____%(100)
auto mode variation ____% in _20_ minutes

magnet switch auto to manual

reg rod ___ ___yes
shim 1 rod___ ___yes
shim 2 rod___ ___yes

All rods up; reg 50% Scram mode ____yes

Pulse Mode

Scram_____ Auto_____ Square_____

Trans rod air off ___yes
Power less than 1 kw ___yes
Period less than 1 DPM ___yes
Enter pulse ready mode ___yes
No rod up motion ___Reg, ___Shim 1, ___Shim 2

Square Mode

Scram_____ Auto_____ Pulse_____

Trans rod air off ___yes
Power less than 1 kw ___yes
Period less than 1 DPM ___yes
Enter square ready mode ___yes
No rod up motion ___Reg, ___Shim 1, ___Shim 2

SCRAM Checks

Network Functions:

IC Network LO Fault	yes_____	no____
IC Network HI Fault	yes_____	no____
Loss of both communication lines:		
SCRAM:	yes_____	no____

Limiting Safety System Setting:

Fuel Temp #1		_______deg.C	Trips okay _______
Fuel Temp #2		_______deg.C	Trips okay _______
NPP1000	(#1)	_______%	Trips okay _______
NP1000	(#2)	_______%	Trips okay _______

System Operable Conditions:

Key Switch			Trips okay_______
Manual SCRAM Switch			Trips okay_______
Magnet Power Grounded			___HI, ____LO
NM1000	(HI)	_______%	Trips okay _______
NM1000	(HV)	_______volts	Trips okay _______
NPP1000	HV_______	AC_______	Trips okay _______
NP1000	HV_______	AC_______	Trips okay _______
Pool Water LO1		_______meters	Trips okay _______
Pool Water LO2		_______meters	Trips okay _______
External (#1)		_____________	Trips okay _______
External (#2)		_____________	Trips okay _______

CSC System:

Scanner Cable: ___DIS064		Trips okay _______
Watchdog trip test		Trips okay _______
Kill sc PID# _____		Trips okay _______

DAC System:

Scanner Cable: __DIS064		Trips okay _______
Watchdog trip test		Trips okay _______
Kill scanner PID# _____		Trips okay _______

NM1000 System:

Stack Fault	_______	Trips okay _______
Communication	_______	Trips okay _______

Interlock Checks and Scram Functions
Acceptance Documentation

<u>Comments</u>:

Date ___/___/____

Performed by:______________________________

Approval(SRO):______________________________

NUCLEAR ENGINEERING TEACHING LABORATORY

MAIN 2 - REV. 2

CALIBRATION AND FUNCTION
CHECKS OF THE ICS SYSTEM
Instrument System Features

Approvals:

Thomas L. Bauer — Reactor Supervisor — Date: 4-8-93

Bernard W. Wehring — Director, NETL — Date: 4/8/93

Randall J. Charbeneau — Chairperson, Nuclear Reactor Committee — Date: 4/8/93

Pages: 1 2 3 4 5 6 7 8 9 10

Attachments:		
	Magnet circuit and fuel temp	1 page
	NP(P)1000 safety channels	1 page
	NPP1000 Pulse functions	1 page
	NM1000 wide range channel	1 page

BALCONES RESEARCH CENTER
THE UNIVERSITY OF TEXAS AT AUSTIN

Number	Title	
ADMN-1	Procedure Outline and Control	Rev. A Date 5/90

Record of Procedure Changes

Page	*Date	*Initial	*Change
8 of 10	12/3/91	MK	STEP 31 : DELETE "PRESS RESET BUTTON", AFTER "... TEST POINT 59." ADD "(CAUTION - OPERATION OF RESET BUTTON WITH 1 MA INPUT CURRENT ON WILL NOT DISCHARGE C58 COMPLETELY RESULTING IN INCORRECT VOLTAGE AT TP 59)"
8 of 10	12/4/91	MK	STEP 32 [illegible] SENTENCE 5 CHANGE TO READ "DEPRESS RESET SWITCH AND APPLY INPUT SIGNAL."

Record of Procedure Changes

Page	*Date	*Initial	*Change
DATA PAGE 1	7/[illegible]	M.K.	DELETE UNDER "FT CHANNEL" ENTIRE LINES STARTING WITH 'OHMS - TO GROUND" AND 'OHMS + TO GROUND"
DATA PAGE 3	7/[illegible]	MK	IN PEAK POWER OUTPUT CIRCUIT" SECTION LINE 3 CHANGE "JZ INPUT AT 0.233 milliamp" TO "JZ INPUT AT 1.0 MILLIAMP".
7	7/[illegible]	M.K.	STEP 16 CHANGE "(Adjust R27)" TO "(Adjust R27 on APP, R23 on NP)"

changes made to data sheet

CALIBRATION AND FUNCTION
Checks of the ICS System
Instrument System Features

I. PURPOSE

The purpose of this procedure is the calibration and functional check of the instrument, control and safety system for the TRIGA reactor. Systems subject to this procedure are the key instrument systems that monitor the control rod power supply, fuel element temperatures and the neutron flux levels or reactor power levels.

II. DESCRIPTION

The instrument control and safety system is a digital processing system that monitors analog and digital signals, displays information for the operator and logs data. Operator interactions with the system determine control of operation modes and rod positions. Safety system function is independent of the ICS system programs.

The Purpose of this procedure is to provide instructions for the annual calibration, check and test of key instrument systems that monitor reactor operation. These systems include the magnet power supply, two fuel temperature channels and three neutron measurement channels. Another procedure for power calibration is necessary for the alignment of the power (neutron) monitoring channels.

III. REFERENCES

1.) UT TRIGA ICS Manual
Parts 1,2,3, and 4
2.) UT TRIGA Mechanical System Manual
Parts 1,2,3, and 4
3.) Procedure for Power Calibration
SRV-10

IV. EQUIPMENT AND MATERIALS

1.) ICS system keys
2.) Multimeter - Fluke 87
3.) Multisource - Keithley 263
4.) Test instrument cables, probes

Step	Action and Response	Comment or Correction

V. PROCEDURE

Note: Log all console operation for diagnostic work, maintenance, surveillance, calibration and test with the password mirage.

1.) Review calibration or functional check requirement. Follow instructions of each of the following sections.

2.) Discontinue operation if any procedure is not successful. Correction of all failures is necessary to continue routine operation.

3.) Run prestart checks to verify operable conditions. Review surveillance results. Approval of the data by the reactor supervisor is necessary to continue operation.

4.) File procedure records and prestart checklist. Initial and date calibration check tag. Tag location should be on key ring with magnet key.

5.) Return to normal operation.

CONTENTS: Page

Step	Action and Response	Comment or Correction

Magnet Power Supply

Refer to GA Operation and Maintenance Manual (E117 - 1004) for adjustments to the magnet supply circuits. See Volume 1, section 4, pages 38-41.

1.) Locate magnet power supply (DAC shelf 1).

2.) Connect volt meter to the magnet power supply. Monitoring of the magnet supply voltage by the ICS System uses a 4 to 20 mA signal. Check calibration of voltage to current conversion if signal levels are not correct (steps 3-6).

3.) Monitor console annunciators for magnet supply lo or hi voltage. Configuration set points are 18 and 23 volts.

4.) Adjust source voltage for low voltage detection (18.0 volts). Verify that the system detects low voltage. Record trip level.

5.) Adjust source voltage for high voltage detection (23.0 volts). Verify that the system detects high voltage. Record trip level.

6.) Reset magnet supply voltage to 20.0 volts. Verify that the circuit detects no magnet supply problems.

7.) Test ground detection circuit. Check trip at Action Pak, LED will indicate status of trip. Trip set to detect 10 kiloohm short to ground.

8.) Short the positive terminal of the magnet power supply to ground thru test potentiometer set to 9 kiloohms.

9.) Verify console annunciation. If OK remove short, skip step 10.

10.) Readjust test potentiometer to 10 kiloohms. Adjust Action Pack span potentiometer: first CCW until the Hi trip LED is OFF, then CW until the Hi trip LED is ON.

11.) Short the negative terminal of the magnet power supply to ground thru test potentiometer set to 9 kiloohms.

12.) Verify console annunciation. If OK remove short, skip step 13.

13.) Readjust test potentiometer to 10 kiloohms. Adjust Action Pack zero potentiometer: first CW until the Lo trip LED is OFF, then CCW until the Lo trip LED is ON.

14.) Repeat steps 8 thru 13 until no further adjustments of the zero and span potentiometers are necessary.

Step	Action and Response	Comment or Correction

Fuel Temperature Circuits

Refer to GA Operation and Maintenance Manual (E117 - 1004) for adjustments to the fuel temperature circuit.

1. Record pool water temperature. Use control console status window.
2. Mercury thermometers may not be used on the third level reactor platform.
3. Do steps 4 - 13 for each fuel temperature channel, #1 and #2. Thermocouple is type K.
4. Disconnect thermocouple connections at calibration test relays. FT#1 is relay K3 (pins 11,14). FT#2 is relay K4 (pins 11,14).
5. Measure circuit resistance from relay thru the TC junction.
6. Connect dc voltage source to test relay pins 11(-) and 14(+).
7. Determine reference voltage at Action Pak modules by a temperature measurement at the module junction. Use reference temperature to determine reference voltage, Vref, from type K thermocouple table.
8. Set source input to simulate 0°C (V = 0.0mV - Vref); For example: Vref is 1.285mV at 32°C.
9. Verify continuous illumination of first LED of bargraph and reactor console indicates 0 ± 2°C.
10. Adjust source to represent 495°C (V = 20.427mV - Vref), verify FT display box is black. Adjust source to represent 505°C (V = 20.853mV - Vref), verify FT display box is red.
11. Set source input to simulate 500°C (V = 20.64mV - Vref).
12. Verify steady illumination of LEDs to the bargraph. Verify reactor console indicates 500 ± 5°C.
13. Change voltage source to test trip at 550°C (V = 22.772mV - Vref).
14. Verify trip at Action Pack (scram) module and calculate trip level. Vtr = V + Vref. Trip should be 550 ± 5 °C. Record trip voltage.
15. Return circuit to operating condition. Run prestart checks and verify test signal value at bar graph meters switches between 527°C and 555°C. Abort prestart checks at completion of fuel temperature check.
16. Compare display fuel temperatures (#1 and #2) to pool water temp.

NP1000 and NPP1000 Calibration

Refer to GA Operation and Maintenance Manual NP1000/NPP1000 Percent Power Channel (E117-1010) for alignment of unit if adjustments are necessary.

Complete steps 1 thru 21 for both NP1000 and NPP1000. Complete steps 22 thru 38 for the NPP1000 only.

1. Verify status of circuit configurations switch settings.

	NP	NPP		Both		Both
S4 - 1	Open	Shut	S5 - 1	Shut	S6 - 1	Open
S4 - 2	Open	Open	S5 - 2	Open	S6 - 2	Open
S4 - 3	Open	Open	S5 - 3	Open	S6 - 3	Shut
S4 - 4	Shut	Open	S5 - 4	Open	S6 - 4	Open
S4 - 5	Open	Open	S5 - 5	Shut		
S4 - 6	Shut	Shut	S5 - 6	Open		
S4 - 7	Shut	Shut	S5 - 7	Open		
S4 - 8	Shut	Open	S5 - 8	Shut		

2. Measure circuit test point voltages in the following steps using test point 10 as the reference ground.

3. Check power supply test points for nominal values.

+24 volts	TP4	-24 volts	TP7
+15 volts	TP5	-15 volts	TP8

   HVPS for PS1 is type PRM. Use VTVM or high impedance probe to measure high voltage outputs at J1 of the channels.

4. Disconnect input signal to unit at J2.
   Jumper U8 pins 8 & 9 (NPP1000 unit only).

5. Measure voltage at test point 63. Value should be less than ±100 microvolts (Adjust R31).

6. Measure voltage at test point 56. Value should be less than ±100 millivolts (Adjust R131). NPP should be slightly negative, about -5 mV.

7. Press manual reset button to clear trip conditions if necessary.
   Remove jumper at U8 pins 8 & 9 (NPP1000 unit only).

8. Measure voltage between test points 57(+) and 58(-). Value should be 0.00 volts. The sign of the voltage will depend on the lead placement (Adjust R120). Verify CSC display and bargraph read 0%.

Step	Action and Response	Comment or Correction

9. Apply current source at input connector J2.
   NP1000 : 8.33×10^{-4} amps
   NPP1000 : 5.0×10^{-7} amps

10. Measure voltage at test point 63 and point 56. Value should be 8.33 ± 0.05 volts dc (Adjust R27).

11. Measure voltage between test points 57(+) and 58(-). Value should be 8.33 ±0.05 volts. The sign of the voltage will depend on the lead placement (Adjust R123). Verify CSC display and bargraph read 100%.

12. Remove current source. Repeat steps 8 thru 11 if adjustments are necessary, if not proceed to step 13.

13. Apply 9.0×10^{-4} amps (5.5×10^{-7} NPP) at input connector, J2. Verify percent power (NV) trip LED illuminates. Decrease current to 8.5×10^{-4} amps (5.0×10^{-7} NPP). Verify trip LED extinguishes.

14. Connect voltmeter to TP 56. Increase current at J2. Record trip current and voltage. Trip should be at 8.75×10^{-4} amps (5.25×10^{-7} NPP). (Adjust R79)

15. Depress test switch S2. Measure voltage at test point 56. Value should be 9.09 ± 0.05 volts dc (Adjust R196). Verify both HV and NV LEDs illuminate.

16. Set HV Test Module resistance to 1.1 megaohm (100 kiloohm 1/2 watt resistor in series with 1 megaohm potentiometer). Connect Test Module at J1. Connect voltmeter at J1.

17. Adjust Test Module potentiometer to decrease high voltage to about 600 volts dc. Verify HV trip LED illuminates (Adjust R96).

18. Disconnect J1. Remove Test Module. Reconnect voltmeter to J1 and verify 750 ± 10 volts dc (Adjust R6). Depress reset switch. Verify HV trip LED extinguishes.

19. Apply 12 volts dc at test point 22 (Hi) with test point 23 (Lo) as the reference ground.

20. Measure Ramp Rate at test point 64. Rate should be 5 ± 1 seconds per volt (Adjust R10).

21. Continue to next step for the NPP1000. Stop here for NP1000, reconnect detector signal and return unit to operating condition.

22. Jumper U8 pins 8 and 9. Jumper AR8 pin 2 to AR8 pin 6. Clip test point 56 to ground.

Step	Action and Response	Comment or Correction

23. Measure voltage 0 ± .05V at AR8 pin 6. Use test point 10 as reference ground (Adjust R134 for minimum zero offset).

24. Measure voltage 0 ± .05V at test point 59. Use test point 10 as reference ground (Adjust R138 for minimum offset).

25. Remove jumpers in step 22.

26. Jumper U7 pin 1 to ground. Short C30 with a clip lead.

27. Measure voltage 0 ± .02 at test point 38. Use test point 10 as reference ground (Adjust R47 for minimum offset).

28. Remove jumpers in step 26. Close switch S4-4.

29. Apply 1.0×10^{-3} amps at input connector, J2.

30. Verify test voltage at test point 56 is 10.00 ± 0.05 volts (Adjust R23).

31. Press reset button. Verify 10.00 ± 0.05 volts at test point 59.

32. Remove connector at J4. Connect milliamp meter between TP60 (J4-22) and TP 61(J4-23). Remove input signal and depress reset switch. Verify 4 milliamp output (Adjust R140). Connect input signal and depress reset switch. Verify 20 milliamps output (Adjust R143). Repeat until no adjustment is necessary.

33. Apply 1.0×10^{-8} amps at input connector, J2. Observe the drift rate between TP60 and TP61. Verify rate does not exceed 0.1 volt per minute.

34. Observe test point 38. Depress reset. Drift rate should be less than 100 mV/min.

35. Increase input to 1×10^{-6} amp and depress reset switch. Ramp rate at TP38 should be 15 sec per volt. (Adjust R42)

36. Connect milliamp meter between TP39(J4-16) and TP40(J4-17). Remove input signal and depress reset switch. Verify 0.00 ± .02 volts at TP38 and 4 milliamp output (Adjust R51).

37. Depress reset switch. Apply input signal to produce 1.0 volt dc at test point 38. Verify 20 milliamps output (Adjust R54). Repeat steps 36 and 37 until no adjustment is necessary. Replace connector at J4.

38. Open switch S4-4. Reconnect detector signal and return unit to operating condition.

Step	Action and Response	Comment or Correction

NM1000 System Calibration

Refer to GA Operation and Maintenance Manual (E117-1000) for alignment of unit if adjustments are necessary.

1. Verify values of data constants in processor stacks. To display data press "Fn x" where "n" is the stack tens digit and "x" is the ones digit.

Computed Values		Single Detector	
10 percent power		20 DET counts	
11 percent power		21 alpha offset	0.00
12 period	100	25 DET pp const	8.33 E-8
13 period	100	29 DET XOVR	1.20 E+6
14 mode		**Campbell Detector**	
15 relay status		30 CMB Counts	
Trip Setpoints		31 noise offset	-2.55E+2
40 Lo Level	2.0 E -7	33 Linear Factor	3.7 E-01
41 Hi Level	1.08 E +2	35 CMB pp const	3.04E+08
42 Float	1.00 E -1	39 CMB XOVR	1.95 E+03
43 Rate	3.00 E +0		
Operation Mode			
50 Operation Mode	0		
51 Flt Trip Mode	1, Lo LVL		
59 Version Number	4.05		

2. Check power supply test points for nominal values.

Designation		Preamplifier Test	Preamplifier Common	Microprocessor Test	Microprocessor Common
PS1	+15 volts	+	-	TB1-1	TB1-4
PS2	-15 volts	-	+	TB1-8	TB1-5
PS3	+5 volts	+	-	TB1-12	TB1-10
HVPS	+800 volts	HV	Mon	N/A	N/A

3. Clear all alarms. Press "F7 9 0 ENTER". Trips display at stack location 15 (F, L, H, R). Lamps A1 and A2 should be extinguished.

4. Test Count Rate mode as directed in steps 5 - 8. Compare stack 20 to expected test cps and stack 10 to expected power in each test.

(Test cps - alpha offset) * count rate power constant = % Power
where Alpha offset = stack 21 = 0.0
Count rate power constant = stack 25 = 8.33×10^{-8}

Mode	Test cps	Stack 50	% Power Expected
Counter LO	120	1	1.00×10^{-5}
Counter MID	9600	2	8.00×10^{-4}
Counter HI	341000	3	2.84×10^{-2}

Step	Action and Response	Comment or Correction

5. Execute counter low test mode. Press "F5 F8 1 ENTER".

6. Note status of low power level trip in stack location 15. Press "F1 5", letters F and L should display.

7. Execute counter mid test. Press "F5 F8 2 ENTER".

8. Execute counter high test. Press "F5 F8 3 ENTER".

9. Test Campbell mode as directed in steps 10 - 11. Compare stack 30 to expected test cps and stack 10 to expected power in each test. (test cps - noise offset)^2 * Linearizing factor * Cambell power constant = % Power

   where noise offset = stack 31 = -255
   linearizing factor = stack 33 = 3.7×10^{-1}
   Campbell Power constant = stack 35 = 3.04×10^{-8}

Mode	Test cps	Stack 50	% Power Expected
Campbell LO	21500	4	5.32
Campbell HI	99600	5	112.15

10. Execute Campbell low test. Press "F5 F8 4 ENTER".

11. Execute Campbell high test. Press "F5 F8 5 ENTER".

12. Note status of high power level trip in stack location 15. Press "F1 5", letters L and H should display.

13. Reset normal mode operation. Press "F5 F8 0 ENTER".

14. Wait 10 seconds, then clear all alarms. Press "F7 9 0 ENTER".

15. Connect digital multimeter to high voltage test point, HV Mon, of the High Voltage Power Supply (HV = HV Mon Reading * 100).

16. Adjust HV ADJUST on power supply to test <u>under</u> voltage trip at 750 volts (7.50V at HP Mon) and <u>over</u> voltage trip at 850 volts (8.50V at Mon). Trip indicated by actuation of A1 and A2 trip lamps on processor display (Press "F7 9 0 ENTER" to clear), and in stack location 60 (Press "F6 0 ENTER").

17. Adjust HV ADJUST for a nominal 800 volts (8.00 at HV Mon)

18. Clear all trips. Press "F7 9 0 ENTER".

Instrument Calibrations

Magnet Voltage

	Found as	Change to
Lo Alarm Trip Point at -2 volts	______	______ volts (18 V)
Hi Alarm Trip Point at +3 volts	______	______ volts (23 V)
Set Operation Voltage at 20 volts	______	______ volts(20 ± 0.1V)

Ground hi side:
chassis to (+)______kiloohm detect ___yes ___no
Ground lo side:
chassis to (-)______kiloohm detect ___yes ___no

Fuel Temperature Pool Water Temperature ______°C

Resistance of thermocouple junction and leads

Element #1:		Element #2:	
element number	______	element number	______
core location	______	core location	______

FT Channel:

	FT #1 TC#_____		FT #2 TC#_____	
ohms + to -	k3	______	k4	______
ohms - to gnd	k3	______	k4	______
ohms + to gnd	k3	______	k4	______

Reference Temperature: ______°C ______mV

FT Ch. 0°C	Box	LED	FT Ch. 500°C	Box	LED
#1 ______mV	______°C	______°C	#1 ______mV	______°C	______°C
#2 ______mV	______°C	______°C	#2 ______mV	______°C	______°C

495°C	Box	505°C	Box	Trip V_{tr}	Box	Calculate
#1 ______mV	___blk	______mV	___rd	#1 ______mV	____°C	____°C
#2 ______mV	___blk	______mV	___rd	#2 ______mV	____°C	____°C

Prestart Checks _____ok Display Temps FT1______°C, FT2______°C
Same as pool temp _____yes
Comments:

Date: ___/___/___ Performed by:______________________________

Approval (SRO):______________________________

NP1000 (NPP1000) Power Safety Channel (Mark channel NP or NPP)

Switch Positions

	NP(P)1000 Found as								NP(P)1000 Change to							
	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
	O X	O X	O X	O X	O X	O X	O X	O X	O X	O X	O X	O X	O X	O X	O X	O X
S4	___	___	___	___	___	___	___	___	___	___	___	___	___	___	___	___
S5	___	___	___	___	___	___	___	___	___	___	___	___	___	___	___	___
S6	___	___	___	___					___	___	___	___				

Power Supplies	Test Point	Found as	Change to
+24 volts dc	4	________	________volts
+15 volts dc	5	________	________volts
-24 volts dc	7	________	________volts
-15 volts dc	8	________	________volts

Circuit Condition (No Input Signal)

Test Point 63 (tp10 gnd)	________	________millivolts
Test Point 56 (tp10 gnd)	________	________millivolts
TP 57 to 58	________	________volts
0 on Display/Bar	____/____	____/____%

Circuit Condition (100% - NP: 8.33×10^{-4} NPP: 5.0×10^{-7} amps)

Test Point 63 (tp10 gnd)	________	________volts
Test Point 56 (tp10 gnd)	________	________volts
TP 57(+) to 58(-)	________	________volts
100% on Display/Bar	____/____	____/____%

Percent Power Trip (105% - NP: 8.75×10^{-4} NPP: 5.25×10^{-7} amps)

Input 9.0×10^{-4} (5.5×10^{-7}) amp	________	________LED On
Input 8.5×10^{-4} (5.0×10^{-7}) amp	________	________LED Off
NV Trip current	________	________milliamps
NV Trip voltage at TP56	________	________volts
Trip Test Switch S2	________	________volts

High Voltage

HV Trip Point (low)	________	________volts
Operating HV Set	________	________volts

Test Signal

Ramp rate 7V to 8V	________	________sec/volt

NPP1000 Pulse Circuits	Found as	Change to
Zero Checks (0.0 mA at J-2)		
Pulse Stretcher AR8 PIN6	________	_______volts
Peak Power TP59	________	_______volts
Integral Power TP38	________	_______volts
Full Scale Checks (1.0 milliamp at J-2)		
Power Level TP56	________	_______volts
Peak Power TP59	________	_______volts
Peak Power Output Circuit		
J-2 Input at 0.0 mA		
Signal TP60(+) to TP61(-)	________	_______milliamp
J-2 Input at 0.833 milliamp		
Signal TP60(+) to TP 61(-)	________	_______milliamp
J-2 Input at 0.010 microamp		
Drift TP60(+) to TP61(-)	________	_______volts/min
Drift TP38	________	_______mvolts/min
Integrated Power Output Circuit		
J-2 Input at 1.0 microamp		
Ramp Rate TP38	________	_______sec/volt
Input set for 0.0 V at TP38		
Signal TP39(+) to TP40(-)	________	_______milliamp
Input set for 1.0 V at TP38		
Signal TP39(+) to TP40(-)	________	_______milliamp
Switch S4-4 open	________yes	XXXXXX (no)

Comments:

Date: ___/___/___

Performed by:________________________________

Approval (SRO):________________________________

NM1000 Wide Range Channel

Power Supplies		Test Point	Common	Found as	Change to	
PS 1	+15 volts	TB 1	TB 4	____	____	processor
PS 2	-15 volts	TB 8	TB 5	____	____	processor
PS 3	+5 volts	TB 12	TB 10	____	____	processor
PS 1	+15 volts	+	-	____	____	preamp
PS 2	-15 volts	-	+	____	____	preamp
PS 3	+15 volts	+	-	____	____	preamp
HVPS	+800 volts	HV Mon		____	____	HV/100

Found as
Stack Data Values: Mode 0 ___(50), Version 4.05 ___(59)

10	____	20	____	30	____	>40	____
11	____	>21	____	>31	____	>41	____
12	____	22	____	32	____	>42	____
13	____	23	____	33	____	>43	____
14	____	24	____	34	____		
15	____	>25	____	>35	____		
16	____	26	____	36	____	50	____
17	____	27	____	37	____	51	____
18	____	28	____	38	____	52	____
19	____	29	____	39	____	53	____

Item	Found as	Change to
____	____	____
____	____	____
____	____	____

	Stack 10 (% power)	20 (CPS)	30 (CPS)
Counter Low Test	____	____	
Counter Mid Test	____	____	
Counter High Test	____	____	
Campbell Low Test	____		____
Campbell High Test	____		____

Low Level Trip: yes no Trip Resets: yes no
High Level Trip: yes no Trip Resets: yes no
High Voltage Failure: yes no Trip Resets: yes no
Undervoltage trip: ________V HV Mon________V
Overvoltage trip: ________V HV Mon________V
Operating voltage: ________V HV Mon________V

Comments: Calculate source level trip: (<2 cps) ______ cps

Date: ___/___/____ Performed by:________________________

Approval (SRO):________________________

NUCLEAR ENGINEERING TEACHING LABORATORY

MAIN 3 - REV. 1

CALIBRATION AND FUNCTION
CHECKS OF THE ICS SYSTEM
Support System Features

Approvals:

Thomas L. Bauer — 1/24/92
Reactor Supervisor — Date

Bernard W. Wehring — 1/24/92
Director, NETL — Date

Harry L. Marcus — 1/24/92
Chairperson,
Nuclear Reactor Committee — Date

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Attachments:		
	Pool parameters	1 page
	Coolant flow rates	2 pages
	Heat exchanger	1 page

BALCONES RESEARCH CENTER
THE UNIVERSITY OF TEXAS AT AUSTIN

ORIGINAL

CALIBRATION AND FUNCTION
Checks of the ICS System
Support System Features

I. PURPOSE

The purpose of this procedure is the calibration and functional check of the instrument, control and safety system for the TRIGA reactor. Systems subject to this procedure are the key instrument systems that monitor the control rod power supply, fuel element temperatures and the neutron flux levels or reactor power levels.

II. DESCRIPTION

The instrument control and safety system is a digital processing system that monitors analog and digital signals, displays information for the operator and logs data. Operator interactions with the system determine control of operation modes and rod positions. Safety system function is independent of the ICS system programs.

Purpose of this procedure is to provide instructions for the calibration, check and test of key instrument systems that monitor reactor operation. These systems include the magnet power supply, two fuel temperature channels and three neutron measurement channels. Another procedure for power calibration is necessary for the alignment of the power (neutron) monitoring channels.

III. REFERENCES

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Parts 1,2,3, and 4
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Parts 1,2,3, and 4
3.) Procedure for Power Calibration
SRV-10

IV. EQUIPMENT AND MATERIALS

1.) ICS system keys
2.) Multimeter - Fluke 87
3.) Multisource - Keithley 263
4.) Test instrument cables, probes

V. PROCEDURE

<u>Note</u>: Log all console operation for diagnostic work, maintenance, surveillance, calibration and test with the password <u>mirage</u>.

1.) Review calibration or functional check requirement. Follow instructions of each of the following sections.

2.) Discontinue operation if any procedure is not successful. Correction of all failures is necessary to continue routine operation.

3.) Review and approval of the procedure activities by the reactor supervisor is necessary to continue operation.

4.) Initial and date calibration check tag. Tag location should be on key ring with magnet key. File the prestart check results and calibration check records.

5.) Return to normal operation.

CONTENTS: Page

Step	Action and Response	Comment or Correction

Pool Level

1.) Verify position of pool level indicator (scale) is set with 25.3cm at the elevation of the tank equipment mounting rink.

2.) Lift up high level sensor float, verify float level and hi/lo alarm indication.

3.) Press down low level sensor float, verify float level and hi/lo alarm indication.

4.) Depress each float switch to low level, verify float level and pool level scram.

Pool Temperature

1.) Remove pool bulk temperature sensor.

2.) Prepare ice water bath at 0°C; hot water bath hot plate heater at 100°C.

3.) CAUTION: Do not use a mercury thermometer in the pool area.
Do not take thermometer on third level platform.
Measure calibration temperatures with thermometer.Place RTD sensor in each water bath. Record calibration temperature, and console indication.

4.) Check alarm set point by heating a solution of water. Monitor water temperature and record alarm point.

5.) If console indications agree with both temperatures ±4°C, go to step 11.

6.) Disconnect wire at pin 7 or 8 of AP5. Connect ammeter to wire and AP5 (pin 7 to DMM+; pin 8 to DMM-), and measure current.

7.) Place temperature sensor (RTD) in ice bath, adjust zero control on AP5 to 4 mA, (0°C).

8.) Place temperature sensor (RTD) in hot bath, adjust span control on AP5 to 20 mA, (100°C).

9.) Repeat steps 7 and 8 until no further adjustments are necessary.

10.) Repeat steps 4 and 5 if zero and/or span adjustments were required.

11.) Replace temperature sensor and reconnect all signal lines. Record bulk pool temperature displayed on console.

Step	Action and Response	Comment or Correction

Water Conductivity

1.) Perform an electronic calibration with 13.33 kΩ and 0.1 MΩ resistances (+0.5%).

2.) Toggle display inputs with selector switch. Local monitor connects to selector cell, other cell connects to console display.

3.) Locate cell 2 tie bar on the conductivity selector switch, remove the 3 sensor wires and connect an 18 kΩ (±0.5%) resistor between terminals 2 and 3 of the circuit.

4.) Check for 1.0 μmho/cm by installing 0.1 MΩ resistance between terminals 2 and 4. Rotate set point dial to steady red-green LED condition. Record local and console indications.

5.) Check for 7.5 μmho/cm by installing 13.33 kΩ resistance between terminals 2 and 4. Rotate set point dial to steady red-green LED condition. Record local and console indications.

6.) If reading is not correct verify resistances, then loosen set screws of indicator dial and reposition dial.

7.) Return circuit connections to original condition.

8.) Prepare solution of high purity deionized water and KCL.
Place 7.465 mg of KCl in 1.0 liters of deionized water.
0.0001 molar = 15 μmho/cm (6.67 kiloohms/cm)

9.) Align valves to prevent water loss on removal of cells.
Close purification skid isolation, flow throttle, and resin tank isolation valves.

10.) Remove each cell and replace with a plug to prevent water drainage.

11.) Clean any deposits from cell with tissue paper and rinse with distilled water.

12.) Immerse sensitive part of cell in each test solution.

13.) Dip each cell in deionized water for ≃ 1.0 μmho/cm.

14.) Dip each cell in KCl solution for +15 μmho/cm.

15.) If improper readings occur replace solutions and repeat.
Replace cells and realign valves for routine operation.

Step	Action and Response	Comment or Correction

Primary Flow Rate

1.) Compare no flow conditions at local gauge and console.

2.) Align valves for maximum flow and start primary flow pump.

3.) Compare console flow rate with local gauge indication.

4.) Verify flow rates are within 10%.
If flow rates are within 10% skip step 5.
Return the system to the operating condition.

5.) Calibrate primary flow sensor.

5.1 Close valves on both Annular flow sensor lines.
Disconnect SS lines at swage fitting.

5.2 Remove front and rear covers from transmitter.

5.3 Connect ammeter in series with the flow sensor transmitter.
Connect ammeter + to - terminal and the other lead to the wire.

5.4 The primary flow transmitter performs the flow square root extraction.

5.5 The Action Pack primary flow square root extractor has been removed and jumpered.

5.6 Open cross valve on transmitter.

5.7 Verify zero indication on local meter, 4 mA output and zero at the console. Use zero set for adjustment.

5.8 Close cross valve on transmitter.

5.9 Connect tygon tube to high side of transmitter and fill with water to a level 29.7" (75.4 cm) above that of the low side disconnected line, this correlates to 360 GPM (22.68 lps).

5.10 Verify disconnected low side line is full of water; if not, momentarily open the cross valve; readjust the level on the high side if necessary.

5.11 Verify local 100% reading, 20 mA signal, and 22.69 lps at the console. Use span set for adjustment.

5.12 If either zero or span adjustments were required, repeat steps 5.6 thru 5.12 until no further adjustments are necessary.

Step	Action and Response	Comment or Correction

Secondary Flow Rate

1.) Compare no flow conditions at local gauge and console.

2.) Align valves for maximum flow and start secondary flow pump.

3.) Compare console flow rate with local gauge indication.

4.) Verify flow rates are within 10%.
If flow rates are within 10%, skip steps 5 and 6.
Return system to the operating condition.

5.) Flow Gauge Calibration

5.1 Close high and low isolation valves below gauge.

5.2 Open cross connect valve, gauge should read 0.

5.3 Close cross connect.

5.4 Open both high and low pressure vents.

5.5 Connect tygon tube to high pressure vent.

5.6 Verify low side vent filled with water.
If not, momentarily open isolation valve.

5.7 Fill tygon tube with water to a level of 110". Measure level from the top of low side vent. Verify gauge reads 600 gpm.

5.8 Return system to condition prior to calibration.

6.) Flow Transmitter Calibration

6.1 Close both sense line valves to transmitter.

6.2 Remove the plug from the top of the flow pressure side of the diaphragm chamber, install fitting and tygon tube.

6.3 Loosen the lock nut and rotate transmitter head, remove both covers.

6.4 Connect ammeter in series with the flow sensor transmitter.
Connect ammeter + to - terminal and the other lead to the wire.

Step	Action and Response	Comment or Correction

6.5 Connect ammeter in series with the flow square root extractor. Connect ammeter + to pin 7 (-) and the other lead to the wire. (Caution - 115v present on adjacent pins).

6.6 Open cross valve on transmitter.

6.7 Verify zero indication on local meter, both 4 mA outputs and zero at the console. Use zero set for adjustment.

6.8 Close cross valve on transmitter.

6.9 Fill tygon tube connected to high side port with water to a level 110" above the low side port, this level correlates to 600 gpm (37.8 lps).

6.10 Verify the low side of the diaphragm is full of water by opening the vent screw and momentarily opening the cross valve until water bleeds. Do not reclose vent.

6.11 Readjust water level to 110" as necessary.

6.12 Verify both transmitter and root extractor outputs are at 20 ma and the console reads 37.8 lps, adjust using span control.

6.13 If either span or zero adjustments were necessary, reclose the low diaphragm bleed and repeat steps 6.6 thru 6.12 until no further adjustments are necessary.

Step	Action and Response	Comment or Correction

Heat Exchanger Differential Pressure
Capsi-photohelic Calibration

1.) Close two ¼" ss valves on line to the sensor.

2.) Remove both plugs on top of the sensor.

3.) Open the two valves to fill each port to the same level, then reclose them.
Note - Snubbers in flow lines slow response. It may be necessary to start the primary or secondary coolant system.

4.) Verify zero reading on meter. Use zero set on meter face for adjustment: zero" H_2O = 0 psi, Photohelic gauge = 0 psi.

5.) Connect tygon tube to high port (right) with low port (left) condition unchanged.

6.) Apply column of water equivalent to approximately 5 psi.
(1 psi = 27.68" H_2O)
(1 psi = 70.3 cm H_2O)

7.) Rotate low setpoint to a level 0.5 psi above indicated reading. Verify ΔP lost status at CSC.

8.) Rotate low setpoint to a level 0.5 psi below indicated reading. Verify ΔP ok status at CSC.

9.) Reset low setpoint to 5 psi setting. Set HI setpoint at 10 psi.

10.) Return system to initial conditions.

Heat Exchanger Temperature Sensors

1.) Compare HX inlet temperature at console with temperature at local gauge.

2.) Compare HX outlet temperature at console with temperature at local gauge.

3.) If each temperature is within 4°C skip step 4.

4.) Calibrate temperature circuit following procedure for bulk pool sensor (page 4).

Step	Action and Response	Comment or Correction

This page blank

Pool Level

Read level at hi-lo alarm point. LO ____________ m

Read level at hi-lo alarm point. HI ____________ m

Read level at SCRAM point:

(1) ____________ m

(2) ____________ m

Pool Temperature

0°C Measure bath temp_____ °C

Measure current ______ mA

Console: _______ °C

100°C Measure bath temp _____ °C

Measure current ______ mA

Console: _______ °C

Hi Alarm set point________ °C

Pool Temperature Console: _________ °C

Water Conductivity

Inlet Cell		Outlet Cell	
Clean ______ yes		Clean _______ yes	
Local	Console	Local	Console
0.10MΩ _______	_______ μmho/cm	0.10MΩ _______	_______ μmho/cm
13.33KΩ _______	_______ μmho/cm	13.33KΩ _______	_______ μmho/cm
DI H_2O: _______	_______ μmho/cm	DI H_2O: _______	_______ μmho/cm
KCL _______	μmho/cm	KCL _______	μmho/cm

ORIGINAL

<u>Primary Flow Rate</u> 22.68 lps = 100%

	no flow condition:		flow condition:	
console flow rate	_______	lps	_______	lps
local gauge indication	_______	%	_______	%

(local______ - console______)/local______ = _______

100% flow calibration:

water level 0.00" (0.00 cm) = 000 GPM (0.00 lps)

Meter _______ % Sensor transmitter out ______mA

Console _______lps Square root extractor out ______mA

zero flow calibration:

water level 29.7" (75.4 cm) = 360 GPM (22.68 lps)

Meter _______ % Sensor transmitter out ______mA

Console _______lps Square root extractor out ______mA

<u>Secondary Flow Rate</u>

.063 lps = 1 gpm

	no flow condition:		flow condition:	
console flow rate	_______	lps	_______	lps
local gauge indication	_______	gpm	_______	gpm

(local______ - console______)/local______ = _______

zero flow calibration:

water level 0.00" (0.00 cm) = 000 GPM (0.00 lps)

Meter _______ %   Sensor transmitter out ______mA

Console _______lps   Square root extractor out ______mA

100% flow calibration:

water level 110" (280 cm) = 600 GPM (37.8 lps)

Sensor transmitter out ______mA

Console _______lps   Square root extractor out ______mA

ORIGINAL

Heat Exchanger Differential Pressure
Capsi-photohelic Calibration

zero" H_2O = 0 psi

Photohelic gauge = ____ psi

(1 psi = 27.68" H_2O)
(1 psi = 70.3 cm H_2O)

_____" H_2O = _____ psi

Photohelic gauge = _____ psi

Setpoint 0.5 psi above reading_____: ΔP lost status at CSC_____yes

Setpoint 0.5 psi below reading_____: ΔP okay status at CSC_____yes

LO setpoint to 5 psi _______

HI setpoint at 10 psi _______

Heat exchanger temperature sensors gauge = console (±4°C)

		compare	calibrate
inlet temperature:			
gauge	_______°F	_______°C	_______°C
console		_______°C	_______°C
outlet temperature:			
gauge	_______°F	_______°C	_______°C
console		_______°C	_______°C

Comments:

Date ____/____/_____ Performed by:_____________________________

Approval (SRO):_____________________________

NUCLEAR ENGINEERING TEACHING LABORATORY

MAIN. 4

AREA RADIATION MONITOR SYSTEMS

Approvals:

[signature] 6/5/90
Health Physicist — Date

Thomas L. Bauer 6/5/90
Reactor Supervisor — Date

Bernard W. Wehring 6/5/90
Director, NETL — Date

[signature] 6/6/90
Chairperson, Reactor Committee — Date

[signature] 7/11/90
Chairperson,
Radiation Safety Committee — Date

List of Pages: 1 2 3 4 5

Attachments:

Dose Eq. Table	Form A	pages 1
Eberline RMS II	Form B	pages 2
Ludlum 333-2	Form C	pages 1
PRM AR1000	Form D	pages 2

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THE UNIVERSITY OF TEXAS AT AUSTIN

ORIGINAL

Record of Procedure Changes

~~MAIN 4~~ MAIN 4

JRB 11/9/93

HV change with new module

Page	*Date	*Initial	*Change
4	8/20/	MK	PART B 3g CHANGE "6085-6397" TO "2097-2613"
4D-2	8/30/	MK	CHANGE "SOURCE COUNT (6075-6397)" TO "SOURCE COUNT (2097-2613)"
4D-1	8/ /		STEP 10 ADD "POSITION SOURCE WITH TAG/LABEL (ACTUAL SIDE) FACING SAMPLE CHAMBER"
4	10/95	MH	PART B 3.g. change range to 2097-2493
4D-2	10/95	MH	CHANGE SOURCE COUNT "2197-2613" TO "2097-2493"
	1/29/96	MK	AFTER REPAIR OF CAM BY GA (PRM) AND LOCAL WORK
			PAGE 4 PART B 3g CHANGE RANGE TO "1850 ± 10%"
			PAGE 4D-2 SOURCE COUNT TO "1850 ± 10%"
4	6/ /	MK	PART B 3g CHANGE TO "... COLLIMATE AT 5000 ± 20% cpm ABOVE..."
4D2	6/20/	MK	CHANGE "VOLTS (0.00)" TO "VOLTS (0.21)"
			CHANGE "VOLTS (4.40)" TO "VOLTS (5.23)"
			CHANGE "VOLTS (4.80)" TO "VOLTS (6.03)"
			CHANGE "VOLTS (7.60)" TO "VOLTS (6.03)"
			DELETE "SOURCE COUNT (2079-2135)"
			CHANGE "SOURCE COUNT ___ (2071-2235)" TO "SOURCE COUNT ___ (5000 ± 20%)"

Repair

Repair

Final 5/?? repair & GA recalibration

Record of Procedure Changes

JRB 11/8/93

Page	*Date	*Initial	*Change
2	9/6/91	RJ	CHANGE: DISC #1 volts (.40)
			DISC #2 volts (4.40)
			DISC #3 volts (4.80)
			DISC #4 volts (7.60)
			SOURCE COUNT (2029 - 2133)
2	9/18/92	M.K.	CHANGE SOURCE COUNT (2091 - 2205).
			[THIS IS ± 3σ of Calibration Transfer Record Average count of 2148 by TLB on 7/3/91]
2	7/7/93	M.K.	After Argon Gas Calibration - change source count rate to "2197 - 2613" [SOURCE TAG TOWARD SAMPLE CHANGER]
2	11/8/93	JRB	Note: the variation in source count rate was found to be due to gradual loss of cooling. Problem has been corrected. New count rate numbers are: 2197 - 2613

Record of Procedure Changes

JKB 11/8/93

Page	Date	Initial	Change
4	10/9/91	RDM	B. DELETE "weekly, not to exceed ten days," ADD "at the following intervals,". At the end of sentence ADD "Record response check data on data sheet."
4	10/9/91	RDM	B.1 ADD ": weekly". at end.
4	10/9/91	RDM	B. 2 ADD ": weekly". at end.
4	10/9/91	RDM	B.2.c after "instrument" ADD "and control room console display". DELETE "at".
4	10/9/91	RDM	B.2.d. ADD "and recorder paper." at end.
4	10/9/91	RDM	B.3 ADD ": monthly" at end.
4	10/9/91	RDM	B.3.b ADD "if operating," at end.
4	10/9/91	RDM	B.3.g CHANGE contrate to "~~2029-2133~~ 2091 - 2205 MK 9/18/92" ADD "on local meter and control room console display" at end of sentence.
4	10/9/91	RDM	B.3.i DELETE step. ADD "Replace the filter and turn on the vacuum pump if necessary."
4E1	10/9/91	RDM	ADD page
4E2	10/9/91	RDM	ADD page.
4	9/9/93	MK	B.3.g CHANGE CONTRATE RANGE TO "2197-TO 2613"

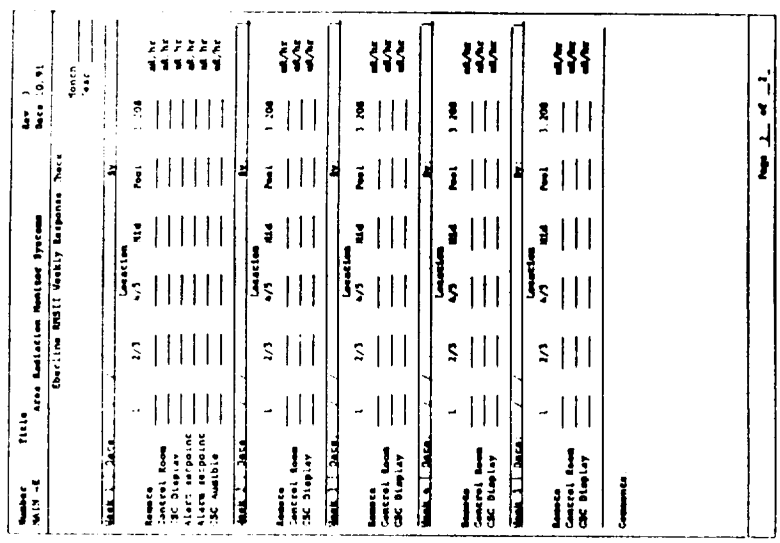
Record of Procedure Changes

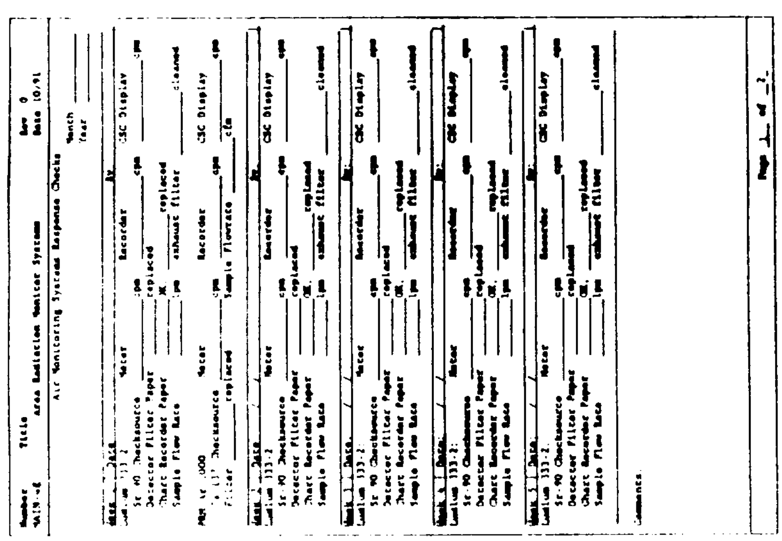
Page	*Date	*Initial	*Change
M4B 3 OF 3	12/7/93	M. K[illegible]	SECOND LINE CHANGE "DISTANCE" TO "DISTANCE (CM)"
M4B 3 OF 3	12/7/93	MK	AT ~~[illegible]~~ TOP OF PAGE ADD BOXED SECTION CONTAINING "DATE: _/_/_ BY: ____"
M4C 1 OF 1	12/7/93	MK	IN STEP 2 CHANGE "...PROCEDURE)." TO "...PROCEDURE) AND TAKE BACKGROUND COUNT. COUNT SHOULD BE LESS THAN 20 CPM."
M4C 1 OF 1	12/7/93	MK	IN STEP 8 CHANGE "...WITHIN ± 20%..." TO "...WITHIN +/- 20%..."
M4C 1 OF 1	12/7/93	MK	STEP 3 LINE 3 "...recorder reading is..." TO "...recorder and CSC readings are..."

Record of Procedure Changes

JRB 11/8/93

Page	*Date	*Initial	*Change
4E	*	*	*
2 PAGES	*10/30/91	* M/C	* Add two new data recording pages as
	*	*	*
	*	*	* shown below:





Step	Action and Response	Comment or Correction

I. PURPOSE

This procedure describes the operation, maintenance and calibration requirements for the installed radiation monitors which consist of:

* Eberline Model RMS II Area Radiation Monitors

* Ludlum Model 333-2 Beta Air Monitor

* PRM Ar-1000 Gas Monitor

II. DESCRIPTION

The RMS consists of six detectors that are strategically positioned in the reactor facility. They provide a constant indication of radiation levels in the area, both locally and on a console in the control room. Alarm functions can be set for each unit; the alarm sounds locally and in the control room. Check sources are installed so that each detector can be periodically response checked.

The Ludlum Beta Air Monitor operates continuously to sample the air in the reactor room. Air is drawn through a filter paper, and radioactive particulates are trapped and counted. Dual alarm setpoints provide a visual alert (strobe and an audible alarm (bell).

The PRM AR-1000 Gas Monitor provides constant monitoring of the air being exhausted from the reactor room. It is designed primarily for detection of the noble gas argon. Alert and alarm setpoints provide indication of abnormal conditions.

III. REFERENCES

* ANSI N323-1978
* Eberline RMS II Technical Manual
* Ludlum Model 333-2 Instruction Manual
* PRM Ar-100 Operation and Maintenance Manual

IV. MATERIALS, EQUIPMENT, OTHER PROCEDURES

* Co 60 source #M897
* Sr 90 source #98125-1
* Cs 137 source #98125-2
* Stanchion, clamps, dolly
* Tape measure and ruler
* Multimeter Test Instrument

V. PROCEDURE

A. Normal Operations

1. Eberline RMS II

The RMS II operates continuously and requires no operator actions.

2. Ludlum 333-2 Control Settings

a. Check AUDIO switch is "ON".
b. Check RCDR switch is "ON".
c. Check that a filter is in place. Filters are typically replaced weekly, or as necessary for special conditions.
d. Check that the MON light is on at least 50% of the time. Normal backgrounds of 30 cpm should keep the monitor light on 90% of the time.

3. PRM Ar-1000 Control Settings

a. Press switch to turn air pump power on.
b. Verify air pressure of sample chamber is about 200mm Hg.
c. Verify air flow rate is approximately 2.5 cfm (5.9 lpm).
d. Press both counter reset switches at the same time. The counter display total should clear.
e. Place totalizer switch in "update" position. Background counts should accumulate.
f. Observe the background countrate increase which should be noticeable depending upon natual and induced radiation backgrounds after several minutes of operation.
g. Allow counts to accumulate for about a minute. The countrate of the background should be between 20 to 40 cpm.
h. Place switch in "latch" position to freeze accumulation of counts. Indication should be frozen.
i. Place switch in "update" position to repeat accumulation of counts. Indication should be active.
j. Note that counts should be displayed for the entire counting time since resetting. The display "update" accumulates counts while the display "latch" freezes the display not the counter.
k. Verify recorder has paper and a functioning pen.
l. Set the recorder speed to slow (1 mm/min).
m. Record date on chart paper. System is ready for operation.

Step	Action and Response	Comment or Correction

B. Response Checks

Response checks shall be performed weekly, not to exceed ten days, for these instruments.

1. Eberline RMS II

a. Two persons, one in the control room and one at the detector assembly, should check the system readings, otherwise a single person must verify conditions at both operations.
b. Press and hold the green NORMAL button at the control room rack unit. Observe the detector response to the source, at the rack unit and remote indicator.
Observe the control room console reading.
c. Verify local and control room readings are within 20%, date and initial the response check tag.

2. Ludlum 333-2

a. Remove the filter assembly (section V.C.1. of this procedure).
b. Hold the Sr90 check source #98125-1 flush with the filter assembly opening.
c. Observe instrument indication ≈4000 cpm above background. The alert strobe will at operate at about 4000 cpm..
d. Replace the filter assembly, date and initial the response check tag.

3. PRM Ar-1000

a. Remove the filter assembly.
b. Turn off the vacuum pump.
c. Mark the time and date on the strip chart recorder.
d. Observe the countrate of digital counter and meter.
e. Open the shield door to the sample chamber and place the Cs 137 check source #98125-2 in the marked position on the detector assembly.
f. Allow the strip chart recorder to reach equilibrium.
g. Observe the countrate between 6085 - 6397cpm above background.
h. Remove check source and close the access door.
i. Turn on the vacuum pump, and reinstall the filter assembly.
j. Initial and date the response check tag on the instrument.

Step	Action and Response	Comment or Correction

C. Particulate Filter Replacement

NOTE: These procedures for filter replacement shall not be used if the replacement occurs due to an alert or alarm. Use the applicable abnormal procedure for filter replacement following an alert or alarm.

1. Ludlum 333-2

a. Turn the PUMP switch to OFF.
b. Lift the filter holder catch knob and pull the holder out of the sampling chamber.
c. Remove the filter hold-down cap, and pull the filter paper off.
d. Place the used filter paper in a swipe envelope and label it with date.
e. Place a new filter on the holder, and replace the hold-down cap. Filter specs. 0.4 micron pore, 47 mm diameter.
f. Lift the holder catch knob and insert the filter holder. Release the catch knob and push the filter holder in until the catch drops behind the holder.

2. PRM Ar-1000

a. Turn off the vacuum pump.
b. Open the prefilter housing.
c. Remove the filter and place in a swipe envelope and label with date.
d. Start the vacuum pump.
e. Place a new filter over the screen.
f. Close the prefilter housing, and observe the pressure gauge for indication of leaks.

D. Calibration Requirements

The instruments covered by this procedure shall be isotopically calibrated every six months, not to exceed seven and one-half months. The calibration procedures for each instrument are the attachments to this procedure.

DOSE EQUIVALENT TABLES

$DE = C_g N_g$

DE = dose equivalent per unit time
(mrem/h), (Sv/s)

C_g = conversion factor for radiation with energy g
(mr/h)/ (#/cm^2.s), (Sv.s)/ (#/m^2.s)

N_g = flux of radiation at the measurement point
(#/cm^2.s), (#/m^2.s)

Conversion Factors:	rem/h/ (#/cm^2.s)	(Sv/s)/ (#/m^2.s)
Co^{60} gamma	4.60×10^{-6}	1.28×10^{-15}
Cs^{137} gamma	1.46×10^{-6}	4.05×10^{-16}
Cf^{252} neutron	1.26×10^{-4}	3.49×10^{-14}
Cf^{252} gamma		
PuBe neutron	1.50×10^{-4}	4.16×10^{-14}
PuBe gamma	5.36×10^{-6}	1.50×10^{-15}
AmBe neutron	1.48×10^{-4}	4.12×10^{-14}
AmBe gamma	5.36×10^{-6}	1.50×10^{-15}

The following equation is applicable to all area and portable gamma monitors:

(1) Determine the present source activity

$$S(t) = S_o \exp(-(\ln 2/T_{1/2})t).$$

(2) Set the dose rate then calculate the radiation flux and distance requirement.

(3) Use conversion factors to calculate dose equivalent.

ORIGINAL

EBERLINE RMS II CALIBRATION

1. Use the formula and information on Attachment A to calculate the distance from the detector that the Co 60 source must be positioned in order to obtain the dose rates required.

2. Position a stanchion, clamp, and dolly such that the source will be at the required distance and at the same level as the detector.

3. Once the stanchion is positioned, hang the source and record the local and control room readings.

4. Repeat steps 2 and 3 for each distance, and each detector.

   NOTE: Prior to calibrating the detector in the control room, ensure that the proper signs are posted to indicate a radiation area.

5. Sign the calibration sheet and attach calibration stickers to each detector.

DISTANCE CALCULATIONS

$$\text{Distance (cm)} = \sqrt{\frac{1.10 \times 10^4 \text{ (Source Activity (mCi))}}{DE}}$$

DOSE EQUIVALENT (mr/hr)	DISTANCE (cm)
0.5	______
5.0	______
50	______
500	______
5000	______

	DECADES									
	1		10		100		1000		10000	
DETECTOR	LOCAL	CR	LOCAL	CR	LOCAL	CR	LOCAL	CR	LOCAL	CR

CALIBRATED BY ______________________ DATE ____________

ORIGINAL

LUDLUM 333-2 CALIBRATION PROCEDURE

1. Reset the alarm to off-scale high.
2. Remove the filter assembly (section V, C.1. of this procedure).
3. Place the Sr90 source number 98125-1 at 10 cm from the detector. Observe and record the counts on the meter; verify that the chart recorder reading is the same as the meter, and the alert light is flashing (>4000 cpm).
4. Repeat step three at 20 cm, 30 cm, and 40 cm from the detector.
5. Place the Cs 137 source number 98125-2 at 10 cm from the detector. Observe and record the counts on the meter; verify that the chart recorder reading is the same as the meter.
6. Repeat step seven at 20 cm, 30 cm, and 40 cm from the detector.
7. Replace the filter assembly.
8. If all readings are within ±20%, place a calibration sticker on the instrument. Sign and date the calibration sheet.
9. Reset the alarm setpoint to 10,000 cpm.

DISTANCE	Cs 137		Sr 90	
(cm)	Range	Reading	Range	Reading
10	24K - 36K	_______	3.2K - 4.8K	_______
20	4.8K - 7.2K	_______	800 - 1.2K	_______
30	1.6K - 2.4K	_______	320 - 480	_______
40	640 - 960	_______	160 - 240	_______

BACKGROUND: __________________ cpm

SETPOINTS: __________________ cpm (ALERT) 4000 = .48 MPC

__________________ cpm (ALARM) 10000 = .98 MPC

______________________________ CALIBRATED BY

______________ DATE

ORIGINAL

PRM AR-1000 CALIBRATION

NOTE: This calibration must be performed with the reactor shutdown.

1. Locate multimeter test instrument.
2. Measure discriminator voltage levels at test points.
3. Measure high voltage by current leakage at test point.
4. Record sample chamber pressure.
5. Record sample chamber flowrate.
6. Check alert level set point. Adjust trip reference to set alert level at 2,000cpm. (0.3% of MPC).
7. Check alarm level set point. Adjust trip reference to set alarm level at 10,000cpm. (1.5% of MPC).
8. Set trip reference level at 100,000 cpm.
9. Reset the digital counter and perform a 5 minute count. Record the total counts and the counts per minute.
10. Install the Cs-137 check source (#98125-2) in the marked position on the detector assembly.
11. Reset the digital counter and perform a 5 minute count. Record the total counts and the counts per minute. Verify that the cpm fall within the acceptable range. If the cpm falls outside the range, repeat this step. If two consecutive counts fall outside of the range, refer to the instrument technical manual for adjustment instructions.
12. Remove the Cs-137 source, and restore the sampler to normal operation.
13. Attach a calibration sticker and sign and date the calibration sheet.

MULTI-METER INSTRUMENT #__________ MODEL__________

PRESSURE:__________mmHg

FLOWRATE:__________cfm

Note: TP-1 is ground.

DISC #1 (TP4):__________volts (.406)

DISC #2 (TP5):__________volts (4.30)

DISC #3 (TP7):__________volts

DISC #4 (TP8):__________volts

HIGH VOLTAGE (TP6):__________microamps

__________volts (μAx10)

TRIP POINTS: ALARM LEVEL__________cpm

ALERT LEVEL__________cpm

TRIP REFERENCE__________cpm

BACKGROUND COUNT:__________cpm

SOURCE COUNT:__________(6085 -6397)cpm

__________ CALIBRATED BY

__________ DATE

NUCLEAR ENGINEERING TEACHING LABORATORY

MAIN-5

FUEL INSPECTION AND MEASUREMENT

Approvals:

Thomas L. Bauer — 1/24/92
Reactor Supervisor — Date

Bernard W. Wehring — 1/24/92
Director, NETL — Date

[signature] — 1/24/92
Chairperson,
Nuclear Reactor Committee — Date

List of Pages: 1 2 3 4

Attachments: None

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Number	Title	Rev. A
ADMN-1	Procedure Outline and Control	Date 5/90

Record of Procedure Changes

MAIN 5

Page	*Date	*Initial	*Change
7 of 4	* 2/2/94	* MK	* Under section "III. REFERENCES" ADD
	*	*	* "Measurement Assembly Calibration Instruction"
	*	*	* and "Strain Gauge Amplifier ~~[illegible]~~ Manual"
	*	*	*
	*	*	*
	*	*	*
	*	*	*
	*	*	*
	*	*	*
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I. PURPOSE

Fuel Inspection and Measurement activities are for the purpose of monitoring physical changes to the fuel elements.

II. DESCRIPTION

Damage to the fuel element clad that allows the escape of fission products from an element requires cessation of normal reactor operation. Physical inspections of the elements are intended to identify dimensional changes to the fuel element. These changes indicate the possible occurrence of stress on the cladding. Two fuel properties can cause these changes. One is the change in phase that will occur with different temperature and hydride ratios. The other is the physical cracking of the individual fuel pieces. Both of these conditions will occur to different degrees depending on fuel element operation history. A change in element length is most likely an indication of substantial phase changes. A change in element bow may be a combination of both causes. Bow changes are of particular interest since the occurrence of bow may complicate the removal of an element from the core. Physical contact of two operating elements is also a concern, however the consequences of such an event should not cause a fuel clad failure.

III. REFERENCES

Simnad, M.T. "The U-ZrH Alloy: Its Properties and Use in TRIGA Fuel," GA Project No. 4314, E117-833, February 1988.

IV. EQUIPMENT AND MATERIALS

Fuel measurement tool
Strain gauge amplifiers and record
Reference fuel element.

Step	Action and Response	Comment or Correction

V. PROCEDURE

1. Setup the fuel measurement device for checkout prior to installation in the pool. CAUTION: Detectable amounts of particulate activity is associated with any abrasive contacts with irradiated fuel elements.

2. Connect leads to strain gauge amplifier and recorder device.

3. Place reference calibration element into measurement device.

4. Swing rollers with strain gauges into latched contact position.

5. Check and adjust position of toller on top of triflutes of the element. It should not rub on the center pin nor should it drop off the edge of the triflutes.

6. Calibrate recorder by rotation at the reference element.
   Calibration points on reference element are:
   Length w.r.t. 26.250 - 0, +0.050, +0.100, +0.150 inches.
   Bend 0, -0.01, -0.02, -0.-3, -0.04, -0.05, -0.06, -0.07 inches.

7. Remove calibration element from the measurement device.

8. Insert measurement device in pool. Secure device to side of pool. Tie off all items which could potentially fall in pool.

9. Reinsert calibration element, and recheck calibration of strain gauge amplifier and recorder.

10. Move each standard fuel element per fuel movement procedure.

11. Verify serial number - etched or stamped on side of top flute.

12. Inspect by visual observation the surface and ends of the element for abnormalities.

13. Check element diameter by passing the go/no-go assembly. The entire 15" fuel region should pass thru the gauge without significant binding.

14. Measure by reference comparison the element dimensions of length and bend.

15. Record go/no-go, length, and bend data in fuel element log. Length and bend are the average of the maximum and minimum value.

Step	Action and Response	Comment or Correction
16.	Compare current data to previous data for trends. Reject any element whose dimension exceeds the original fabrication by the specification limit. (1/10 inch for length or 1/16 inch for bend)	
17.	Remeasure and remove elements with significant deviations from recorded histories if specifications are not as required.	
18.	Repeat the inspection and measurement for each standard fuel element that is in the reactor core grid plates.	
19.	Repeat for standard fuel elements that have been or could be in the core between the previous and the next inspection and measurement.	
20.	Reevaluate the alignments and adjustments for length and bend measurement prior to inspection and measurement of instrument fuel elements.	
21.	Remove fuel measurement device from pool at completion of measurement activities.	

NUCLEAR ENGINEERING TEACHING LABORATORY

MAIN-6

ROD AND DRIVE MAINTENANCE, INSPECTION

Approvals:

Thomas L. Bauer — 1/24/92
Reactor Supervisor — Date

Bernard W. Wehring — 1/24/92
Director, NETL — Date

[signature] — 1/24/92
Chairperson, Nuclear Reactor Committee — Date

List of Pages: 1 2 3 4 5 6

Attachments: None

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Record of Procedure Changes

MAIN 6

Page	*Date	*Initial	*Change
6 OF 6	1/20/94	MK	STEP 6 CHANGE "...dial indicator zero..." to "... ~~[illegible] or depth gauge~~ zero..."
5 OF 6	1/20/94	MK	STEP 6 CHANGE "...IS 43.13 inches (CHECK?)." to "... is 45.995 inches."
5 OF 6	1/20/94	MK	STEP 4 AT END ADD " MEASUREMENT READOUT DEVICE SHOULD HAVE AT LEAST 0.001 INCH SENSITIVITY "
6 OF 6	1/20/94	MK	STEP 17 DELETE ~~[illegible]~~ "... dial indicator ..."

I. PURPOSE

Rod Drive Inspection and Maintenance activities are for the purpose of monitoring and correcting the condition of control rod drives.

II. DESCRIPTION

For proper operation control rod drives must meet specific operation requirements. Periodic inspections will identify potential problems by visual observation of physical conditions of the control rod and its drive system. Maintenance that corrects deficiencies found during an inspection or failure of the control to calibrate or operate correctly, will return the control rod system to acceptable working status. Acceptable working status means the control rod system will operate as its original design specifications require. All replacement parts for rod drive system maintenance shall meet or exceed the requirements of the original system installation.

Measurement of the fuel sections of fuel follower control rods are subject to this procedure.

III.REFERENCES

SURV-6
ICS Operation and Maintenance Manual, Chapters 5, 6 and 7

IV. EQUIPMENT AND MATERIALS

Transient rod and drive
Reg rod and drive - translator
Shim 1 rod and drive
Shim 2 rod and drive
Fuel follower reference tube (bow)
Fuel follower reference rod (length)

Step	Action and Response	Comment or Correction

V. PROCEDURE

A. Rod Drive Maintenance

1. Repair rod drive mechanism with the supervision of a senior reactor operator.

   a. Perform repair using available drawings, circuit diagrams, functional descriptions, or procedures in General Atomic supplied manuals as guidance.

   b. Replace parts with identical part to the original part or substitute part with equivalent or superior specifications.

   c. Execute steps necessary to requalify the system as operational prior to resumption of routine reactor operation.

2. Perform the following actions for each non-pulse control rod drive:

   a. Remove rod drive cover.

   b. Inspect mechanism for visual evidence of deterioration or component failure.

   c. Observe operation of mechanical limit switches noting any abnormalities.

   d. Verify that set screws or locking nuts on switch actuators appear secure.

   e. Replace rod drive cover.

   f. Verify that bolts securing drive mechanism to bridge are secure.

Step	Action and Response	Comment or Correction

3. Perform the following actions for the pulse rod drive:

   a. Inspect air supply line from drive to filter and regulator.

   b. Check regulator filter. Remove air pressure, clean or replace filter, restore air pressure.

   c. Blow down regulator assembly and air surge tank near rod drive to remove liquid accumulations.

   d. Remove rod drive covers.

   e. Check air hose for evidence of deterioration or leakage.

   f. Check shock isolation mounts.

   g. Verify bolts between drive mechanism and bridge are secure.

   h. Replace Rod drive covers.

   i. Examine inside of drive cylinder using a light.

   j. Verify power and signal cable plug connections are secure.

   k. Remove stainless steel shock absorber by rotation in clockwise direction.

   l. Examine inside of drive cylinder using a light.

   m. Clean with alcohol swab and check that cylinder is clean and smooth.

   n. Coat cylinder interior walls with light application of silicone spray lubricant.

   o. Replace shock absorber (hand tighten).

   p. Clean and coat cylinder exterior threads with light coat of lubriplate grease (lubricant and rust preventative) if oxidation is apparent or if surface appears dirty.

4. Perform operation test of rod. Measure rod drop time. Measure rod drive insertion and withdrawal times.

5. Document inspection or repair data in the Reactor Maintenance Log.

Step	Action and Response	Comment or Correction

B. Rod drive Inspection

1. Verify that a gamma sensitive survey instrument is present near the pool surface to monitor radiation levels.

2. Remove sufficient fuel from the core such that the reactor maintains a calculated or measured minimum shutdown margin greater than 0.2% $\Delta k/k$ with the two most reactive rods (shims) removed.

3. Verify shutdown margin condition and approval by supervisory reactor operator prior to removal of control rod.

4. Setup fuel follower measurement device for checkout prior to installation in pool.

5. Place reference fuel followed control rod calibration element in device.

6. Calibrate dial indicator zero indication. Reference element length is 43.13 inches (Check?).

7. Remove calibration element, insert measurement device in pool and secure to side of tank.

8. Tie off all loose items which could fall into pool.

9. Remove only one control rod at a time. Reinstall each control rod prior to removal of another.

10. Disconnect electrical and air (Transient Rod only) connections. Unbolt rod drive mechanism from bridge plate.

11. Lift rod drive assembly manually or with overhead crane until the bolts securing the upper and lower sections of the extension rod are accessible.
    CAUTION: Great care must be taken to prevent damaging switch/actuator mechanisms as they are passed thru the deck plate penetration. Also do not apply excessive torque on the end of control rod as it is removed from the guide tube.

12. Remove connecting bolts (do not drop in pool) and relocate control rod assembly in pool as necessary for inspection.
    WARNING: The Reg and Shim rods are stainless steel with a fuel follower, these will be highly radioactive. Do not remove from the pool without special precautions. The Transient Rod (no fuel follower, aluminum clad) may be removed from the pool for inspection.

Step	Action and Response	Comment or Correction

13. Inspect extension rods, control rod, fuel follower, and connections for evidence of wear, deterioration, or corrosion. Replace any suspect roll pins or connecting bolts. Photographs or x-rays should be made of suspect areas.

14. Verify fuel follower element serial number - etched or stamped.

15. Move fuel follower control rods to the measurement device.

16. Insert fuel follower into the tube of the measurement device for bow measurement. If the follower fits in the tube without significant binding its bow is less than 1/16 inch.
CAUTION: Never force or drop the follower into the tube.

17. With follower resting bottomed in the measurement tube, swing dial indicator extension shaft into position and measure length.

18. Record data and compare current data to previous data for trends.

19. Remeasure elements with significant deviations from recorded histories. Remove any element whose length exceeds the original fabrication length by 1/10 inch or the bend exceeds 1/16 inch from service.

20. Reinstall control rod assembly by executing removal steps in reverse order.

21. Remove measurement device from pool.

22. Verify that control rods are operable, including measurement of withdrawal times and drop times per procedure.

23. Return removed fuel elements to their original core locations.

24. Measure control rod worths, excess reactivity and shutdown margin.

25. Review inspection results and rod worths prior to resuming routine reactor operation.

NUCLEAR ENGINEERING TEACHING LABORATORY

SURV-1

FUEL TEMPERATURE CALIBRATION

Approvals:

Thomas L. Bauer — 1/24/92
Reactor Supervisor — Date

Bernard W. Wehring — 1/24/92
Director, NETL — Date

[signature] — 1/24/92
Chairperson, Nuclear Reactor Committee — Date

List of Pages: 1 2 3
Attachments: Calibration Record

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Step	Action and Response	Comment or Correction

I. PURPOSE

The purpose of this procedure is to verify that each thermocouple within an instrument fuel element is operable.

II. DISCUSSION

Calibration of the fuel temperature monitoring system consists of two separate procedures. This procedure demonstrates the function of the thermocouple sensors. Procedures in MAIN-2 calibrate the electronic circuit with a dc voltage source equivalent to the thermocouple temperature response. Standard reference tables document the temperature versus voltage response of the chromel-alumel type K, thermocouple junctions.

A temperature calibration must be done once each year.

III. REFERENCE

MAIN-2
Type K reference data

IV. EQUIPMENT

Galvanometer or microvolt meter

ORIGINAL

Step	Action and Response	Comment or Correction

V. Instructions

1. Verify one instrument fuel element is in the B or C ring.

2. Disconnect thermocouple lead junctions at reactor bridge. Measure and record resistance between leads and between each lead and ground.

3. Attach a millivolt measurement device and measure the junction voltage of each thermocouple. Use a reference junction in an ice bath.

4. Convert thermocouple voltage to temperature and compare with bulk pool ambient temperature.

5. Reconnect thermocouple leads. Confirm correct lead connections.

6. Verify completion of ICS calibration for calibration, measurement and test of both fuel temperature channels.

Type K reference junction
NIST - monograph #125

°F
0

DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F
0	-0.692	-0.671	-0.650	-0.628	-0.607	-0.585	-0.564	-0.543	-0.521	-0.500	-0.478	0
10	-0.478	-0.457	-0.435	-0.413	-0.392	-0.370	-0.349	-0.327	-0.305	-0.284	-0.262	10
20	-0.262	-0.240	-0.218	-0.197	-0.175	-0.153	-0.131	-0.109	-0.088	-0.066	-0.044	20
30	-0.044	-0.022	0.000	0.022	0.044	0.066	0.088	0.110	0.132	0.154	0.176	30
40	0.176	0.198	0.220	0.242	0.264	0.286	0.308	0.331	0.353	0.375	0.397	40
50	0.397	0.419	0.441	0.464	0.486	0.508	0.530	0.553	0.575	0.597	0.619	50
60	0.619	0.642	0.664	0.686	0.709	0.731	0.753	0.776	0.798	0.821	0.843	60
70	0.843	0.865	0.888	0.910	0.933	0.955	0.978	1.000	1.023	1.045	1.068	70
80	1.068	1.090	1.113	1.135	1.158	1.181	1.203	1.226	1.248	1.271	1.294	80
90	1.294	1.316	1.339	1.362	1.384	1.407	1.430	1.452	1.475	1.498	1.520	90
100	1.520	1.543	1.566	1.589	1.611	1.634	1.657	1.680	1.703	1.725	1.748	100
110	1.748	1.771	1.794	1.817	1.839	1.862	1.885	1.908	1.931	1.954	1.977	110
120	1.977	2.000	2.022	2.045	2.068	2.091	2.114	2.137	2.160	2.183	2.206	120
130	2.206	2.229	2.252	2.275	2.298	2.321	2.344	2.367	2.390	2.413	2.436	130
140	2.436	2.459	2.482	2.505	2.528	2.551	2.574	2.597	2.620	2.643	2.666	140
150	2.666	2.689	2.712	2.735	2.758	2.781	2.804	2.827	2.850	2.873	2.896	150
160	2.896	2.920	2.943	2.966	2.989	3.012	3.035	3.058	3.081	3.104	3.127	160
170	3.127	3.150	3.173	3.196	3.220	3.243	3.266	3.289	3.312	3.335	3.358	170
180	3.358	3.381	3.404	3.427	3.450	3.473	3.496	3.519	3.543	3.566	3.589	180
190	3.589	3.612	3.635	3.658	3.681	3.704	3.727	3.750	3.773	3.796	3.819	190

190

°C
0

DEG C	0	1	2	3	4	5	6	7	8	9	10	DEG C
0	0.000	0.039	0.079	0.119	0.158	0.198	0.238	0.277	0.317	0.357	0.397	0
10	0.397	0.437	0.477	0.517	0.557	0.597	0.637	0.677	0.718	0.758	0.798	10
20	0.798	0.838	0.879	0.919	0.960	1.000	1.041	1.081	1.122	1.162	1.203	20
30	1.203	1.244	1.285	1.325	1.366	1.407	1.448	1.489	1.529	1.570	1.611	30
40	1.611	1.652	1.693	1.734	1.776	1.817	1.858	1.899	1.940	1.981	2.022	40
50	2.022	2.064	2.105	2.146	2.188	2.229	2.270	2.312	2.353	2.394	2.436	50
60	2.436	2.477	2.519	2.560	2.601	2.643	2.684	2.726	2.767	2.809	2.850	60
70	2.850	2.892	2.933	2.975	3.016	3.058	3.100	3.141	3.183	3.224	3.266	70
80	3.266	3.307	3.349	3.390	3.432	3.473	3.515	3.556	3.598	3.639	3.681	80
90	3.681	3.722	3.764	3.805	3.847	3.888	3.930	3.971	4.012	4.054	4.095	90

90

Number	Title	Rev. 1
SURV-1	Fuel Temperature Calibration	Date 9/91

Resistance of thermocouple junction and leads

Element #1:
element number ________
core location ________

Element #2: (Optional)
element number ________
core location ________

ohms	1	2	3	1	2	3
+ to -	___	___	___	___	___	___
- to gnd	___	___	___	___	___	___
+ to gnd	___	___	___	___	___	___
Measurement						
mV	___	___	___	___	___	___
°C	___	___	___	___	___	___

Pool Temp ______°C

Leads Reconnected _____ yes

FT1 = Element # _____ TC# _____
FT2 = Element # _____ TC# _____

CSC Display Reads Correctly _____FT1, _____FT2

Date ___/___/___ Approval: ________________

ORIGINAL

NUCLEAR ENGINEERING TEACHING LABORATORY

SURV-2

REACTOR POOL POWER CALIBRATION

Approvals:

Thomas L. Bauer — 1/24/92
Reactor Supervisor — Date

Bernard W. Wehring — 1/24/92
Director, NETL — Date

[signature] — 1/29/92
Chairperson,
Nuclear Reactor Committee — Date

List of Pages: 1 2 3 4
Attachments: None

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I. PURPOSE

The Reactor Pool Power Calibration procedure determines the heat output of the TRIGA reactor by measurement of the change in the bulk pool water temperature.

II. DISCUSSION

Accurate knowledge of the reactor power level depends on the total amount of water in the pool and several corrections. The corrections adjust for conditions that cause the pool-reactor system to deviate from an adiabatic condition. Power calibration depends on the pool constant which is a function of the pool water volume. A change in volume equivalent to a 10 centimeter water depth will cause a 1.2% change in the pool constant.

A reactor pool calibration is to be done once each year.

III. REFERENCE

"Power Calibration for TRIGA Reactors" by W.L. Whittemore, J. Razvi and J.R. Shoptaugh Jr. February 1988.

IV. EQUIPMENT

Thermocouple array (three-3 element linear arrays)
Ice bath reference junction for thermocouple array
Galvanometer or microvoltmeter

Step	Action and Response	Comment or Correction

V. Instructions

1. Record air and shield temperatures.
   Install pool water thermocouple and set up ice bath for reference junction.

   a. Room air temperature - approximate measurement point at pool railing 1 meter above pool deck, south rail.
   b. Shield concrete temperature - approximate measurement point at shield surface 1 meter above room floor, south side.
   c. Pool water temperature - type E 9 element array. Sense points at approximate depths of 1, 2 and 3 meters across minor pool axis near major axis midpoint.
   d. Close pool surface argon purge valve.

2. Adjust pool depth to 8.10 meters.
   Adjust bulk pool temperature to approximately 20°C.

3. Secure the operation of pool purification and coolant pumps.
   Close pool water isolation valves.

4. Install pool stirrer mechanism into the reactor pool.
   Initiate operation of the stirrer.

5. Complete reactor startup procedures.
   Perform reactor prestart checks.

6. Record pool temperatures at 5 minute intervals for a 90-minute period before reactor startup. (Temp. to nearest hundredth °C.)

7. Operate reactor at 1.0 Megawatts for 30 minutes. Power level is to be measured by linear channel.

   a. The operation modes for startup and shutdown should be manual and scram respectively.
   b. Startup rate should be equivalent to a 20-second period.
   c. Record startup and shutdown times (to nearest tenth of a minute).

8. Record pool temperatures for time of power of 1.0 MW at 2 minute intervals. (Temp. to nearest hundredth °C.)

9. Record pool temperatures at 5 minute intervals for 60 minutes after reactor shutdown. (Temp. to nearest hundredth °C.)

10. Calculate power level by the slope method from the time rate of temperature changes. Use a linear least-squares fit of the data.

    P=[dT/dt (°C/HR)] / [Pool °C/MW-HR]

ORIGINAL

Step	Action and Response	Comment or Correction

11. Return pool conditions to pre-experiment conditions.

12. Complete shutdown checklist.

13. **Verify pool calibration by ballistic calibration method.**

    a. Calculate pool temperature at startup by least-squares fit of the temperatures before reactor operation. T_i is extrapolated to initial time of 1.0 MW.
    b. Calculate pool temperature at shutdown by least-squares fit of the temperatures after reactor operation T_f is extrapolated to final time at 1.0 MW.
    c. Calculate the temperature change from the initial temperature at startup and the final temperature at shutdown.

    $E = (T_f - T_i)\ ^\circ C / (\text{Pool}\ ^\circ C/\text{MWHR})$

14. Evaluate ballistic method power calibration.

    a. Correct the time, t_i (initial time at power) and t_f (final time at power) for the startup and shutdown energy, Δt.
    b. Correct for the contribution of fission product energy following operation, ΔT.
    c. Correct for the heat flow of pool inflow or outflow during power operation.

15. Compare results of slope method and ballistic method for agreement.

16. Check records for initial temperatures, water, air and concrete, at startup, final pool temperature at shutdown, the reactor operation time and power level indication.

17. Measurement errors for the pool power calibration should be less than 5% at one standard deviation. Senior operator shall approve acceptance or adjustment of power channels.

18. Instrumentation power channels shall be adjusted to within 2% of the experimental indication. Adjust detection chambers with reactor in manual mode only.

19. The pool constant shall be reevaluated in any significant change of pool water volume or mass of other materials occurs in the pool.

20. Repeat procedure if the calibration requires more than a 10% adjustment of any power chamber.

ORIGINAL

NUCLEAR ENGINEERING TEACHING LABORATORY

SURV-3

EXCESS REACTIVITY AND SHUTDOWN MARGIN

Approvals:

Thomas L. Bauer — 1/24/92
Reactor Supervisor — Date

Bernard W. Wehring — 1/24/92
Director, NETL — Date

[signature] — 1/29/92
Chairperson, Nuclear Reactor Committee — Date

List of Pages: 1 2 3 4
Attachments: None

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Number	Title	Rev. A
ADMN-1	Procedure Outline and Control	Date 5/90

Record of Procedure Changes

SURV 3

Page	*Date	*Initial	*Change
3/4	8/22/9?	MK	DELETE ALL OF OLD SECTION V AND REPLACE WITH

V. Instructions

1. Perform a routine prestart check.
2. Verify that the reactor core is in a cold clean critical condition. Check log book to determine that measurements represent a cold critical core.
3. Determine reactivity worth of any experiments.
4. Measurement of excess reactivity in normal operating configuration (reference for experiment dk/k):
   a. **Proceed with a routine startup to 50 watts banking all rods to approximately equal positions.**
   b. Calculate from calibtation curves the amount of excess reactivity for each rod remaining in the core.
   c. Determine excess reactivity as follows:

      ________ transient excess worth
      ________ shim 1 excess worth
      ________ shim 2 excess worth
      -________ reg excess worth
      ________ total core excess worth
      +/-________ adjustment for experiments
      ________ total core potential excess
      x 0.7 % dk/k per $
      ________ % dk/k core excess rods banked

   d. Proceed or shutdown reactor.
5. Measurement of shutdown margin (>0.2% dk/k):
   a. **Maintain transient rod in down position, DN lamp illuminated.**
   b. Withdraw the reg rod to the fully removed position, UP lamp illuminated.
   c. Startup to 50 watts by removing the highest worth shim rod fully and adjusting the other shim for criticality.
   d. Calculate the reactivity removed in each rod to obtain 50 watt steady power level.

CONTINUED NEXT PAGE

Record of Procedure Changes

SURV 3

Page	*Date	*Initial	*Change
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3/4	* 8/22/88	* JMK	* CONTINUED FROM PREVIOUS PAGE
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e. Determine minimum shutdown margin (most reactive rod removed) as follows:

______ shim 1 worth withdrawn
______ shim 2 worth withdrawn
+ ______ reg worth withdrawn
______ shutdown margin
+/- ______ adjustment for experiments
______ shutdown margin
- ______ most rx rod worth (reg)
______ min shutdown margin
x 0.7% dk/k per $
______ % dk/k min shutdown margin

f. Shutdown reactor.

6. Calculation of maximum excess reactivity(<4.9% dk/k)

a. The maximum excess reactivity is acheived with the same rod configuration as used when measuring the shutdown margin with all rods down in step 5.

b. Determine excess reactivity as follows:

______ transient total worth
______ shim 1 total worth
______ shim 2 total worth
+ ______ reg total worth
______ total core rod worth
- - ______ adjustment for experiments
______ total core rod worth
- ______ s/d margin (all rods down)
______ k excess
x 0.7% dk/k per $
______ % dk/k max excess reactivity.

I. PURPOSE

The purpose is to determine the reactor core reactivity conditions. These two conditions are safety considerations that directly effect the possible accident consequences.

II. DISCUSSION

Evaluation of the TRIGA safety analysis demonstrates the limiting safety system settings (LSSS's) and limiting conditions for operation (LCO's). Excess reactivity and shutdown margin are directly related to reactor safety by defining the available control capability of the reactor. Operation of the reactor core within these limits is a necessity to maintain the proper control functions for all credible conditions.

Excess reactivity and shutdown margin are to be done annually or after significant changes to the core configuration. Normal practice, however, should check the excess and shutdown at 2 - 4 month intervals even if no core changes have been made.

III. REFERENCE

Docket 50-602 Technical Specifications
TRIGA Control Rod Calibration Curves
Reactor Core load configuration

IV. EQUIPMENT

Reactor Core System
Reactor Pool System
Instrument Control and Safety System

Step	Action and Response	Comment or Correction

V. Instructions

1. Perform a routine prestart check.

2. Verify that the reactor core is in a cold-clean critical condition. Check log book to determine that measurements represent a cold clean critical core.

3. Determine reactivity worth of any functional experiments.

4. Measurement of shutdown margin (<.2% Δk/k/sec):

   a. Maintain transient rod in down position, DN light illuminated;
   b. Withdraw shim rod #1 to fully removed position, UP light illuminated;
   c. Startup reactor to 50 watts by removing the regulating rod.
   d. Calculate reactivity removed by regulating rod to obtain 50 watt steady-state power level.
   e. Determine minimum shutdown margin (most reactive rod removed) as follows:

________	shim rod #1 worth withdrawn
+________	regulating rod worth withdrawn
________	shutdown margin
±________	adjustment for core experiments
________	shutdown margin
-________	most reactive rod worth (shim #1)
x .7 % Δk/k 100¢	minimum shutdown margin
________	% Δk/k minimum shutdown margin

   f. Shutdown reactor and proceed.

5. Measurement of shutdown margin (<.2% Δk/k/sec):

   a. Maintain transient rod in down position, DN light illuminated;
   b. Withdraw shim rod #2 to fully removed position, UP light illuminated;
   c. Startup reactor to 50 watts by removing the regulating rod.
   d. Calculate reactivity removed by regulating rod to obtain 50 watt steady-state power level.
   e. Determine minimum shutdown margin (most reactive rod removed) as follows:

________	shim rod #2 worth withdrawn
+________	regulating rod worth withdrawn
________	shutdown margin
±________	adjustment for core experiments
________	shutdown margin
-________	most reactive rod worth (shim #2)
x .7 % Δk/k 100¢	minimum shutdown margin
________	% Δk/k minimum shutdown margin

   f. Shutdown reactor and proceed.

ORIGINAL

Step	Action and Response	Comment or Correction

6. Measurement of excess reactivity (< 4.9% Δk/k):

a. Push UP button to remove transient rod; AIR light illuminates.
b. Proceed with a routine startup to 50 watts by removing shim and regulating rods as necessary. Maintain both shim rods at equal position (reactivity).
c. Calculate from calibration curves the amount (excess) of reactivity for shim rod and for regulating rod remaining in reactor core.
d. Determine excess reactivity as follows:

________	shim rod excess worth
+ ________	regulating rod excess worth
________	total core excess worth
± ________	adjustment for experiments
________	total core potential excess
x .7 % Δk/k 100¢	
________	% Δk/k core excess reactivity.

e. Shutdown reactor or proceed with steady-state operation.

NUCLEAR ENGINEERING TEACHING LABORATORY

PROCEDURE SURV-4 REV. 1

REACTOR WATER SYSTEMS SURVEILLANCE

Approvals:

Thomas L. Bauer — 12/10/90
Reactor Supervisor — Date

Bernard W. Wehring — 12/10/90
Director, NETL — Date

[signature] — 12/11/90
Chairperson, Reactor Committee — Date

[signature] — 1/22/91
Chairperson,
Radiation Safety Committee — Date

List of Pages: 1 2 3 4 5

Attachments:

Weekly Checklist	1 page
Monthly Checklist	1 page
Annual Checklist	1 page

BALCONES RESEARCH CENTER
THE UNIVERSITY OF TEXAS AT AUSTIN

I. PURPOSE

This procedure details weekly, monthly, and annual surveillances of reactor water system parameters. Periodic reviews of system operation are intended to identify abnormal parameters or deteriorating characteristics so that corrective or repair actions can be taken.

II. DISCUSSION

The reactor water system is consists of three subsystems which must function properly for reactor operation. The three systems are the purification loop, coolant loop, and reactor pool. Periodic checks of the pool system verify that the pool water level is acceptable, no water leakage is evident, no foreign materials have been introduced, all instrumentation is working properly, and no system hardware has failed or been damaged. Purification system periodic checks verify acceptable water purity (conductivity and PH), water flow rate, and performance of filter and ion exchange bed. Coolant system periodic checks verify proper operation of pumps, heat exchanger, controls, and pressure/flow monitoring instrumentation.

III. REFERENCE

1. Docket 50-602 SAR
2. NETL Operations Manual Part 1, Section 9
3. GA UT TRIGA Mechanical Operation and Maintenance Manual Part 7
4. MAIN-3 Calibration And Function Checks of the ICS System Support Features.
5. Reactor Water Systems, Operation Procedure, OPER-4

IV. CONTENTS

V. PROCEDURE

Perform weekly checks (Section A) of operable systems within 10 days of previous check.

Perform monthly checks (Section B) of operable systems within 6 weeks of previous check.

Perform annual checks (Section C) of operable systems within 15 months of previous check. The annual checklist must include the completion of the procedure in reference (4).

If a water system is inoperable at the schedule time, the appropriate checks are to be done when the system status changes to operable.

Step	Action and Response	Comment or Correction

A. Weekly Checklist Instructions

1. Pool System

   a. Inspect pool for abnormal conditions. Check appearance of entire pool surface for deposits or accumulation of material. If surface is not clean check water skimmer. Adjust and clean water skimmer to control surface deposits.
   b. Record bulk pool temperature and level.
   c. Replace pool water evaporation losses with makeup supply of deionized water. Record start level, stop level, and fill volume for reactor pool. Normal pool level is 8.10 ± 0.05 m.
      i. Connect makeup supply line and open makeup water supply valves when the pool level is near or below the 8.05 meter level.
      ii. Verify makeup water system conductivity lamps illuminate during fill.
      iii. Close makeup water supply valves when the pool level reaches the 8.15 meter level, disconnect and cap makeup supply line.
      iv. Multiply pool level change by 49.4 l/cm to obtain volume change in liters.

2. Purification System

   a. Check inlet and outlet conductivity at demineralizer.
   b. Check system flowrate 22-38 lpm (6-10 gpm) and pressure drop across filter 84-168 kpa (12-24 psi). Adjust flow control valve to compensate for increase in filter pressure drop.
   c. Check operation of skimmer. Remove debris accumulations.

3. Coolant System

   No routine weekly surveillance is necessary for coolant water system operation.

Step	Action and Response	Comment or Correction

B. Monthly Checklist Instructions

1. Reactor Pool System
   a. Check position of purification and coolant system suction and discharge lines. Siphon break holes in suction and discharge lines above the 7.60 meter level protect against accidental pool water loss. Suction lines should not extend below the 6.30 meter level.
   b. Inspect pool by visual observation. Check for presence of improper materials and evidence of deterioration or damage to pool liner including beam penetrations.
   c. Measure pool pH using low ion pH paper or equivalent.
   d. Inspect overflow drains for blockage and acceptable discharge area. Inspect the seal between the pool liner and concrete shield for damage. Repair any damage with acceptable material.
   e. Inspect pool covers and acrylic liners for evidence of damage; repair or replace acrylic if necessary.
   f. Test Pool Level Sensor. Mechanically displace level floats and check for appropriate abnormal level indications, and scram indications.
   g. Inspect accessible beam ports (do not remove covers or experiments) for evidence of moisture and pool leakage.
   h. Review pool water makeup volumes.
   i. Take 20 ml pool water sample at two month intervals (odd months) perform gross alpha/beta count, record results on checklist.

2. Pool Purification System

   a. Review pool water conductivity measurements. Schedule resin change if conductivity levels exceed 2 μmho/cm. A Radiation Work Permit (RWP) is required for changing resin.
   b. Check flowmeter and differential pressure across filter. Schedule filter change if flow rate drops below 22 lpm (5.8 gpm) with flow control valve fully open. An RWP is required for changing filters.
   c. Check pump seal, pool suction line and pool discharge line for leakage.

3. Pool Coolant System

   a. Startup coolant system. Adjust temperature controller setpoint 5.5°C (10°F) below pool temperature. Allow readings to stabilize and record local readings. Review current readings with respect to previous data for trends of system deterioration.
   b. Check primary and secondary pump seals for evidence of leakage.
   c. Shutdown system and return temperature setpoint to initial setting, 32.2°C (90°F).

ORIGINAL

Step	Action and Response	Comment or Correction

C. Annual Checklist Instructions

1. Reactor Pool System

   a. Verify pool level and pool temperature checks are complete (per procedure in Reference 4).
   b. Test Bulk Pool Temperature Sensor. Place temperature probe in hot water bath and verify alarm at ≤48°C (118°F).
   c. Test low pool level alarm signal circuit to security. Notify security of intended test, mechanically displace float, verify security alarm indication.
   d. Test pool radiation alarm signal circuit to security. Notify security of intended test, alarm pool radiation monitor using source, verify security alarm indication.
   e. Remove covers from beam tubes without experiments and check for evidence of water or moisture. Inspect beam tubes with experiments for indications of water leakage or corrosion. A review of each experiment installation should be made each 2 years to determine whether to inspect the beam tube.
   f. Check operation of beam tube shutter control rod isolation valves and beam tube purge isolation valves. Operation should require minimal effort.
   g. Take 500 ml pool water sample: Prepare sample for gamma spectroscopy analysis by evaporation or use a standard geometry configuration. Perform gamma spectroscopy analysis. Attach results to checklist.

2. Pool Purification System

   a. Verify conductivity cell calibration are complete (per procedure in Reference 4).
   b. Inspect piping from purification skid to pool suction and discharge for damage. Check pipe supports.
   c. Inspect makeup water system piping for leakage or damage.

3. Pool Coolant System.

   a. Verify flow, differential pressure and temperature instrumentation calibration (per procedure in Reference 4). Check local pool water and chilled water instrumentation readings with system shutdown (not operated in past 48 hours). Check pressures for values typical of hydrostatic head in the pool water piping and typical of blending station pressures on the chilled water system. Temperatures in both systems should be approximately in equilibrium with ambient room temperature.
   b. Start coolant system and check whether local values agree with remote readings.
   c. Inspect piping from coolant treatment room to pool for damage. Check pipe supports.

ORIGINAL

Number	Title	Rev. 1
SURV-4	Reactor Water Systems	Date 9/90

Weekly Water System
Surveillance Checklist

Month ______________
Year ______________

Week 1 | Date: / / By:

POOL: Clean Surface ☐ Level ______m Temp ______°C.
MAKEUP: Conductivity ☐
Day: M T W T F Start ______m Stop ______m volume______ liters
PURIFICATION: NO Leakage ☐
Flow ______lpm ΔP ______kpa in:out______ μmho/cm
Comments:

Week 2 | Date: / / By:

POOL: Clean Surface ☐ Level ______m Temp ______°C.
MAKEUP: Conductivity ☐
Day: M T W T F Start ______m Stop ______m volume______ liters
PURIFICATION: NO Leakage ☐
Flow ______lpm ΔP ______kpa in:out______ μmho/cm
Comments:

Week 3 | Date: / / By:

POOL: Clean Surface ☐ Level ______m Temp ______°C.
MAKEUP: Conductivity ☐
Day: M T W T F Start ______m Stop ______m volume______ liters
PURIFICATION: NO Leakage ☐
Flow ______lpm ΔP ______kpa in:out______ μmho/cm
Comments:

Week 4 | Date: / / By:

POOL: Clean Surface ☐ Level ______m Temp ______°C.
MAKEUP: Conductivity ☐
Day: M T W T F Start ______m Stop ______m volume______ liters
PURIFICATION: NO Leakage ☐
Flow ______lpm ΔP ______kpa in:out______ μmho/cm
Comments:

Week 5 | Date: / / By:

POOL: Clean Surface ☐ Level ______m Temp ______°C.
MAKEUP: Conductivity ☐
Day: M T W T F Start ______m Stop ______m volume______ liters
PURIFICATION: NO Leakage ☐
Flow ______lpm ΔP ______kpa in:out______ μmho/cm
Comments:

ORIGINAL

Number	Title	Rev. 1
SURV-4	Reactor Water Systems	Date 9/90

Monthly Water Systems Surveillance Checklist

Month ________
Year ________

Date: / / By:

Pool System:

Pool Piping	☐ OK	Level Sensor:	HI	☐ OK
Pool Liner	☐ OK		LO	☐ OK
No Debris	☐ OK		SCRAM 1	☐ OK
Drains Clear	☐ OK		SCRAM 2	☐ OK
Lip Seal	☐ OK	Water Makeup Normal		☐ OK
Covers	☐ OK	Water Sample: Taken		☐ OK
Pool pH	______	Gross Alpha	________cpm	
Beam Ports	☐ OK	Gross Beta	________cpm	

Purification System:

Avg. Conductivity	☐ < 2 μmho/cm	Pump Seal Condition	☐ OK
Flow	☐ > 22 lpm	No Leakage	☐ OK

Coolant System:

Pool Temp _____°F Temperature Controller Setpoint _____°F

Chilled Water Data:

Supply _____°F, Blended Supply _____°F, _____psi

Flow _____gpm, Return Line _____°F, _____psi

Pool Water Data:

Hx ΔP _____psi, Supply _____°F, _____psi

Flow _____%, Return _____°F, _____psi

Pump Seals OK: Primary ☐, Secondary ☐

Comments:

ORIGINAL

Number	Title	Rev. 1
SURV-4	Reactor Water Systems	Date 9/90

Annual Water Systems
Surveillance Checklist

Month________
Year________

Date: ____/____/____ By: ____________

Pool System:

Pool Level Checks ☐ OK
Temperature Source Checks ☐ OK

Pool Temp Alarm _____°C

Pool Level Security Alarm ☐ OK
Pool Radiation Security Alarm ☐ OK

Beam Ports Dry: 1☐ 2☐ 3☐ 4☐ 5☐
Valves Operational: Shutter Control (5) ☐, Purge (6) ☐
Water Sample: ☐ Taken, ☐ Analysis complete

Purification System:

Conductivity Cell Calibration ☐ OK
Piping/Pipe Supports ☐ OK

Coolant System:

Shutdown Chilled Water Data:

Supply _____°F, Blended Supply _____°F, _____psi

Flow _____gpm, Return _____°F, _____psi

Shutdown Pool Water Data:

Hx ΔP _____psi, Supply _____°F, _____psi

Flow _____%, Return _____°F, _____psi

Flow Calibration OK: Primary ☐ Secondary ☐ Hx Delta P Calibration OK ☐

Temperature Sensors OK: Hx Inlet ☐ Hx Outlet ☐

Agreement of console display values with system instruments OK ☐

Piping/Pipe Supports OK ☐

Comments:

ORIGINAL

Pool Water Evaporation Experiment

Experiment to determine pool water evaporation.

1. Place metal tray floating on the pool surface.
    a. Tether tray so that it is recoverable if it sinks.
    b. Choose a metal with good conductivity properties.
    c. Choose a pan with a depth dimension that is shallow.
    d. Mark fill level for water, but do not fill.
2. Determine alignment condition of air flow paths and water systems.
    a. Deck plates up or down. Specify configuration if both up and down.
    b. Argon vent system on or off; pool surface value open or shut; experiment purge line open or shut.
    c. Pool purification system operating, coolant system operating.
    d. Room air temperature and pool water temperature.
3. Measure water input to fill tray with a calibration or similar beaker or flask.
4. Calculate evaporation rate by recording time and amount of water fill to the tray for a period of several days.

Pool Water Evaporation

Dates:
Start ______________
Stop ______________

Measurement Units:
Time: __________
Volume: __________

Configuration:

Amount: date	time	quantity	Totals: time	volume

Evaporation Rate: volume/time = ________________________

Pool Water Evaporation

Dates:
Start ______________
Stop ______________

Measurement Units:
Time: __________
Volume: __________

Configuration:

Amount: date	time	quantity	Totals: time	volume

Evaporation Rate: volume/time = ________________________

NUCLEAR ENGINEERING TEACHING LABORATORY

PROCEDURE SURV-5, REV.1

AIR CONFINEMENT SYSTEM SURVEILLANCE

Approvals:

Thomas L Bauer — 12/10/90
Reactor Supervisor — Date

Bernard W. Wehring — 12/10/90
Director, NETL — Date

[signature] — 12/11/90
Chairperson, Reactor Committee — Date

[signature] — 1/22/91
Chairperson,
Radiation Safety Committee — Date

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Monthly Checklist	1 page
Annual Checklist	1 page

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ORIGINAL

Record of Procedure Changes

Page	Date	Initial	Change
4 AND 5	10/15/91	MK	MOVE STEP 3 PART b ON PAGE 5 OF 5 TO PAGE 4 OF 5 IN SECTION 3 AND RENUMBER AS STEP e.
1 OF 1	10/15/91	MK	MOVE ARGON PURGE VALVE ALIGNMENT CONFIGURATION DATA FROM ANNUAL DATA SHEET TO MONTHLY DATA SHEET

ORIGINAL

Number	Title	Rev. A
ADMN-1	Procedure Outline and Control	Date 5/90

Record of Procedure Changes

Page	*Date	*Initial	*Change
2	6/10/98	MK	SECTION II, LINE 2, CHANGE "ARGON PURGE SYSTEM, ACCESS..." TO "ARGON PURGE SYSTEM, FUME/SORTING HOOD, ACCESS..."
2	6/10/98	MK	SECTION II, END OF PARAGRAPH ADD "FUME/SORTING HOOD CHECKS VERIFY EXHAUST DUCT ISOLATION DAMPERS ARE FUNCTIONING PROPERLY."
2	6/10/98	MK	SECTION III, ADD "3. FUME/SORTING HOOD OPERATING PROCEDURE"
2	6/10/98	MK	SECTION V, CHANGE "CONEFINEMENT" TO "CONFINEMENT" - SPELLING ERROR
3	6/10/98	MK	SECTION A, AT TOP OF SECTION ADD "THE MONTHLY ISOLATION TESTS IN STEPS 2, 3, AND 4 BELOW SHOULD BE DONE CONCURRENTLY."
3	6/10/98	MK	STEP 2. C. LINE 2 CHANGE "BRC" TO "PRC"

Number	Title	Rev. A
ADMN-1	Procedure Outline and Control	Date 5/90

Record of Procedure Changes

Page	*Date	*Initial	*Change
4	8/10/98	M.Ph	SECTION 3 STEPS "c, d, e," RENUMBER
			AS STEPS "d, e, f"
4	8/11/98	Mlm	SECTION 3 ADD NEW STEP c AS:
			"c. TEST OPERATION OF ARGON ISOLATION.
			NOTIFY ARC PHYSICAL PLANT AUTOMATED
			SYSTEMS (471-3601) OR CHILLING STATION
			(471-3770)
			i. USING RADIOACTIVE CHECK SOURCE INITIATE
			ALARM (10,000 CPM) ON AIR PARTICULATE
			CAM.
			ii VERIFY ARGON PURGE FAN ON
			STATUS LAMP INDICATES OFF WITHIN 30
			SECONDS OF ALARM INDICATION
			iii. REMOVE CHECKSOURCE AT MONITOR AND
			DEPRESS HVAC RESET BUTTON ON CRP.
			ARGON PURGE FAN SHOULD RESUME NORMAL
			OPERATION

Number	Title	Rev. A
ADMN-1	Procedure Outline and Control	Date 5/90

Record of Procedure Changes

Page	*Date	*Initial	*Change
4	8/10/93	M.H.	ADD NEW STEP
			" 4. FUME/SORT HOOD
			a. START FUME/SORTING HOOD PER
			PROCEDURE
			b. VERIFY NORMAL OPERATING CONDITIONS
			c. TEST OPERATION OF ISOLATION DAMPER:
			NOTIFY PHYSICAL PLANT (471-3601, OR
			471-3770) OF TEST.
			i. USING RADIOACTIVE CHECK SOURCE INITIATE
			ALARM (10000 CPM) ON AIR PARTICULATE CAM.
			ii. VERIFY LAMPS ON CRP AND FUME/
			SORTING HOOD CONTROL PANEL INDICATE
			FAN MOTOR OFF AND SMOKE DAMPER
			CLOSED WITHIN 30 SECONDS OF ALARM
			INITIATION
			iii. REMOVE CHECK SOURCE AT CAM AND
			PRESS RESET BUTTON ON CRP. FUME/
			SORTING HOOD SHOULD RESUME NORMAL OPERATION.
			d. SHUT DOWN FUME/SORTING HOOD PER
			PROCEDURE

Record of Procedure Changes

Page	*Date	*Initial	*Change
5	8/10/98	M.R.	DELETE - EXISTING STEP 3.b. ADD NEW STEP
			"3.b. DURING CORRESPONDING MONTHLY
			INSPECTION (ARGON PURGE SYSTEM OFF AND
			ISOLATION DAMPER CLOSED) CHECK POSITION
			OF VALVE SHAFT ON ISOLATION VALVE
			AT ARGON FILTER BANK INLET AND VERIFY
			CLOSED ALIGNMENT."
5	8/10/98	M.R.	ADD NEW STEP:
			4. FUME/SORTING HOOD
			DURING CORRESPONDING MONTHLY INSPECTION
			OF FUME/SORTING HOOD SYSTEM (HOOD FAN
			SHUTDOWN AND DAMPERS CLOSED) REMOVE
			ACCESS PANEL AT SMOKE DAMPER AND
			INSPECT DAMPER CONDITION. ALSO
			CHECK VALVE SHAFT AT HOOD FILTER
			OUTLET FOR CLOSED ALIGNMENT POSITION

Number	Title	Rev. A
ADMN-1	Procedure Outline and Control	Date 5/90

Record of Procedure Changes

SURV 5 MONTHLY CHECKLIST

Page	*Date	*Initial	*Change
1/1	* 8/10/98	* M.K.	* AT BOTTOM OF ARGON PURGE SYSTEM BLOCK ADD
	*	*	* " SYSTEM ISOLATION ☐ OK "
	*	*	*
1/1	* 8/10/98	* M.K.	* AFTER ARGON BLOCK ADD NEW BLOCK
	*	*	* " FUME/SORTING HOOD ISOLATION:
	*	*	* FAN OFF ☐ OK
	*	*	* SMOKE DAMPER CLOSED ☐ OK "
	*	*	*
	*	*	*
	*	*	*
	*	*	*
	*	*	*
	*	*	*
	*	*	*
	*	*	*
	*	*	*
	*	*	*
	*	*	*
	*	*	*
	*	*	*

Record of Procedure Changes
SURVS ANNUAL CHECKLIST

Page	*Date	*Initial	*Change
1/1	* 8/10/98 *	* M. [illegible] *	* AFTER ARGON PURGE SYSTEM BLOCK ADD
	* *	* *	* NEW BLOCK:
	* *	* *	* " FUME/SORTING HOOD:
	* *	* *	* SMOKE DAMPER ☐ OK
	* *	* *	* FILTER EXIT VALVE ☐ OK "
	* *	* *	* *
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I. PURPOSE

This procedure details monthly and annual surveillances of the air confinement system parameters. Periodic reviews of system operation are intended to identify abnormal parameters or deteriorating characteristics so that corrective or repair actions can be taken.

II. DISCUSSION

The air confinement system encloses the reactor bay. An HVAC system, argon purge system, access doors and construction joints provide the pathways for air flow into and out of the reactor bay. Periodic checks of the reactor room boundary and door weatherstrip determine the condition of the most significant leakage paths. Less significant leakage paths, such as construction joints, should be examined at the time of maintenance or repair to any joint. HVAC system periodic checks verify that the system components necessary for control of reactor bay negative pressure, isolation damper closure, fan shutdown, and acceptable exhaust stack velocity are functioning properly. Argon purge system periodic checks verify that the fan, prefilters, HEPA filters, valves, and associated control system components are functioning properly.

III.REFERENCE

1. Docket 50-602 SAR
2. Air Confinement System, Operation Procedure, OPER-5.

IV. CONTENTS

V. PROCEDURE

1. Perform <u>monthly checks</u> (Section A) of operable systems within 6 weeks of previous check.

2. Perform <u>annual checks</u> (Section B) of operable systems within 15 months of previous check.

If conefinement system is inoperable at the schedule time, the appropriate checks are to be done when the system status changes to operable.

Step	Action and Response	Comment or Correction

A. Monthly Checklist Instructions

1. Confinement Boundary

   a. Check confinement boundary integrity. Observe the function of reactor bay access doors, the condition of observation area windows, and the condition of seals at other room penetrations.

   b. Check operation of the annunciator indicating an opened or closed status for the five doors to the reactor bay.

2. HVAC System

   a. Change HVAC system mode to REACTOR ON

   b. Verify normal indications on Control Room Panel (CRP). Open panel to document manometer readings. Compare with previous data for trends indicating system performance. See Reference 2 Attachment for normal readings.

   c. Test operation of isolation dampers: Notify Automated Systems group of the BRC Physical Plant for the test (471-3601)

      i. Using radioactive check source initiate alarm (trip point is at 10,000 cpm = 1 mpc, $3x10^{-9}$ μCi/cc) on air particulate monitor.

      ii. Verify SUPPLY DAMPER and RETURN DAMPER status lights on Control Room Panel indicate CLOSED position within 30 seconds of alarm initiation. The lamps for the HVAC SUPPLY FAN ON and RETURN FAN ON should also extinguish.

      iii. Remove check source at monitor, depress HVAC RESET button on CRP.

      iv. Verify system will not restart and remains in isolation mode.

ORIGINAL

Step	Action and Response	Comment or Correction

d. Restart system in REACTOR OFF mode.
Contact BRC Physical Plant Personnel if HVAC recovery is unsuccessful.

i. Place HVAC ISOLATION switch in OPERATE. Depress HVAC RESET button on CRP.

ii. Verify SUPPLY DAMPERS and RETURN DAMPERS are OPEN.

iii. Verify REACTOR MODE OFF, SUPPLY FAN ON, and RETURN FAN ON lamps illuminate.

If either fan (AHU-3 or RF-2) is not on, check for the source of the trip in the penthouse and reset.

3. Argon Purge System

a. Startup argon purge system with the pool surface and beam port purge valves open.

b. Check purge exhaust velocity on manometer in Control Room Panel and check filter pressure drop on magnehelic gauges in 4.1M4.

Compare to normal values in Reference 2 Attachment.

c. Shutdown argon purge system.

d. Schedule inspection of the filter system every 6 months (June and December). A Radiation Work Permit is required for opening the filter caisson.

i. Replace the prefilter during each 6 month inspection.

ii. Perform a visual inspection of the 95% filter. Replace filter if physical deterioration is apparent.

iii. Initiate plans to change the filters when the pressure drops reach fully loaded values:

1.0" H_2O - 95% filter, 2.0" H_2O HEPA filter.

iv. Do not change the final HEPA filter without recertification of filter system efficiency.

The maximum acceptable leakage is 0.05% for 0.3 micron particles.

Step	Action and Response	Comment or Correction

B. Annual Checklist Instructions

1. Confinement Boundary

   a. Inspect and repair any damage to weatherstrip seals on the five doors to the reactor bay or other penetration seals.

   b. Check the condition of air movement control barriers at the five pipe penetration ports through the platform at the pool surface.

2. HVAC System

   a. Inspect reactor bay isolation dampers.

   During the corresponding monthly inspection (HVAC system shutdown and isolation dampers closed), remove the inspection panels and inspect each of the six isolation dampers.

   Verify dampers appear to be in the shut position and do not show evidence of damage or deterioration.

   b. Repeat step 2c of monthly HVAC system checks except test function of both manual isolation button on first level of reactor bay and HVAC ISOLATE switch on the Control Room Panel instead of CAM alarm.

   c. Inspect HVAC System ducts for evidence of damage.

3. Argon Purge System

   a. Check operation of pool, beamport, dilution and isolation valve for evidence of malfunction.

   b. Check alignment and function of each valve at the argon collection manifold.

Number	Title	Rev. 1
SURV-5	Air Confinement Systems	Date 10/90

Monthly Air Confinement
System Surveillance Checklist

Month________
Year ________

Date: / / By:

Confinement Boundary:

Doors/weatherstrip ☐ OK Window units ☐ OK
Doors: floor seals ☐ OK Other Penetrations ☐ OK

HVAC System:

Fan System Switch REACTOR MODE ON ☐ OK

Support 3 vs RX _____"H_2O, RX vs Outside _____"H_2O

Support 2 vs Rx _____"H_2O, Academic 3 vs Rx _____"H_2O

Support 1 vs Rx _____"H_2O, Academic 2 vs Rx _____"H_2O

HVAC Stack Exhaust Velocity _____fpm CAM Alarm ☐ ON

Isolation Dampers Closed: ☐ Supply ☐ Return

Fans Off: ☐ Supply ☐ Return

System Restart ☐ OK

Argon Purge System:

Fan ☐ ON Pool Surface Purge ☐ ON Beam Port Purge ☐ ON

Argon Purge Exhaust Velocity ___________________________ fpm
Prefilter ☐ OK
Pressure Drop: _____"H_2O 95% Filter _____"H_2O HEPA #1
_____charcoal _____"H_2O HEPA #2

Comments:

ORIGINAL

Number	Title	Rev. 1
SURV-5	Air Confinement Systems	Date 10/90

Annual Air Confinement
System Surveillance Checklist

Month ________
Year ________

Date: ____/____/____ By: ____________

Confinement Boundary:

Weatherstrip ☐ OK Seals ☐ OK
Pool Surface Access Trench Seals ☐ OK

HVAC System:

Damper closed and in good condition:

Supply - Rectangular (2) ☐ OK
Return - Rectangular (2) ☐ OK, Circular (2) ☐ OK
Level 1 Isolation Button ☐ OK
CRP Isolation Switch ☐ OK

Ducts ☐ OK

Argon Purge System:

System Valves: Pool Surface ☐ OK Beamport ☐ OK
Dilution ☐ OPEN Isolation ☐ OK
Manifold Stopcock Valves (6) ☐ OPERABLE

Alignment Configuration OPEN 1 2 3 4 5 6

Alignment Configuration SHUT 1 2 3 4 5 6

Comments:

ORIGINAL

NUCLEAR ENGINEERING TEACHING LABORATORY

SURV-6

CONTROL ROD CALIBRATION

Approvals:

Thomas J. Bauer — Reactor Supervisor — Date 1/24/92

Bernard W. Wehring — Director, NETL — Date 1/24/92

[signature] — Chairperson, Nuclear Reactor Committee — Date 1/24/92

List of Pages: 1 2 3 4

Attachments:
Rod Drop Experiment
Positive Period Experiment
Figure 1 Reactivity vs power level
Figure 2 Reactivity vs R(T) - 1
Figure 3 Reactivity vs period

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Step	Action and Response	Comment or Correction

I. PURPOSE

The Control Rod Calibration Procedure benchmarks the primary system for reactor control and safety.

II. DISCUSSION

Knowledge of the control rod worth is the necessary requirement to assure the performance of the control rod system. Both routine operating conditions and the safety functions of the control rod system depend on the calibration data. Two separate experiments provide calibration data. The Rod Drop Experiment determines integral control rod worth by observation of the change in reactor power level. This experiment provides the initial estimate of a rod worth after major core rearrangements. The experiment may also verify the total rod worth after minor core changes. Details of the differential rod worth are found with the Positive Period Experiment. This experiment determines both the total control rod worth and the shape of the control rod position versus control rod worth curve.

Measurement of the rod drop time and rod removal time verify the performance of the system safety function. The SCRAM switch or relay in the safety circuit initiates the safety circuit action. Rod switches initiate step reactivity insertions.

Rod calibrations are to be done at least once each year and after any significant change to the reactor core configuration.

III. REFERENCE

MAIN-6
- Graph or data:
- Reactor power vs time
- Reactor period vs reactivity

IV. EQUIPMENT

Step	Action and Response	Comment or Correction

V. INSTRUCTIONS

A. Control Rod Calibration:

1. Perform ICS system prestart checks.

2. Follow the appropriate rod calibrations procedures for the listed conditions.

   a. Rod Drop - after initial core critical conditions substantial core rearrangements
   b. Period Response - minor core rearrangements
   c. Positive Period - annual rod worths
   d. Other methods may provide supplemental rod worths data. Two methods are:
      i. Prompt Jump - demonstrations - experiments
      ii. Flux Dependence - demonstrations - experiments

3. Review measurement results with supervisory operator.

4. Document control rod worth and date in Operation Manual.

5. Plot Differential Rod Worth Curve (or data) for reference.

Step	Action and Response	Comment or Correction

B. Rod Drop Time and Insertion Rate:

1. Perform control console (ICS) prestart check.

2. Attach measurement system to the console rod power control switch and transient rod drive down limit switch.

   a. Measurement equipment should be a storage oscilloscope, or electronic timer with signal start-stop features.
   b. Measurement resolution for oscilloscope should be 0.2 sec/div. by 5 volt/div. with x10 signal probe.
   c. Connect start signal (trigger) to the console rod power control switch (CSC terminal __________).
   d. Connect stop signal (signal) to the rod drive down limit switch (DAC terminal __________).

3. Withdraw control rod to stop limit.

4. Reset oscilloscope or electronic timer.

5. Drop control rod to trigger and record trace.

6. Repeat steps 2 through 5 for each shim rod and the regulating rod.

7. Complete a routine startup check.

8. Check of reactivity insertion rate:

   a. Measure the time required to move the regulating rod from full insertion to full withdrawal;
   b. Reinsert control rod;
   c. Repeat part (a) and (b) for transient rod.
   d. Repeat part (a) and (b) for shim rod one.
   e. Repeat part (a) and (b) for shim rod two.
   f. Obtain differential rod worth near rod midpoint;
   g. Calculate insertion rate (<.2% $\Delta k/k$/sec) as follows:
      rate (% $\Delta k/k$/sec) =
      rate (units/sec)* worth (¢/unit)*(.7% $\Delta k/k$/100).

CONTROL-ROD CALIBRATION BY ROD-DROP METHOD

Introduction

The following is a description of the theory and some comments on the procedures for the determination of rod worth by the integral rod drop method.

Theory

The reactor kinetic equations have been integrated to find the power as a function of time following a negative reactivity insertion, Δk, on a 0.2-sec ramp. The following assumptions were made:

1. The reactor was assumed to be operating at a low-enough power level that temperature effects could be neglected.
2. The prompt generation time was taken to be 45 μ sec[1].
3. The effective delayed fraction was taken as 0.0070. (The delayed neutron data were taken from Keepin et al.[2])

The integration was performed by the Runge-Kutta technique with a time interval of 0.01 sec.

The integral method is based on the fact that a useful relation exists between the reactivity worth of the rod drop, and the average power over short periods of a few seconds following the drop. If the reactor is operating at power, P_0 , before the rod drop, and at $P(t)<P_0$ after the drop, which started at t = 0, the following can be calculated:

$$[R(T)]^{-1} = \frac{1}{T}\int_0^T \frac{P(t)}{P_0}\,dt.$$

In Fig. 1 is a plot of the reactivity worth of the rod drop in dollars versus $P(T)/P_0$ at the time interval of 5, 10, and 15 seconds. In Fig. 2 is a plot of the reactivity versus [R(T)-1] for the same time periods. These curves are almost linear over a wide range of values of $\Delta k/\beta$.

Procedures

a. Take the reactor critical, remove the source from the core, and carefully establish a critical position at low power.
b. Before the rod is dropped, counts will be taken for a 30-sec period in order to determine the counts/sec., which will establish TP_0.
c. At the instant the rod to be measured is dropped, counts will be taken for a period of 5, 10 or 15-sec.

---

[1]Information indicates that 45 μ sec is reasonable. A change in this value however, will not affect the results.
[2]Keepin, et al., Phys. Rev. 107, 1044 (1957).

Step	Action and Response	Comment or Correction

1. This count is a measure of $\int_0^T P(t)\,dt$.
2. R(T) can be calculated from Fig. 1 for the integral period T, and the reactivity worth of the rod in dollars ($\Delta k/\beta$) can be determined.
3. The experiment will have to be repeated several times to obtain any reasonable accuracy, due to the inherent errors in dropping the rod simultaneous with starting the scaler clock, as well as the errors in precisely setting the scaler clock.
4. Repeat for each control rod. Document data on a form such as the following recommendation, TABLE I.

TABLE I
Rod Drop Calibration

Rod(s) ____________________ Date ____________________

Critical Power ____________ Core configuration __________

Source Out ________________ Fuel Load _________Elements

Integration Time __________

Initial Rod Position

Trans	Shim 1	Shim 2	Reg	rod TS1S2R	TP_0	Total Counts	R(t)	$\Delta k/\beta$

DIFFERENTIAL CONTROL ROD CALIBRATION BY DIFFERENTIAL WORTH

Introduction

The following is a description of the theory and some comments on the procedures for determination of rod worth by differential worths.

Theory

The reactivity equation (inhour eq.) provides the relationship between reactor period, s^{-1}, and the reactivity, ρ, in units of $'s($\Delta k/\beta$). The following assumptions are made:

1. The reactor kinetics are considered to model a prompt neutron lifetime, ℓ, is 45 microseconds.
2. The neutron response is characterized by six delayed neutron groups.
3. The equation for reactivity is:

$$\frac{\rho}{\beta} = \frac{s\ell/\beta}{s\ell+1} + \frac{1}{s\ell+1}\sum_{i=1}^{6}\frac{s\beta_i/\beta}{s+\lambda}.$$

In Fig. 3 is a plot of the reactivity in dollars versus the period in seconds for negative and positive reactivities. These curves are for the prompt neutron lifetime of 45 μsecs.

The period can be determined by noting the time required for a flux reading (such as micromicroammeter current) to change by a factor of 1.5. This reading should be repeated a few times to insure that the reactor is on a steady period and that the initial transient change caused by movement of the rod has disappeared. From these readings the period can easily be determined. For example, 3 measurements with a 1.5 factor could be 2.0 to 3.0, 3.0 to 4.5, 4.0 to 6.0 and 6.0 to 9.0 The period is then 2.47 times the interval time.

Procedures

a. The reactor will be made critical by removing the rod to be calibrated and going critical on the adjacent rods. (If the loading is such that this cannot be done, it will be necessary to modify the following procedure.)

b. After the reactor is critical, the source should be completely removed from the core to insure that it does not effect rod calibrations.

c. The transient rod calibration can now begin by alternatively moving the transient rod into the core and removing the regulating rod.

Step	Action and Response	Comment or Correction

The detailed procedures for this are as follows:

1. The reactor should then be put on a positive period of about 60 seconds by removing the regulating rod slightly.
2. The reactor will now be put on a negative period of <u>100 seconds or greater</u> by partially inserting the transient rod.
3. From the inhour curve (refer to plot) the reactivity corresponding to the period will be determined.
4. Repeating the steps described above, the reactivity equivalent to this period will be determined. The effective reactivity worth of the movement of the transient rod is then the summation of the reactivities corresponding to the previous positive period and negative period.
5. This process will be continued until the regulating rod is fully inserted. This completes the calibration of the regulating rod. After the first few points have been determined, it will be possible to estimate by extrapolation how far the regulating rod should be inserted in the next step or how far the transient should be removed. When possible, this should be done before actually changing the position of the rod. See Table II for the recommended method and form for recording the data. A curve should be drawn on linear coordinate paper, plotting rod worth against rod position.

d. Since the regulating rod will be worth more than the transient rod, it will be possible to calibrated the regulating rod by continuation of the previous steps.

1. Repeat the step to remove the rod for a positive 60 second period after complete insertion of the transient rod.
2. Substitute the movement of the shim rods for the negative periods previously related to the insertion of the transient rod.
3. Evaluate the regulating rod calibration from the worth of the transient rod and the sum of the positive and negative periods.

e. Calibration of the shim rods should now be performed.

1. Shut the reactor down, and remove the transient rod.
2. Then remove one shim rod completely, go critical on the regulating rod.
3. By the period method outlined above, using alternate movement of the two shim rods, calibrate both rods as far as possible until one shim rod is full out or the other is full in.
4. Continue the calibration procedure by insertion of the transient rod if the shim rod is fully down or removal of the regulating rod if one shim rod is fully out. Stop when both shim rods are at the full down and full up positions.
5. Then shut down, and reinstall the source.

Step	Action and Response	Comment or Correction

f. If it is necessary to add, subtract or relocate fuel within the core after the rods have been calibrated, it will of course be necessary to repeat the period calibration of all rods.

TABLE II
Rod Period Calibration

control rod	start	stop	#1	#2	#3	$+\rho$	$-\rho$	total

NUCLEAR ENGINEERING TEACHING LABORATORY

SURV-7

PULSE CHARACTERISTIC COMPARISON

Approvals:

Thomas L. Bauer — 1/24/92
Reactor Supervisor — Date

Bernard W. Wehring — 1/24/92
Director, NETL — Date

[signature] — 1/24/92
Chairperson,
Nuclear Reactor Committee — Date

List of Pages: 1 2 3

Attachments: None

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Step	Action and Response	Comment or Correction

I. PURPOSE

The purpose of this procedure is to monitor the core performance for a reference pulse reactivity insertion.

II. DESCRIPTION

The pulsing characteristics of the TRIGA reactor release large amounts of energy, 20M Joules, in a very short time period <0.5 seconds. Some variation of the peak power, energy release and fuel temperatures will occur as a function of fuel history. In fact long term full power runs with few pulses may differ from many pulses with no long term full power runs.

No pulse program should proceed without a comparison of reference pulse characteristics. A $3 reference pulse at least once each year or prior to resumption of pulsing if no annual pulse has been made will provide pertinent data to verify that the peak power, energy release, and fuel temperatures are within acceptable limits.

The pulse characteristics are to be done annually or prior to the resumption of any pulsing program if the time interval to the previous pulse exceeds one year.

III. REFERENCES

Pulse records

IV. EQUIPMENT AND MATERIALS

Step	Action and Response	Comment or Correction

V. Instructions

1. Review present reactor system conditions with respect to previous reactor configuration. Several conditions may cause different pulse characteristics such as number of elements, history and burnup.

2. Review previous comparative pulse data. Set rod drive air pressure at 65 psi.

3. Specify pulse ID as "COMPARE - Month/Year."

4. Perform reactor pulse ($2.00). Reactivity insertion should be equivalent to that of previous comparative pulse based on current rod worth measurements.

5. Print the pulse data screen. Print the graphic pulse data. Use the same scales as used on previous comparative pulse.

6. Document the following additional data on the printed pulse data:

   a. Core configuration; # control, # elements, # graphite, # exp.
   b. Initial steady-state power and excess reactivity.
   c. Worth of transient rod insertion

7. Review current pulse data and record core conditions. Compare with previous data for indication of a significant change in reactor core transient characteristics.

8. Place data in Pulse Data Sheet Log.

NUCLEAR ENGINEERING TEACHING LABORATORY

PROCEDURE OPER-1 - REV 0

STARTUP - SHUTDOWN CHECKS

Approvals:

Thomas L. Bauer	8/6/90
Reactor Supervisor	Date
Bernard W. Wehring	8-14-90
Director, NETL	Date
[signature]	8-21-90
Chairperson, Reactor Committee	Date
[signature]	8/29/90
Chairperson, Radiation Safety Committee	Date

List of Pages: 1 2 3 4

Attachments:	Startup Shutdown Checklist	2 pages
	Operation Request	1 page

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ORIGINAL

Record of Procedure Changes

OPER1

Page	*Date	*Initial	*Change
CHECKLIST 1 OF 2	3/16/93	MK	IN ROOM VENTILATION SECTION CHANGE "dp level..." TO "OK dp level..."
CHECKLIST 1 OF 2	3/16/93	MK	IN POOL WATER SYSTEM SECTION CHANGE: "temp.(°C)" TO "temp.(°F)" ALL PLACES. IN LAST LINE CHANGE: "___ Hxdp ___ psig" TO "___ Hxdp psig"
CHECKLIST 2 OF 2	3/16/93	MK	IN SCRAM CHECKSECTION ADD "CSC WDOG ___" AND "DAC WDOG ___"
CHECKLIST 1 OF 2	3/16/93	MK	IN RAD MONITORS SECTION AIR ACTIVITY SECTION CHANGE "925 CONS ___ GPM" TO "925 CONS ___ GPM TIME CAM ON ___"
CHECKLIST 2 OF 2	3/16/93	MK	IN SHUTDOWN CHECKLIST ADD "TIME AIR CAM OFF ___"
CHECKLIST 1 OF 2	3/96	MK	IN POOL H2O SYS ADD "Hx dP ___ ALARM OK" AND IN REACTOR STARTUP CHECKS" ADD "RUN #".

*see back of page for ... *

Number	Title	Rev.
OPER-1	Startup-Shutdown Checks	Date 6/90

Startup/Shutdown Checklist

Date ___/___/___

STARTUP CHECKS | Run # By

Visual inspection: core ____ pool ____ room ____

Experiment areas: pool ____ area: 1__ 2__ 3__ 4__ 5__

Radiation Monitors:

portable __________ unit checks ok ____

area: 1_ 2_ 3_ 4_ 5_ 6_ area: a_ b_ c_ d_ e_

air activity:
particulate _____ cpm
gaseous _____ cpm Time CAM on ______

Room Ventilation System:

Operation mode Q__E__ exhaust Stack velocity _____fpm

Argon purge on__off__exhaust Stack velocity _____fpm

Room pressure dp____(in. H2O) OK dp level:1___2___3___

Pool Water System:

purification: pump _on _off conductivity __in __out

pool isolation: valve (open: close) In_ Out_ align H16 ____

Hx pool side: valves(open:close) In_Out_ pump(on:off)

Hx chill side: valves(open:close) In_Out_ pump(on:off)

chill water:_____ flow(gal/min) HX dp ______alarm ok

______ pres.(psig) ______ temp.(F)
______ pres.(psig) ______ temp.(F)

pool water:_____ flow(percent)

______ pres.(psig) ______ temp.(F)
______ pres.(psig) ______ temp.(F)
______ Hx dp (psia)

Number	Title	Rev.
OPER-1	Startup-Shutdown Checks	Date 6/90

ICS Autocalibration: ICS program boot successful __yes __no

Prestart checks ___ satisfactory | Pulse-Square Wave Checks:

Error condition __________

Manual SCRAM ___ satisfactory | Restart check :

External SCRAM _ NA _1 _2 OK

Print: prestart diagnostic ____ status window ____

CSC Watchdog ____OK DAC Watchdog ____OK

SHUTDOWN CHECKS | By

All rods down	___	Heat exchanger pumps	__ (p) __ (s) off
Remove key	___	Hx inlet valve	__ inlet secure
Scram mode	___	Hx outlet valve	__ outlet secure
# of SCRAMS	___	Pool isolation valves	__ __ __ secure
		Pool level	_____ meters
		Purification pump	__ on __ off
Historical File____			CAM _____ cpm
Filename______		HVAC __ normal	Off _____ time Ar41
Diskette No._____		Purge __ secure	Ar41 _____ cnts

Comments |

ORIGINAL

I. PURPOSE

This procedure describes the facility and reactor system checks to be done prior to startup of the reactor and subsequent to shutdown of the reactor. A check of valid experiments and operation requests.

II. DISCUSSION

Several facility systems must function properly for the reactor systems to operate safely. The two most important are the pool water system and air confinement system. Other equipment such as communication equipment and radiation monitoring equipment are also necessary for operation. A checklist documents the status of various systems. Both prestart checks and post shutdown checks are for the purpose of verifying the operability or condition of key systems.

Prior to actual operation a review of the operation requirements and check of valid experiment requests and approvals is made. An operation request form documents the request and the valid experiment approval.

III. REFERENCE

Docket 50-602 SAR
ANS 15-6, Reg. Guide 2.2

IV. CONTENTS

V. PROCEDURE

Review the requirements of operation, see section A, then perform the startup checks prior to operation, section B, and perform the shutdown checks to complete the operations, section C.

A. Operation Request

1. Review the operation request form for each experiment.

2. The operation and experiment approval on the request form document each experiment, including routine operations.

3. Maintain the request form on file in the console log during all reactor operations for that request.

4. The operation request includes a list of samples or materials subject to irradiation or exposure. This list is to be kept with the operation request until the irradiation or exposure is complete.

5. Remove operation requests that are no longer applicable from the console log and place in the appropriate files.

B. Startup Checks

1. Identify experiment classification and personnel requirements.

   a) Perform visual inspection of reactor and experiment areas.
   b) Designate the SRO, RO and experimenter.
   c) Review the operation request (see section A).

2. Set reactor room ventilation conditions, as specified.

   a) Change room fan operation from return to exhaust. Exhaust mode operation of the ventilation system should be the normal mode of operation.
   b) Operate argon purge fan and source valves. This system must be operating if the exhaust mode ventilation is not available and the reactor is operating.

3. Set reactor pool cooling conditions, as required.

   a) Note status of water purification loop. Pool water purification system should be operating.
   b) Operate primary and secondary water cooling loops. Power levels greater than 250 kilowatts should have cooling system operating prior to startup.

4. Check other facility conditions.

   Several systems must be operable or operating.
   a) Communication - telephone and intercom (1 way)
   b) Area radiation - particulate CAM (1), gamma ARM (3)
   c) Evacuation Alarm

5. Initiate ICS bootstrap sequence, refer to Chapter 1 & 2 of ICS Operation Manual.

6. Verify successful ICS bootstrap sequence.

7. Perform prestart checks sequence.

8. Complete Startup Checklist.

ORIGINAL

C. Shutdown Checks

1. Turn MAGNET POWER Key switch from ON to OFF.

2. Secure RCC key and switch RCC power to OFF.

3. Secure experiment areas, radiation areas and radioactive materials.

4. Secure operation of heat exchanger system.

   a) Turn off power to primary and secondary pumps.
   b) Close primary and secondary valves to heat exchanger.

5. Secure operation of room ventilation exhaust.

   a) Change room fan operation from exhaust to return.
   b) Secure argon purge fan and source valves.

6. Perform visual inspection of reactor and experiment areas.

7. Complete shutdown checklist.

8. File previous operating records, check lists and other datasheets.

Number	Title	Rev.
OPER-1	Startup-Shutdown Checks	Date 6/90

Startup/Shutdown Checklist

Date _____/_____/_____

STARTUP CHECKS | By __________________

Visual inspection: core _____ pool _____ room _____

Experiment areas: pool _____ area: 1___ 2___ 3___ 4___ 5___

Radiation Monitors:

portable ____________________ unit checks ok ____

area: 1__ 2__ 3__ 4__ 5__ 6__ area: a__ b__ c__ d__ e__

air activity:
particulate _______ cpm
gaseous _______ cpm

Room Ventilation System:

Operation mode Q___R___ exhaust Stack velocity ______fpm

Argon purge on___off___exhaust Stack velocity ______fpm

Room pressure dp_____(in. H2O) dp level:1____2____3____

Pool Water System:

purification: pump __on __off conductivity ___in ___out

pool isolation: valve (open: close) In__ Out__ align N16 ______

Hx pool side: valves(open:close) In__Out__ pump(on:off)

Hx chill side: valves(open:close) In__Out__ pump(on:off)

chill water:________ flow(gal/min)

________ pres.(psig) ________ temp.(C)
________ pres.(psig) ________ temp.(C)

pool water:________ flow(percent)

________ pres.(psig) ________ temp.(C)
________ pres.(psig) ________ temp.(C)
________ Hx dp ________ psig

ICS Autocalibration: ICS program boot successful __yes __no

Prestart checks ____ satisfactory

Error condition __________________

Manual SCRAM ____ satisfactory

External SCRAM __ NA __1 __2 OK

Pulse-Square Wave Checks:

Restart check :

Print: prestart diagnostic _____ status window _____

SHUTDOWN CHECKS By ____________

All rods down ______	Heat exchanger pumps	___ (p) ___ (s) off	
Remove key ______	Hx inlet valve	___ inlet	secure
Scram mode ______	Hx outlet valve	___ outlet	secure
# of SCRAMS ______	Pool isolation valves	___ ___ ___	secure
	Pool level	________ meters	
	Purification pump	___ on ___ off	

Historical File_______

Filename______________	HVAC ___ normal	CAM _________cpm
Diskette No.__________	Purge ___ secure	Ar41 ________cnts

Comments

ORIGINAL

Operation Request

Date: ____/____/____ Req. No._____

Requested by:______________________________Phone_________ Exp. No._____

Project Description:

Mode of Operation: [ ] Manual [ ] Pulse [ ] Auto [ ] Square

Power level _____kws   Pulse transient _____$s
Time at power _____hrs   Number of pulses _____##

[ ] Class A experiment, senior operator:
[ ] Class B experiment, reactor operator:
[ ] Class C experiment, operator __________experimenter:__________________

Irradiation: [ ] In-core RSR PNT CTR Other_____________
Exposure: [ ] Ex-core BP 1 2 3 4 5 Other_____________

Material: ____
Neutron flux: ______________________________n/cm^2 - sec
Radiation dose: ______________________________rads/sec

[ ] Class D experiment (non reactor) experimenter:

Experiment in Reactor Pool [ ]   Experiment in Room [_______________]
Experiment in Reactor Area [ ]

Time Estimates: Time of operation ______________________
Setup and breakdown time______________________
Total time (min. 1.0 hr)______________________

Experiment type: Authorization [ ] Special [ ] Routine [ ]

Special Requirements/Notes:

Approval for Operation: ___/___/___	Review of Operation: ___/___/___
Reactor Supervisor _______________	Reactor Supervisor _______________

ORIGINAL

NUCLEAR ENGINEERING TEACHING LABORATORY

OPER - 2, REV. 0

REACTOR STARTUP AND SHUTDOWN

Approvals:

Thomas J. Bauer — 8/6/90
Reactor Supervisor — Date

Bernard W. Wehring — 8-14-90
Director, NETL — Date

[signature] — 8-21-90
Chairperson, Reactor Committee — Date

[signature] — 8/29/90
Chairperson,
Radiation Safety Committee — Date

List of Pages: 1 2 3 4

Attachments:	Typical Sequences	2 pages
	Console Log Sheets	2 pages
	SCRAM Log Record	2 pages

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ORIGINAL

Number	Title	Rev. 0
OPER-2	Reactor Startup and Shutdown	Date 6/90

I. PURPOSE

This procedure specifies actions to be done for startup and shutdown of the reactor.

II. DISCUSSION

Actions for reactor startup and shutdown require certain specific conditions. Prior to startup the correct conditions are checked by the performance of the prestart check list. Guidance for startup of the reactor is available in the console operators manual. Features of this procedure provide guidance and requirements. Some deviations will occur depending on the experience of the operator and the operation requests. An example of the guidance is the attachment of a typical startup sequence. Subsequent to reactor shutdown a checklist documents the condition of key systems. Abnormal shutdown, SCRAMS, require an SRO approval prior to restart.

III. REFERENCES

Startup-Shutdown Checklist
Control Console Operators Manual
Reactor Operation Log

IV. CONTENTS

Square Wave - MF389R-Lab
Sequence:
Pull Rog full out
Set demand to 1MW
Set transient position
Set critical S1 + S2
Drop TR
Move Line to 960
Set Square wave
Fire transient
Ramp Mode → steady-state

ORIGINAL

V. PROCEDURE

A. Reactor Startup

1. Review Operation Procedures for the mode of operation, refer to ICS Operation Manual. Console log sheets for each operation will record operator comments regarding important system conditions. These log sheets in the console logbook will supplement computer printouts from the ICS system. Other datasheets such as the checklist, operation request, and sample irradiation and exposure log complete the documentation for a typical reactor run.

2. Review completion of the startup checklist and note the recorded conditions. Use the comment section of the startup-shutdown checklist to document unusual conditions at the time of reactor startup or shutdown. If any question exists regarding acceptability of the condition consult the supervisory senior reactor operator.

3. Perform operator log-on function to set mode to steady-state Manual. Turn MAGNET POWER key switch from OFF to RSET to ON.

   a) Check Manual SCRAM, if this is the first startup.
   b) Check External SCRAM, if an experiment shutdown is applicable.
   c) Verify the cause of any previous SCRAM condition.

4. Verify SRO approval of startup for an experiment. Verify SRO approval of restart from a SCRAM condition.

5. Determine mode of operation and review Attachment A for typical startup sequence.

6. Refer to Reactor Startup-Shutdown procedure for termination of reactor operation.

B. Reactor Shutdown

1. Insert Reg rod to the 0% withdrawn position.

2. Insert each Shim rod to the 0% withdrawn position.

3. Insert Transient rod to the 0% withdrawn position.

4. Assure that all rod drives and control rods are in the down position.

5. Perform operator log-off function to set mode to steady-state scram. Turn MAGNET POWER key switch from ON to OFF.

6. Press SCRAM button for exit from any operation mode.

   The SCRAM is an immediate shutdown for response to abnormal conditions or a severe emergency. Record all abnormal shutdowns in the SCRAM log. These do not include manual scrams by the operator that are for non emergency conditions.

   Abnormal shutdowns are of the following types:

   a. Manual SCRAM - Operator activation of magnet key switch or SCRAM button.

   b. Limiting Safety System Setting (LSSS) - fuel temperature (#1, #2), percent power (#1, #2), linear power (NM1000).

   c. IC System Operable (ICSO) - HV (#1, #2, NM1000), WD (CSC, DAC), Pool Level (2), External (2), others (program conditions).

Typical Startup Sequence

Sequence for pulse mode or square wave operation positions pulse rod so that positive reactivity insertion occurs as rod moves from set position to 100% withdrawn.

Pulse position for full stroke pulse -
Pulse reactivity remains in core -

a) Manual Mode:

Withdraw transient rod to 100% withdrawn position.
Withdraw reg rod to 25% withdrawn position.
Withdraw shim rods in steps of 50 units or less.
Check for positive period of about 20 seconds.
Do not exceed a 10 second period.
Adjust shim rods to maintain period.
Move shim rods to stabilize power level.
Move reg rod to maintain power level.

b) Pulse Mode:

Calculate pulse rod position for reactivity value.
Withdraw transient rod to pulse position.
Withdraw reg rod to 25% withdrawn position.
Withdraw shim rods in steps of 50 units or less
Check for positive period of about 20 seconds.
Do not exceed a 10 second period.
Adjust shim rods to maintain period.
Move shim rods to stabilize power level.
Move reg rod to maintain power level.
Insert transient rod to 0% position.
Check rod at low limit, air pressure off.
Withdraw drive cylinder to 100% position.
Check power < 1kw, DPM < $\pm$ 1.
Press Pulse Mode switch.
Enter record information for pulse data.
Press Fire switch.

c) Auto Mode:

Set demand power switches.
Withdraw transient rod to 100% withdrawn position.
Withdraw shim rods to 10% withdrawn position.
Withdraw reg rod to 25% withdrawn position.
Check reg rod between down and up limits.
Check shim rods between down and up limits.
Check DPM < ± 1
Press Auto Mode switch.

d) Square Wave Mode:

Calculate pulse rod position for reactivity insertion.
Withdraw transient rod to pulse position.
Withdraw reg rod to 25% withdrawn position.
Withdraw shim rods in steps of 50 units or less.
Check for positive period of about 20 seconds.
Do not exceed 10 second period.
Adjust shim rods to maintain period.
Move shim rods to stabilize power.
Move reg rod to maintain power level.
Check reg rod not at top or bottom limit.
Check shim rods not at top or bottom limit.
Insert transient rod to 0% position.
Check rod at low limit, air pressure off.
Withdraw drive cylinder to 100% position.
Check power < 1kw, DPM < ± 1.
Check DPM < ± 1.
Press Square Wave switch.

Operation Log Sheet

Run No.________

UT-TRIGA The University of Texas
NETL Balcones Research Center

Page ____ of ____
Date __ / __ / __

Complete startup checks ___ okay
Operation : ___ pulse ___ non pulse
Experiment No. ____________
Samples In-core: yes ___ no ___
In-beam: yes ___ no ___
SCRAM Recovery Approval ____________

Reactivity:

	static	moveable
RSR		
PNT		
Total		

Shutdown checks complete: ________
Number of pulses performed: ________

Integrated burnup ____ KWHRs
Operation time ____ Hours

Samples In core: yes ___ no ___
In beam: yes ___ no ___

Location ____________

Comments: ____________

Operator/Title	Time in/out	Operator/Title	Time in/out

Time	Comments

ORIGINAL

Number	Title	Rev. 0
OPER-2	Reactor Startup and Shutdown	Date 6/90

Operation Log Sheet

Run No.__________

Page _____of_____

Date ___/___/___/

Time	Comments

ORIGINAL

Number	Title	Rev. 0
OPER-2	Reactor Startup and Shutdown	Date 6/90

Scram Log
for General System

Record each scram with the type designation. Note the cause or other information as a comment.

A. SCRM MANUAL

A. SCRM FT 1
B. SCRM FT 2
C. SCRM %P1
D. SCRM %P2
E. SCRM PPWR HI

A. SCRM NO OPTR
B. SCRM KEY OFF
C. SCRM POOL LO
D. SCRM NPP HV
E. SCRM NP HV

A. SCRM EXTRN1
B. SCRM EXTRN2

Date	Time						Comments
Totals							

ORIGINAL

Scram Log
for Digital Systems

Record each scram with the type designation. Note the cause or other information as a comment.

A. SCRM NM COMM
B. SCRM NM DATA

A. CSC WD FLT
B. CSC WD TO
C. DAC WD FLT
D. DAC WD TO

A. SCRM IC NET
B. SCRM CSC DS
C. SCRM DAC DS
D. SCRM DBASE

A. SCRM DOM32
B. SCRM AIO16 1
C. SCRM AIO16 2

Date	Time	CSC/DAC WD	SCRM NM	SCRM IC NET / CSC DS / DAC DS / DBASE	SCRM DOM32 / AIO16	Comments
Totals						

NUCLEAR ENGINEERING TEACHING LABORATORY

PROCEDURE OPER - 3, REV. 0

REACTOR OPERATION MODES

Approvals:

Thomas L Bauer — 8/6/90
Reactor Supervisor — Date

Bernard W. Wehring — 8-14-90
Director, NETL — Date

[signature] — 8-21-90
Chairperson, Reactor Committee — Date

[signature] — 8/29/90
Chairperson,
Radiation Safety Committee — Date

List of Pages: 1 2 3 4 5 6

Attachments: None

BALCONES RESEARCH CENTER
THE UNIVERSITY OF TEXAS AT AUSTIN

ORIGINAL

I. PURPOSE

This procedure describes the different operation modes of the reactor.

II. DISCUSSION

The ICS system operation modes control the program logic interlock requirements and set the operation conditions for the reactor control rod drives. There are four operation mode conditions set by the control panel switches. Mode descriptions in the display annunciator box may differ from the switch labels to qualify conditions within a mode. The SCRAM mode is a non operation mode (no mode light on).

III. REFERENCES

Control Console Operator's Manual

IV. CONTENTS

V. PROCEDURE

A. Manual Mode

1. Review Manual Mode operation, refer to Chapter 4 of ICS Control Console Operator's Manual.

2. Determine reactor power level. Estimate control positions at steady-state power. Refer to

   a) previous operation history, and
   b) typical rod positions, or
   c) rod worth curves.

3. Move control rods to achieve power level or go to step 5 to enter another mode..

   a. Status window printouts should be done before and after each power change and approximately every 30 minutes while at a steady-state power level.

   b. Operation such as control rod calibrations that require "continual" power changes do not require a printout for each power change.

   c. If a linear recording is to be made:

      1. Record the date, time and operation # on the chart prior to switching recorder power on.

      2. At the end of the record switch the recorder power off and record "eor" on the chart.

4. Monitor system operation, power level and control rod positions at periodic intervals. Record data logs at recommended intervals.

5. Refer to Operation Procedure, "MODE", for exit to alternate operation mode.

   a) Operation Procedure, Auto, Mode, Section B
   b) Operation Procedure, Square Wave, Section C
   c) Operation Procedure, Pulse, Section D

6. Press SCRAM button for exit from Manual Mode to Scram Mode.

B. Auto Mode

1. Review Auto Mode operation, refer to Chapter 5 of ICS Control Console Operator's Manual.

2. Set Demand Power switches to desired power level.

3. Press AUTO switch and verify AUTO light illuminates. Verify System Mode is Auto.

4. Monitor system operation, power level, and control rod positions at periodic intervals. Record data logs at recommended intervals.

5. Press MAN switch for exit from Auto mode to Manual Mode.

6. Press SCRAM button for exit from Auto mode.

C. Square Wave Mode

1. Review Square Wave Mode operation, refer to Chapter 5 of ICS Control Console Operator's Manual.

2. Set Demand Power switches to desired power level.

3. Press SQUARE WAVE switch and verify SQUARE WAVE light illuminates. Verify System Mode is Square Wave Ready.

4. Determine Transient reactivity and adjust cylinder position.

5. Press FIRE button and verify System Mode is Square Wave Rampup. Exit Rampup mode is to Auto mode, or if demand power is not reached in 1 second to Manual mode.

6. Refer to Operation mode, Auto procedure.

Scram circuit status subseq

Verify status of ~~pu~~ scram circuit pulse mode ~~gain &~~ ~~bypass~~ relays ~~for~~ gain(1) ~~positions~~ and bypass(2, 3) ~~by~~ functions by

1.) Test NPP1000 Hi Power trip with scram test signal

2) Test NP1000 Hi Power trip with scram test signal

3.) Note response of NM1000 power signal to the ~~reactor powe~~ reactor decay power.

D. Pulse Mode

1. Review Pulse Mode operation, refer to Chapter 6 of ICS Control Console Operator's Manual.

2. Determine Transient rod reactivity insertion and adjust Transient rod drive cylinder position.

3. Press PULSE switch and verify PULSE light illuminates. Verify System Mode is Pulse Ready.

4. Determine alphanumeric pulse description and enter string.

5. Press FIRE button and verify System Mode is Pulse. Exit Pulse mode is to Pulse Display mode then Manual mode.

6. Refer to Operation mode, Manual procedure.

   a. Check NP1000 channel for Hi Power scram to show that bypass relay resets.

   b. Check NPP1000 channel for Hi Power scram to show that gain relay resets.

NUCLEAR ENGINEERING TEACHING LABORATORY

PROCEDURE OPER-4, REV. 1

OPERATION OF REACTOR WATER SYSTEMS

Approvals:

Thomas L. Bauer — 12/6/90
Reactor Supervisor — Date

Bernard W. Wehring — 12/7/90
Director, NETL — Date

[signature] — 12/11/90
Chairperson, Reactor Committee — Date

[signature] — 1/22/91
Chairperson,
Radiation Safety Committee — Date

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Attachments: Abnormal Conditions Page 1, 2, 3

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ORIGINAL

Step	Action and Response	Comment or Correction

I. PURPOSE

This procedure details the steps for operation, startup, and shutdown of the reactor water systems.

II. DISCUSSION

The reactor water system is composed of the reactor pool structure coupled to a water purification system and a water cooling system. The pool structure contains water which cools the reactor core and provides radiation shielding. Pool water purity is maintained by operation of the purification system. Bulk pool water temperature is controlled by operation of the coolant system when the reactor is operated for an extended time at high power.

III. REFERENCE

1. Docket 50-602 SAR
2. Startup Checklist
3. Reactor Water System, Surveillance Procedure SURV-4.

IV. CONTENTS

ORIGINAL

Step	Action and Response	Comment or Correction

V. PROCEDURE

1. Check pool water level each time the status (startup or shutdown) of the purification or coolant system changes. Normal level is 8.10 ± 0.05 meters measured relative to the bottom of the reactor tank.

2. Monitor pool level by continual or intermittent (daily) observation. A pool level monitor will provide the monitoring of hi (+5cm) or lo(-5cm) conditions. Make visual observations of the pool level at least twice each day if the pool level monitor is not functioning and a system without siphon breaks that can cause a siphon action extends below the siphon break level. Siphon break level is 7.6 meters or above.

3. Replace pool water evaporation losses with makeup supply of deionized water per instructions in surveillance procedures.

4. Operate the pool purification system per instructions in Section A to maintain normal pool water conductivity less than 2 μmho/cm, limit - 5 μmho/cm. Purification system operation is not a requirement for reactor operation and does not require the presence of a licensed reactor operator in the facility.

5. Operate the pool coolant system per instructions in Section B to maintain normal bulk pool temperatures less than 38°C (100°F), limit 48°C (118°F). Coolant system operation is not a requirement for reactor operation. A reactor operator should be present at the facility and periodically check system conditions if the system is operating.

6. Monitor performance of pool purification and coolant water systems. Refer to instructions in Attachment for response to abnormal conditions. Determine the cause for abnormal condition and implement corrective or maintenance actions for conditions which effect system performance. Report abnormal conditions to a supervisory operator.

ORIGINAL

Step	Action and Response	Comment or Correction

A. POOL PURIFICATION SYSTEM

1. Operation
   a. Operate the purification system to maintain pool water purity. Operate system continuously except for maintenance or special conditions. Pool water pH should be neutral ($5<pH<9$) and conductivity <2 μmho/cm (>0.5 megohm-cm). Conductivity limit for any condition is 5 μmho/cm (0.2 megohm-cm).

   b. Operate pool water surface skimmer to lessen particulate deposits in the pool. Pool subsurface intake may bypass the skimmer but it is not the preferable normal condition.

   c. Review purification system function each day the reactor is operated by observation of flow rate, conductivity, and pressure.

2. Startup
   a. Verify valve alignment at purification skid: open pool supply valve; open pool return valve; close both resin sluice valves.

   b. Open skimmer suction valve or subsurface suction valve and discharge isolation valve at pool surface. (1½" PVC valves)

   c. Startup purification pump and check pump mechanical seal for leakage.

   d. Adjust flow control valve at purification skid for water flowrate of 22-38 lpm (6-10 gpm).

   e. Check flow pressure drop across line filter, for pressure difference of 84-168 kpa (12-24 psi).

   f. Verify inlet and outlet conductivity is less than 2 μmho/cm.

   g. Note water conductivity difference between supply water to resin and return water to pool.

   h. Check system for leaks.

3. Shutdown
   a. Shutdown purification pump and check flow indication goes to zero.

   b. Close skimmer suction and subsurface suction isolation valves at pool surface.

   c. Close discharge isolation valve at pool surface.

Step	Action and Response	Comment or Correction

B. POOL COOLANT SYSTEM

1. Operation
   a. Operate the coolant system to maintain bulk pool temperature. Operate system at reactor power levels that exceed 100 kW. Pool temperature limit for any condition is 118°F (48°C).
   b. Control reactor core thermal convection to lessen nitrogen-16 activities at the surface by operation of pool discharge diffuser.
   c. Review coolant system function during each operation by observation of flow rates, temperature, and primary to secondary system differential pressure.

2. Startup
   a. Open suction (4" SS), pool discharge (4" SS) and pool diffuser (2½" SS) isolation valves at pool surface. Align discharge valves for diffuser mixing. Discharge valve position should be 3/4 open. Diffuser valve position should be at 1/2 open.
   b. Verify heat exchanger supply and heat exchanger return valves are open.
   c. Start pool water pump and check mechanical seal for leakage. Normal flowrate 90% on transmitter (20 lps).
   d. Verify differential pressure provides alarm indication: < 7 kpa (1 psi).
      i. Close 1/4" valve to high side of DP monitor.
      ii. Open 1/4" vent valve on high side of DP transmitter.
      iii. Observe pressure decreasing below 7 kpa (1 psi), note sound of pneumatic valve operator actuation at about 7 kpa (1 psi).
      iv. Return valves to original alignment, verify differential pressure alarm at console.
   e. Open chill and water return isolation valve to the heat exchanger.
   f. Open chill and water supply isolation valve to the heat exchanger.
   g. Start chill and water pump and check mechanical seal for leakage. Normal flowrate 1930 lpm (510 gpm).
   h. Verify differential pressure indicates nominal value: > 35 kpa (5 psi)
   i. Confirm chill water supply temperature is approximately 7°C (45°F)
   j. Observe other system instrumentation for normal status.

3. Shutdown
   a. Stop chill water pump and pool water pump.
   b. Close chill water supply isolation valve at the heat exchanger.
   c. Close chill water return isolation valve at the heat exchanger.
   d. Close suction valve at pool surface.
   e. Close pool discharge and pool diffuse valves at pool surface.

ABNORMAL CONDITIONS

Abnormal Pool Level

1. Low level - Check the following areas for evidence of leakage:
   a. Pool liner - Check pool system structure, estimate loss rate.
   b. Beam Ports - Secure covers with gaskets, close shutter control valve, close beam port argon purge valve.
   c. Purification or Coolant Piping - Stop system operation, close isolation valves at pool surface, drain pool water from pipes and return water to pool.
   d. Experiment Systems - remove and repair.

2. High Level - Check for the following causes:
   a. Makeup Overfill - Lower water level to normal level of 8.10± 0.05 meters by transfer to suitable temporary storage.
   b. Coolant/Purification System - Heat exchanger primary to secondary leak - secure pool coolant system and close pool isolation valves, close heat exchanger isolation valves, check for change of pool water conductivity, check heat exchanger system operation, correct pool level to normal level.

Purification, Coolant, or Pool System Leaks

1. Determine whether the leakage is in the purification or coolant system.

2. Identify whether the leakage is primary or secondary water.

3. Determine qualitative leak rate by relative comparison. Substantial amount compares the leak rate of a static pool from small leaks to a flowing pool from a large leak.

4. Shutdown purification or coolant system operation if leak rate creates a substantial amount of water.

5. Close isolation valves at pool surface.

6. Drain piping system into suitable container for storage or, if possible, return pool water to the pool.

7. Repair leak with acceptable materials, sealants or replacement components.

8. Review emergency plan to determine if leak condition is an emergency classification.

ORIGINAL

Step	Action and Response	Comment or Correction

Purification System

1. Low flowrate -
   a. Check pump operation and valve alignments, adjust flow control valve.
   b. Check filter differential pressure, if greater than 168 kpa (24 psi) schedule filter replacement.

2. High flowrate -
   a. Check pump operation and valve alignment.
   b. Adjust flow control valve for flow of 22-38 lpm (6-10 gpm).

3. High conductivity and nearly equivalent conductivity at both conductivity cells -
   a. Check records for slow conductivity increase indicating depletion of resin.
   b. Change resin.

4. Sudden conductivity change -
   a. Review recent operation and activities in pool.
   b. Check conductivity cell calibration or perform independent conductivity measurement.

Coolant System

1. Loss of differential pressure control -
   a. Alarm status < 14 kpad differential (2 psid) requires shutdown of coolant system unless the event is a single, infrequent transient indication.
   b. Inspect system operation for cause.
   c. Deficient control margin < 35 kpad (5 psid) should initiate check of functional performance for possible faulty operation prior to repeat system operation.

2. Loss of operation heat sink control -
   a. High temperature > 45°C (113°F) requires monitoring of pool bulk temperature to determine operation status of reactor.
   b. Check blending station nominal values and check central chilling station status.

3. Loss of primary flow -
   Shutdown coolant system operation until flow rate can be restored.

4. Loss of secondary flow -
   Shutdown coolant system operation until flow rate can be restored.

ORIGINAL

Step	Action and Response	Comment or Correction

Radioactivity Release to Water

1. Identify release type according to the following guidelines:

   a. Immediate - observable event

      i. Breakage of a material containment

      ii. Accidental drop of an object into the pool

   b. Unknown - discovery of unusual radiation levels

      i. High radiation level at pool area monitor from unknown cause (reactor on, > 20mr/hr, reactor off > 1 mr/hr)

      ii. High radiation level in water treatment area from unknown cause (portable survey > 2mr/hr at door)

   c. Persistent - indication of radioactivity release

      i. Fuel element failure

      ii. Failure of experiment or experiment facility

      iii. Source failure such as gamma irradiator component or startup element.

2. Notify supervisory operator of any material or object that drops into the pool as an uncontrollable event (immediate) and:

   a. Observe location to allow effective removal, schedule removal of the material as soon as practical,

   b. Stop reactor operation if object rests on the core grid structure or control rod devices.

   c. Identify material as solid or dispersible such as liquid or powder,

   d. Consider possible corrosion impact if material chemically reacts with aluminum, stainless steel or other reactor system materials.

ORIGINAL

Step	Action and Response	Comment or Correction

3. Stop reactor operation if <u>unknown</u> radiation levels are observable in the immediate area of the pool or water treatment areas.

   a. Shutdown operation of purification and coolant systems. Close all pool isolation valves.

   b. Review radiation levels at the particulate air monitor and gaseous argon-41 monitor.

   c. Notify supervisory reactor operator and health physicist to evaluate radiation source.

   d. Control access to pool water system areas until protective and/or corrective actions are taken.

4. Determine the cause of possible <u>persistent</u> radioactive releases by a measurement of a sample volume of the pool water.

   a. Take a 500 ml sample, allow for N^{16} decay then measure contact dose,

   b. Shutdown reactor, pool coolant and pool purification system if the sample contact dose exceeds 0.1 mr/hr or 5000 dpm.

   c. Perform alpha/beta and/or gamma spectroscopy analysis to identify source of radioactivity.

   d. Perform radiation survey; survey area includes the pool access area, pool structure stairway and water treatment room. Dose rates at the deionizer tank and heat exchanger are of particular concern.

   e. Approval by supervisory operator is required prior to restart of the water systems.

NUCLEAR ENGINEERING TEACHING LABORATORY

PROCEDURE OPER-5, REV 1

OPERATION OF AIR CONFINEMENT SYSTEM

Approvals:

Thomas L Bauer — 12/6/90
Reactor Supervisor — Date

Bernard W. Wehring — 12/7/90
Director, NETL — Date

[signature] — 12/11/90
Chairperson, Reactor Committee — Date

[signature] — 1/22/91
Chairperson, Radiation Safety Committee — Date

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Attachments: Abnormal Conditions Page 1, 2

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Step	Action and Response	Comment or Correction

I. PURPOSE

This procedure details the steps for operation, mode change, startup, shutdown, and response to abnormal conditions for the air confinement system.

II. DISCUSSION

The air confinement system is composed of the room enclosing the reactor coupled to an HVAC system and an argon purge system. The reactor room walls and weather stripped doors confine the air in the reactor bay. The HVAC system composed of fans, ducts, and heating/cooling coils, controls temperature and humidity of the air for personnel comfort. The system also maintains a negative pressure in the reactor bay with respect to adjacent spaces for leakage path control. Isolation dampers are installed in all ducts entering the reactor bay, these close automatically if a high radiation level is sensed by a particulate air monitor. Operation of the system is in either the recirculation mode for economy or in the exhaust mode providing two fresh air changes per hour for controlling the buildup of radioactive gases during extended reactor operation. The argon purge system is a separate exhaust system which can be operated to reduce the quantity of radioactivity released to the bulk air in the reactor bay. The system draws air directly from the reactor pool surface and from experimental cavities. This air is then exhausted through a high efficiency particulate air (HEPA) filter to the exterior of the building. An Argon 41 monitor samples, displays, and records the radioactivity levels of the argon purge system exhaust. Visual, audible and remote alarms indicate abnormal levels of radioactivity in either the particulate air monitor or gaseous argon-41 monitor.

III. REFERENCE

1. Docket 50-602 SAR
2. Startup Checklist
3. Air Confinement System, Surveillance Procedure SURV-5.

IV. CONTENTS

V. PROCEDURE

1. Verify reactor room air particulate monitor and argon-41 gaseous activity monitor are operating.

2. Verify HVAC automatic isolation feature was functional during the last system surveillance.

3. Operate the HVAC system in the REACTOR ON or OFF mode per Reactor Room HVAC procedures (Section A) to control room air dilution rates and radioactivity. HVAC system operation in REACTOR OFF mode recirculates reactor bay air, REACTOR ON mode operation exhausts reactor bay air and supplies fresh air.

4. Operate the argon purge system per Argon Purge System procedures (Section B) to exhaust argon-41 from above the reactor pool surface and experimental cavities.

5. Monitor operating confinement system's performance. Refer to instructions in Attachment for response to abnormal conditions. Determine the cause of abnormal conditions and implement corrective or maintenance actions for conditions. Conditions that substantially affect performance are of two types. One is the isolation function of the system for air confinement. The other type is the control of pressure differences (>0.04 inches) between the reactor room and adjacent areas. Report abnormal conditions to a supervisory operator.

Step	Action and Response	Comment or Correction

A. REACTOR ROOM HVAC SYSTEM

1. Operation

a. Determine HVAC system mode required. During reactor operation the HVAC system mode should normally be switched to REACTOR ON mode. The HVAC system may be operated in the REACTOR OFF mode during reactor operation only if: the argon purge system is operating, or reactor operation is at low power (< 20kW), or operation is only for a short duration (< 1hr).

b. Operate HVAC system for confinement of room air from the control room panel (CRP). Automatic operation of HVAC duct isolation dampers and shutdown of HVAC fans is necessary for reactor operation. Isolation is initiated by an automatic trip signal (setpoint 10,000 cpm) from the particulate air monitor or by manual shutdown.

c. Check readings on air particulate monitor. Mark reactor run #, date, startup and shutdown on chart record.

d. Monitor system operation and room confinement control by review of status lights on the CRP for area differential pressures and exhaust velocity.

2. Mode Change - REACTOR OFF to ON

a. Turn REACTOR FAN SYSTEM switch to REACTOR ON.

b. Verify REACTOR MODE ON lamp illuminates.

c. Verify SUPPLY FAN ON and RETURN FAN ON lamps illuminate.

d. Verify ROOM EXHAUST VELOCITY status lamp is green.

e. Check NORMAL status on all area pressure monitors.

3. Mode Change - REACTOR ON to OFF

a. Turn REACTOR FAN SYSTEM switch to REACTOR OFF.

b. Verify REACTOR MODE OFF lamp illuminates.

c. Verify SUPPLY FAN ON and RETURN FAN ON lamps illuminate.

ORIGINAL

Step	Action and Response	Comment or Correction

B. ARGON PURGE SYSTEM

1. Operation

   a. Startup Argon Purge System to control the amounts of inert gaseous activity of argon-41 in areas within the reactor room. This system must operate if the reactor is operating and the HVAC system is not in the Reactor On mode. Annual continuous average release limit is $2x10^{-6}\mu Ci/cm^3$ (continuous 300 cpm on argon-41 CAM). Maintain record of release activities for calculation of total periodic release.

      A manual room air dilution valve in its normal fully open position provides 100% dilution of the purge exhaust air humidity prior to entering the HEPA filter bank.

   b. Check alignment of POOL SURFACE PURGE and BEAM PORT PURGE valves. Suction from the pool surface controls argon-41 release to the reactor bay airspace. Suction from the beam port manifold is for controlling the release of argon-41 from open beamports on other air cavity type experiments.

   c. Check readings on argon-41 monitor at startup and shutdown of the reactor. Mark reactor run #, date, startup shutdown on chart record.

   d. Monitor system operation by review of status lights and radioactivity levels.

2. Startup

   a. Align manual valve on beamport purge manifold as required for current experimental setup. Pool deck covers should be down.
   b. Turn ARGON PURGE FAN switch to AUTO (ON) position.
   c. Verify PURGE FAN ON lamp illuminates.
   d. Turn POOL SURFACE PURGE valve control switch to ON position for control of argon-41 at the pool surface.
   e. Turn BEAMPORT PURGE valve control switch to ON position for control of argon-41 at the beam ports or experiment cavities.
   f. Verify PURGE EXHAUST VELOCITY status lamp is green.
   g. Verify PURGE PREFILTER and HEPA HI DP status are green.

3. Shutdown

   a. Turn ARGON PURGE FAN switch to OFF.
   b. Verify PURGE FAN ON lamp extinguishes.
   c. Turn POOL SURFACE PURGE valve control switches to OFF position.
   d. Turn BEAMPORT Purge valve control switch to OFF position.

ABNORMAL CONDITIONS

1. High Airborne Radioactivity Level

   > 10,000 cpm air particulate monitor
   > 10,000 cpm argon-41 gaseous monitor.

   a. Perform emergency shutdown of HVAC system:

      i. Move the HVAC ISOLATION switch to ISOLATE.
      ii. Verify SUPPLY DAMPER and RETURN DAMPER indicate CLOSED.
      iii. Turn REACTOR FAN SYSTEM SWITCH to REACTOR OFF.
      iv. Verify SUPPLY FAN ON and RETURN FAN ON lamps extinguish.
      v. Refer to surveillance procedure for system startup from ISOLATE condition.

   b. Perform emergency shutdown of Argon Purge System by following the normal shutdown procedure.

   c. Push the EMERGENCY ALARM switch on Control Room Panel to initiate evacuation of reactor room area if any personnel hazards exist in the reactor area.

   d. Replace ~~Change~~ filters on the CAM's with new filters.

   e. Notify HP of conditions and give the CAM filters to HP for verification of High Airborne condition.

   f. Determine the isotopic composition by analysis of the CAM's filters. Do not restart HVAC or Argon purge until isotopic analysis is complete. Determine operation requirements and procedures if an airborne radioactivity emergency occurs. Procedures for recovery or release of any airborne radioactivity other than argon-41 require the approval of the Supervisory Reactor Operator and Radiation Safety Officer.

   g. Review emergency plan to determine if leak condition is an emergency classification. Implement emergency procedures, if applicable, according to the requirements of the emergency plan. In general, isolation of the room will be sufficient, but the plan may require notifications, and determinations of release rates, release quantities and identities of radionuclides.

Step	Action and Response	Comment or Correction

2. HVAC System
HVAC system failure during reactor operation is permitted provided room confinement dampers remain operational and airborne radioactivity concentrations remain within limits. (Maximum $3x10^{-9}$ $\mu Ci/cm^3$ = 10,000 cpm on air particulate monitor in laboratory).

   a. Press LOCAL ALARM SILENCE pushbutton to silence alarm.

   b. ROOM EXHAUST VELOCITY - Yellow Status -
   Open control panel cover, check EXHAUST VELOCITY on manometer.
   Normal indication: 1700 fpm at pitot tube probe.
   Check for blockage or damage to pressure sensor lines.

   c. Area HI or LO DP - alarm status -
   Check for open doors.
   Open control panel cover.
   Check area differential pressure on manometer.
   Normal Pressure:
   i. Reactor area W.R.T. outside: -0.06" w.c. (Rx OFF MODE)
   -0.06" w.c. (Rx ON MODE)
   ii. Support Areas W.R.T. Reactor Area: +0.06" w.c.
   iii. Academic Areas W.R.T. Reactor Area: +0.125" w.c.
   Check for control system or component failures.

   d. Contact University Physical Plant for repair and alignment of system fans, control equipment, or other components.

3. Argon Purge System
Argon Purge System failure requires operation of HVAC in reactor ON mode. Initiate measures to return system function to normal.

   a. Press LOCAL ALARM SILENCE pushbutton to silence alarm.

   b. PURGE EXHAUST VELOCITY - Yellow Status -
   Open control panel cover.
   Check EXHAUST VELOCITY on manometer with sensor line valve set to ARGON PURGE position.
   Normal indication: 3800 fpm at pitot tube probe.
   Check for blockage or damage to pressure sensor line.

   c. PURGE PREFILTER or HEPA HI DP - Yellow Status -
   Check filter differential pressure manometers at filter housing for filter media particulate clogging.
   Nominal differential pressures:
   i. 95% Prefilter clean: 0.45" w.c. dirty: 0.9" w.c.
   ii. HEPA clean: 0.50" w.c. dirty: 1.5" w.c.
   Change filters as per surveillance procedures.

NUCLEAR ENGINEERING TEACHING LABORATORY

OPER-6, REV. 0

REACTOR BAY SYSTEMS

Approvals:

Thomas L. Bauer — 1/24/92
Reactor Supervisor — Date

Bernard W. Wehring — 1/24/92
Director, NETL — Date

[signature] — 1/24/92
Chairperson, Nuclear Reactor Committee — Date

List of Pages: 1 2 3 4 5

Attachments: Maintenance Log (Key Systems)
Bridge Crane Load Test

BALCONES RESEARCH CENTER
THE UNIVERSITY OF TEXAS AT AUSTIN

Record of Procedure Changes

Page	*Date	*Initial	*Change
	*	*	* ADD
1/1	* 3/96	* MK	* NEW
	*	*	*
	*	*	* DATA
	*	*	*
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Number	Title	Rev 0
SURV-6	Control Rod Calibration	Date 3/96

Rod Drop/Withdrawal Data

Rod Drop Time: (less than 1 second)

Rod	Time(sec)	Check
Transient	______	____ok
Shim 1	______	____ok
Shim 2	______	____ok
Regulating	______	____ok

Maximum Reactivity Insertion Rate: (less than 0.2 % dk/k/sec)

Rod	Withdrawal Time(sec)	Differential Worth(c/unit)	Insertion Rate(%dk/k/sec)
Transient	______	______	______
Shim 1	______	______	______
Shim 2	______	______	______
Reg	______	______	______

Comments:

Date ___/___/___ Accepted ____________
SRO

Control Rod Operable

Page 1 of 1

Step	Action and Response	Comment or Correction

I. PURPOSE

Several key building systems are either necessary for reactor operation or represent a potential hazard to safe operation. This procedure identifies key systems and operation constraints, but should be operable at all other times.

II. DESCRIPTION

Key systems such as the security or access control system must be operable at all times. Other systems such as the communication system must be operable for reactor operation, but should be operable at all other times.

Operability checks and Maintenance logs record the condition or modification of <u>Key</u> systems. These logs supplement the requirements of Surveillance and Maintenance Procedures.

The 5 ton lifting capacity of the bridge crane has the potential to seriously injure personnel and damage equipment. Proper operation and understanding of the consequences is necessary to assure safe, effective and reliable use of the crane system.

III.REFERENCES

OPER-4; Operation of Pool Water Systems
OPER-5; Air Confinement System Operation
Instruction Manual; Reactor Bay Bridge Crane Operation
Service Manual; KRANCO Overhead Cranes
Load Capacity Test Data

IV. EQUIPMENT

Mechanical Equipment
Electrical Equipment
Communications
Bridge Crane
Radwaste system
Water demineralizer
Area and Air Radiation Monitors
Area video surveillance
Air confinement system
Pool water systems

Step	Action and Response	Comment or Correction

V. INSTRUCTIONS

A. Building utilities such as electric power, chilled water, compressed air, and other utilities should be functional at all times.

Safety systems for emergency light, fire protection, physical security and communication shall be functional at all times unless special provisions are in effect.

B. Check for normal operational status of each system. In the event that key equipment does not perform properly do the following:

1. Report conditions that are not normal.

2. Tag components that are not functional.

3. Classify component as inoperable or defective.

4. Record date, problem and status on each tag.

5. Remove tag only after correction of the problem. If applicable, record corrective action in maintenance log.

C. A maintenance log will document repairs and modifications to key systems. These systems include the TRIGA ICS, Radiation Monitors, Pool Water System and Room Confinement System. Use a Maintenance Log Sheet.

D. Operation of the reactor and other special conditions will require:

1. Physical security system shall be continuously operable or appropriate steps taken to provide adequate protection of control access area. Documentation of physical security requirements is not a requirement of this procedure.

2. Communications via phone lines to off site locations shall be available and must be operable for any reactor operation.

3. Video camera system should be operable in areas where experiments and personnel are active.

4. Air confinement system and pool water systems must be operable for reactor operation (see reference for OPER-4 and OPER-5). Documentation of Operating conditions for these systems are in OPER-1 startup checks and OPER-4 and OPER-5.

Step	Action and Response	Comment or Correction

E. Reactor Bay Bridge Crane Operation

1. Check date and lift capacity of last load test. Load tests shall test capacity at 125% of load. The load test includes test of crane, cable, hook and load rigging. Identify the rigging components and, the test object and weight.

   a. Load lifts less than one ton will require verification of previous load test date and capacity.

   b. Load lifts greater than one ton will require execution of appropriate load test within previous two years.

   c. Loads of less than one ton should not be lifted more than 5 feet above the floor except at lift terminal points.

   d. Loads greater than one ton shall not be lifted more than 5 feet above the floor except at lift terminal points.

   e. No suspended load more than 5 feet above the floor shall be unattended.

   f. Storage location of crane should be:
      Direction of bridge: South
      Direction of trolley: West
      Level of hook: Four

2. Any person operating the crane shall require training equivalent to the information in the Instruction Manual.

   a. The key to the control pendant or power to the crane are to be available only during periods in which the crane is in use.

   b. Review and approval by the facility supervisor shall be required for load lifts over the reactor shield structure.

   c. No loads shall be lifted above the reactor shield structure during operation of the reactor.

   d. All personnel are to avoid performing activities directly beneath a suspended load.

   e. No loads should be suspended directly above other facility equipment.

Step	Action and Response	Comment or Correction

3. Review caution information at crane controls.

4. Review functional operation of crane controls.

5. Switch control pendant key to ON position. Check power to crane bridge if control pendant switches do not operate.

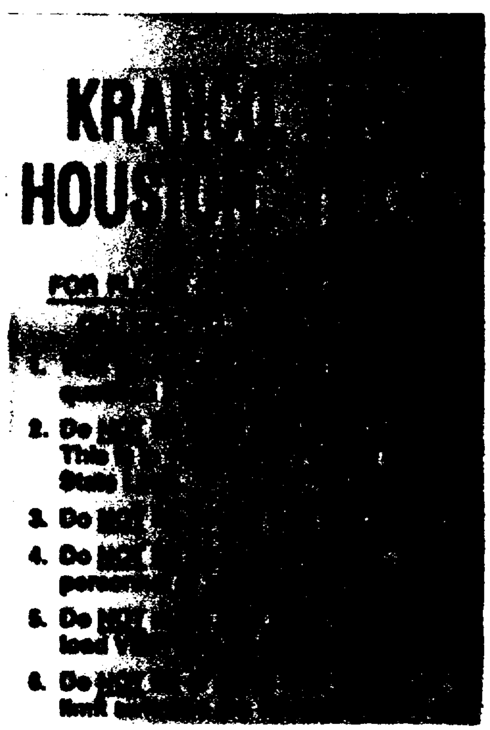
6. Move bridge, trolley, and hook to lifting position.

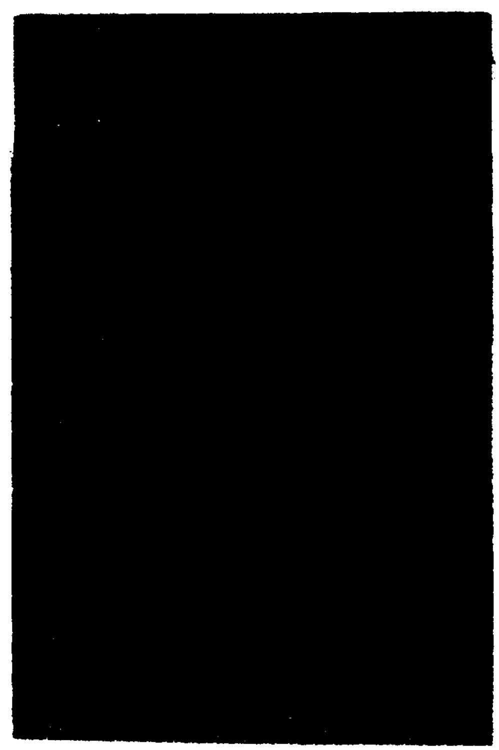
7. Load rigging shall be checked for alignment and binding as lift tension is applied.

8. Motion of load should be controlled to avoid collisions with other facility structures or equipment.

9. Move bridge, trolley, and hook to storage position.

10. Switch control pendant key to OFF position. Secure control pendant key. The control box can shutoff all power to the bridge crane system.





Action and Response — Comment or Correction

Review caution information at crane controls.

Review functional operation of crane controls.

Switch control pendant key to ON position. Check power to crane bridge if control pendant switches do not operate.

Move bridge, trolley, and hook to lifting position.

Load rigging shall be checked for alignment and binding as lift tension is applied.

Motion of load should be controlled to avoid collisions with other facility structures or equipment.

Move bridge, trolley, and hook to storage position.

Switch control pendant key to OFF position. Secure control pendant key. The control box can shutoff all power to the bridge crane system.

KRANCO, INC.
HOUSTON, TEXAS

FOR FLOOR OPERATED CRANES

CAUTION TO AVOID INJURY

1. This equipment shall be operated by qualified personnel only.
2. Do NOT lift more than rated load. This is in violation of Federal and State Laws.
3. Do NOT lift people with this crane.
4. Do NOT lift loads over people. WARN personnel of approaching loads.
5. Do NOT make side pulls. LIFT all load VERTICALLY.
6. Do NOT lift or move load unless all limit switches are operating correctly.
7. Do NOT use hoist limit switches as routine operating stops. These are safety devices only.
8. Do NOT operate with twisted, kinked or damaged rope, or rope not in drum or sheave grooves.
9. Do NOT lift or move load unless hook travel is same as direction shown on control.
10. Do NOT leave a load suspended while crane is unattended.
11. Do NOT operate crane with personnel on service platform.
12. Depress OFF or STOP button when crane is not in use.
13. Do NOT operate malfunctioning equipment. Report condition for REPAIR by qualified personnel.
14. READ: Manufacturer's instructions furnished with crane, applicable American National Safety Standards and OSHA rules.
15. Do NOT remove, deface, or obscure this label.

Number	Title	Rev. 0
OPER-6	Reactor Bay Systems	Date 9/91

Monthly Operability Checks

Security System

Sense Point	Integrity OK	CSC Status OK	Keypad Status OK	Intrusion Detection
3.200	______	______		______
3.2S3/3.210	____/____		____/____	______
3.206	______	______		______
2.204	______	______		______
1.104	______	______		______
Motion	____/____		____/____	______
Equip Door	____/____	____/____	____/____	

Comments:

Date: ____/____/____ By: ______________

Number	Title	Rev. 0
OPER-6	Reactor Bay Systems	Date 9/91

Maintenance Log

TRIGA ICS System ___ Pool Water Systems ___
Radiation Monitors ___ Room Confinement System ___ Page _____

Date ___/___/___

Unit ______________ Component ______________

Problem:

Repair:

Successful test
Initials: _______

adjustment only ___

Date ___/___/___

Unit ______________ Component ______________

Problem:

Repair:

Successful test
Initials: _______

adjustment only ___

Date ___/___/___

Unit ______________ Component ______________

Problem:

Repair:

Successful test
Initials: _______

adjustment only ___

Date ___/___/___

Unit ______________ Component ______________

Problem:

Repair:

Successful test
Initials: _______

adjustment only ___

ORIGINAL

Number	Title	Rev. 0
OPER-6	Reactor Bay Systems	Date 9/91

DATE	TEST COMPONENTS Crane, Cable & hook Rigging Components	TEST ITEM Object Weight	Initial	COMMENTS

INSTRUCTION MANUAL

REACTOR BAY BRIDGE CRANE OPERATION

Nuclear Engineering Teaching Laboratory

Balcones Research Center

The University of Texas at Austin

Foreword

This booklet has been prepared as an information and instruction manual so the Crane Operator may know how careful and thoughtful actions can protect personnel in the area and how careless operation or not following these rules can result in serious accidents.

Overhead cranes generally handle materials over working areas where personnel can be seriously injured and equipment heavily damaged if the crane is not safely and properly operated. It is therefore important that the operator be carefully instructed in the use of the crane and understand the severe consequences of careless operation.

It is not intended that these suggestions take precedence over existing plant safety rules and regulations, OSHA regulations, or instructions issued by the Crane Manufacturer.

A thorough study of the following information will give a better understanding of safe operation and provide a greater margin of safety for people and machinery on the floor. It should be clearly understood however, that under no circumstances does the Crane Manufacturers Association of America, Inc. assume any liability for the use of these suggestions.

It must be recognized that this is a condensed manual for crane operator's use. It is the responsibility of the owner to make personnel aware of all federal, state and local rules and codes, and to make certain operators are properly trained.

Introductory

QUALIFICATIONS

Crane operation, to be safe and efficient, requires skill, the exercise of extreme care and good judgment, alertness and concentration, and a rigid adherence to proven safety rules and practices.

In general practice, no person should be permitted to operate a crane:

(a) Who cannot speak the appropriate language or read and understand the printed instructions

(b) Who is not of legal age to operate this type of equipment

(c) Whose hearing or eyesight is impaired (unless suitably corrected — with good depth perception)

(d) Who may be suffering from heart or other ailments which might interfere with the operator's safe performance

(e) Unless the operator has been properly instructed

(f) Unless the operator has demonstrated his instructions through practical operation, and has a thorough knowledge of this book

(g) Unless the operator is familiar with hitching equipment and practices

(h) Unless the operator becomes completely familiar with applicable ANSI standards and current safety requirements of the Occupational Safety and Health Act (OSHA)

OPERATION

Before operating the crane the crane operator should carefully read and study the operation manual supplied with the crane by the crane manufacturer and note any special instructions not given previously by the proper instructor or supervisor.

Cranes may be either floor-controlled or cab-controlled depending upon the point from which the crane is operated.

With the mainline switch open (power off) the crane operator should operate each master switch or pushbutton in both directions so as to get the "feel" of each device and also determine that they do not bind or stick in any position. If any of them do, before doing anything else, the operator should report the condition to the proper supervisor.

Learning the Controls

Having observed the feel of the controllers, the crane operator is now ready to try the crane with power applied.

After checking to be sure no one is on or near the crane, close the crane disconnecting means and press the "on" or "reset" button so that power is "on".

Try the hoisting motion first. The hook should be in an intermediate position. Move the master or pushbutton slowly in the "up" direction or press the "up" button in the pendant in the same manner. The resultant movement should correspond with master switch or pushbutton markings for all motions. Observe the speed increase in relation to the steps in the controller. Try to feel the steps in a pendant type controller. Move the hook to a position *near* the upper hook position and slowly inch the hook into the upper limit stop position. The limit switch should cause the hoisting motion to stop at the upper limit of travel. If any malfunction of either the hoist brake or the limit switch is suspected, this condition should be reported to the supervisor before proceeding. The hoist limit switch should never be used as an operating control for stopping the load. It is to be considered as an emergency limit switch only.

Repeat this procedure with the trolley controller. If the trolley is not equipped with a brake, note how it can be stopped by momentarily operating the control in the first point of the reverse direction. This is known as "plugging". Next try the bridge motion, first making sure that the first movement is in the direction the bridge is free to travel. Check the stopping of the bridge by means of the brake and by plugging.

GOOD operators always remember and follow four simple rules:

1. Start all motions slowly, by moving the controller handle or pushbutton step by step until the fastest safe speed is reached.
2. Stop slowly, by bringing the master switch or pushbutton to the "off" position step by step so as to minimize "swinging" of the load, and unnecessary wear of the brakes.
3. Learn to judge the drift of each motion of the crane after power is removed. Proper use of this drift will facilitate spotting of the load, and minimize wear of crane components.
4. Handle the load in a safe manner with the area free of personnel and other obstructions.

HANDLING THE BRIDGE TRAVEL MOTION

Before using the trolley or bridge of the crane, be sure the hook is high enough in the air to clear any obstruction or person below. Before a load is handled by the crane, the bridge should be brought in position so that it is directly over the load. Otherwise it will be impossible to "spot" the trolley and hoist hook over the load.

In addition to other operating controls, the bridge has a brake, usually operated by a foot pedal in the cab or an electric brake where pushbutton floor control is used. The purpose of this brake is to permit stopping the bridge exactly where desired. After the operator has learned the distance that the bridge travels after power is removed, the operator will be able to judge distances so that the need to use the bridge brake will be greatly reduced. On floor controlled cranes, the electric brake will set automatically when the pushbutton is released.

Start the bridge slowly and bring it up to speed gradually. Approaching the place where it is desired to stop the bridge, reduce the bridge speed. If the operator finds that the crane is going to "over-run" the point where the bridge is to be stopped, apply the bridge brake. If extra fine control or creeping speed is not provided, follow the practice of "inching", namely: move the controller handle or button on and off the point that produces a minimum of motion. This practice should be followed only as necessary because it causes extra wear on the controller contacts and the electric brake. Skidding of wheels when stopping will result in flat spots on the wheels and rough bridge action.

HANDLING THE TROLLEY TRAVEL MOTION

Before a load is handled, the trolley should be brought directly over the load that is to be handled. When the slack is taken out of the slings, if the trolley is not exactly over the load, bring it exactly over the load before hoisting is continued. Otherwise the load will start swinging.

If the trolley is equipped with a brake, follow the instruction given for controlling the bridge.

If the trolley is not equipped with a brake, this motion may require more skillful handling than any other motion of the crane. As the operator becomes familiar with the crane he can gauge the amount of "drift" and allow for it. This will eliminate the necessity of quickly reversing power to the trolley motor to bring the trolley to a stop.

Always start the trolley motion slowly and reduce the trolley speed gradually. For very slight trolley movements, follow the practice of "inching" as described in "Handling the Bridge Travel Motion."

HANDLING THE HOIST MOTION

After the hook has been brought over the load, lower it until the load can be attached to hook. As the hook approaches this level, reduce the speed so that the lowering can be stopped smoothly and quickly.

If load slings are used to handle the load, the slings should be fully seated in the saddle of the hook, the hook should be started upward slowly until all slack has been taken out of the slings, then the load should be lifted slowly until it is clear and it has been determined that the load is properly balanced and the slings properly placed. The hoisting speed may then be increased and maintained until the load is clear of all obstructions or if a hitcher gives the signal to stop.

When lowering loads, the lowering speeds should be gradually decreased until the load is near the place where it is to be stopped. If a hitcher is used it is very important that the operator pay particular attention to the directions of the hitcher. When the operator is signaled to continue lowering, it should be done at the slowest possible speed. If extra fine control is not provided, final spotting should be accomplished by following the practice of "inching" described in "Handling the Bridge Travel Motion."

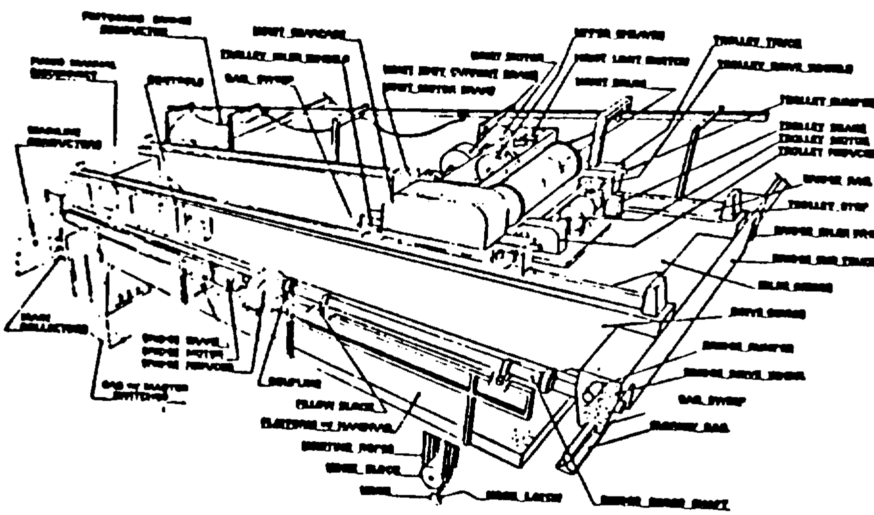
When it is necessary that loads be raised or lowered extremely short distances, particularly when raising loads off the floor or out of machine tools or fixtures, the practice of "inching" may be followed if extra fine control is not provided. *Note:* A good operator always minimizes the number of inching operations.

The operator should check the hoist brake by raising the load a short distance and stopping. If the hoist brake allows excessive drift or does not hold, set the load on the floor and report the defect immediately to the Supervisor.

General Rules

KNOW YOUR CRANE

Crane operators, particularly of cab operated cranes, should be familiar with the principal parts of a crane and have a thorough knowledge of crane control functions and movements. (See Figure 1)



TYPICAL CRANE COMPONENTS

Figure 1 — Bridge Crane

Both the crane operator and the person hitching (or rigging) the load should be required to know the location and proper operation of the main runway conductor disconnecting means for all cranes in the area.

RESPONSIBILITY

Each crane operator should be held directly responsible for the safe operation of the crane. Whenever there is any doubt as to SAFETY, the crane operator should stop the crane and refuse to handle loads until (1) safety has been assured or (2) has been ordered to proceed by the Supervisor, who then assumes all responsibility for the SAFETY of the lift.

Do not permit ANYONE to ride on the hook or a load.

DON'T ARGUE

Cab controlled crane operators should never argue with personnel on the floor. The crane operator's job requires close cooperation with the hitcher.

All disagreements concerning crane operation should be called to the attention of the Supervisor.

ENTERING A CRANE (CAB OPERATED CRANES)

Crane operators should enter and leave cranes only at designated places using the platform, steps or ladder provided — unless otherwise authorized by the Supervisor.

Both hands should be used when ascending or descending a crane ladder. Keep hands free. A handline should be used for lifting or lowering material, tools, lunch buckets, etc. Operators should fasten handlines securely to the crane or building structure, not to themselves.

HOUSEKEEPING

Good housekeeping must be maintained at all times. The crane operator is expected to keep the crane cab and access clear and clean.

Do not permit loose objects such as tools, bolts, boards, etc. around the cab or on the crane for they are a safety hazard.

INSPECTION

Test all controls on the crane at the beginning of each shift. Be sure the limit switches, brakes, ropes, hooks and other protective devices are in good working order. Check crane for proper functioning of all controls, and check for loose or damaged parts.

Whenever the operator finds anything wrong or apparently wrong, the problem should be reported immediately to the proper Supervisor.

SIGNALS

Standard crane signals (See Figure 2) should be accepted only from ONE authorized person — except where it is apparent that to do so would result in an accident.

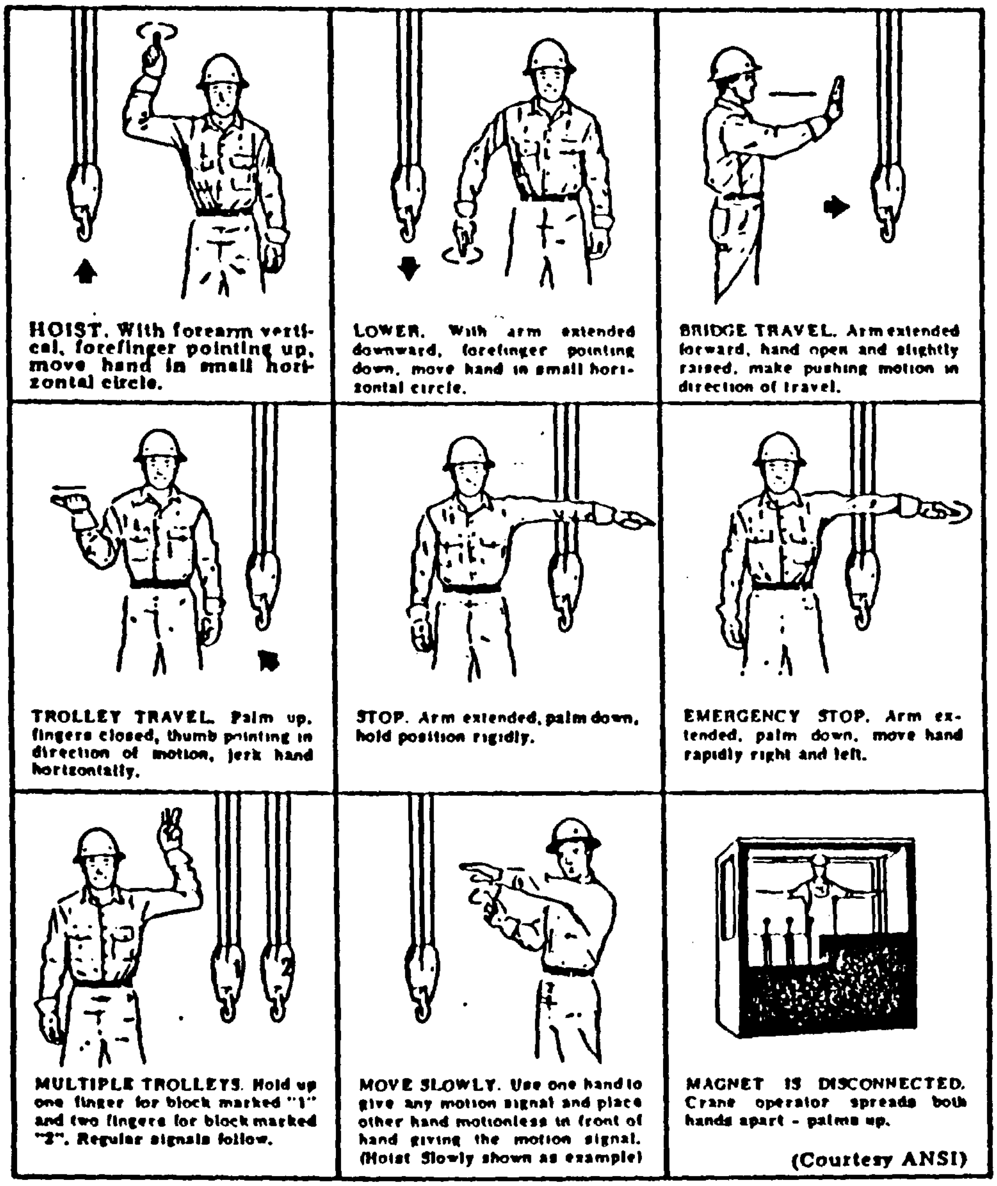
Obey a STOP signal at all times, no matter who gives it.

Loads should not be moved unless the standard crane signals are clearly given, seen and understood.

Unusual signals are seldom required, but if used they should be thoroughly understood by the crane operator and authorized person giving signal.

Standard Hand Signals

OPERATOR SHOULD WEAR PROPER SAFETY CLOTHING



HOIST. With forearm vertical, forefinger pointing up, move hand in small horizontal circle.

LOWER. With arm extended downward, forefinger pointing down, move hand in small horizontal circle.

BRIDGE TRAVEL. Arm extended forward, hand open and slightly raised, make pushing motion in direction of travel.

TROLLEY TRAVEL. Palm up, fingers closed, thumb pointing in direction of motion, jerk hand horizontally.

STOP. Arm extended, palm down, hold position rigidly.

EMERGENCY STOP. Arm extended, palm down, move hand rapidly right and left.

MULTIPLE TROLLEYS. Hold up one finger for block marked "1" and two fingers for block marked "2". Regular signals follow.

MOVE SLOWLY. Use one hand to give any motion signal and place other hand motionless in front of hand giving the motion signal. (Hoist Slowly shown as example)

MAGNET IS DISCONNECTED. Crane operator spreads both hands apart - palms up.

(Courtesy ANSI)

Figure 2

STAY ALERT

The crane operator should keep hands on the handles of the controller or master switches which control the motions in operation so stops can be made quickly in case of an emergency. Stand up, when necessary to improve vision, when making a lift or when moving a load in any direction. Be especially alert for any unusual sounds or warnings. Danger may be present that the crane operator cannot see.

Operating Rules

One measure of a good crane operator is the smoothness of operation of the crane. Jumpy and jerky operation, flying starts, quick reversals and sudden stops are the "trademarks" of the careless operator. The good operator knows and follows these tried and tested rules for safe, efficient crane handling.

1. Crane controls should be moved smoothly and gradually to avoid abrupt, jerky movements of the load. Slack must be removed from the sling and hoisting ropes before the load is lifted.

2. Center the crane over the load before starting the hoist to avoid swinging the load as the lift is started. Loads should not be swung by the crane to reach areas not under the crane.

3. Crane hoisting ropes should be kept vertical. Cranes shall not be used for side pulls.

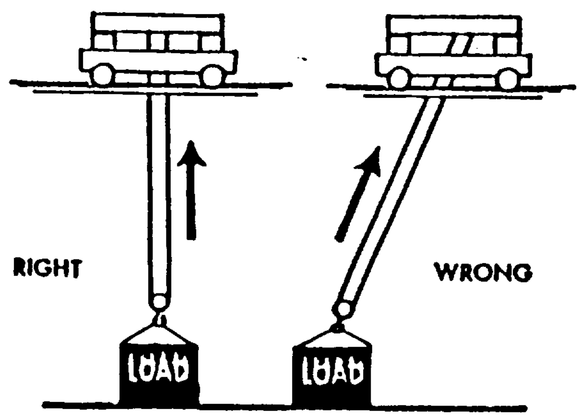


Figure 3 — Center Crane Over Load Before Lifting

4. Never lower the block below the point where less than two full wraps of rope remain on the hoisting drum. Should all the rope be unwound from the drum, be sure it is rewound in the correct direction and seated properly in the drum grooves or otherwise the rope will be damaged and the hoist limit switch will not operate to stop the hoist in the high position.

5. Be sure everyone in the immediate area is clear of the load and aware that a load is being moved. Sound the warning device (if provided) when raising, lowering or moving loads wherever people are working to make them aware that a load is being moved.

6. Do not make lifts beyond the rated load capacity of the crane, sling chains, rope slings, etc.

7. Do not operate the crane if limit switches are out of order or if ropes show defects, or wear.

8. Make certain that before moving the load, load slings, load chains, or other load lifting devices are fully seated in the saddle of the hook.

9. When a duplex hook (double saddle hook) is used, a double sling or choker should be used to assure that the load is equally divided over both saddles of the hook.

10. On all capacity or near capacity loads, the hoist brakes should be tested by returning the master switch or pushbutton to the OFF position after raising the load a few inches off the floor.

If the hoist brakes do not hold, set the load on the floor and do not operate the crane. Report the defect immediately to the Supervisor.

11. Check to be sure that the load is lifted high enough to clear all obstructions and personnel when moving bridge or trolley.

12. At no time should a load be left suspended from the crane unless the operator is at the master switches or pushbutton with the power on, and under this condition keep the load as close as possible to the floor to minimize the possibility of an injury if the load should drop. When the crane is holding a load, the crane operator should remain at the master switch or pushbutton.

13. When a hitcher is used, it is the joint responsibility of the crane operator and the hitcher to see that hitches are secure and that all loose material has been removed from the load before starting a lift.

14. Do not lift loads with any sling hooks hanging loose. (If all sling hooks are not needed, they should be properly stored or use a different sling.)

15. All slings or cables should be removed from the crane hooks when not in use. (Dangling cables or hooks hung in sling rings can inadvertently snag other objects when the crane is moving.)

16. Crane operators should not use limit switches to stop the hoist under normal operating conditions. (These are emergency devices and are not to be used as operating controls.)

17. Do not block, adjust or disconnect limit switches in order to go higher than the switch will allow.

18. Upper limit switches (and lower limit switches, when provided) should be tested in stopping the hoist at the beginning of each shift, or as frequently as otherwise directed.

19. Never move loads carried by magnets or vacuum devices over anyone. Loads, or parts of loads, held magnetically may drop. Failure of power to magnets or vacuum devices will result in dropping the load unless a backup power supply is furnished.

20. Molten metal shall never be carried over people.

21. If the electric power goes off, place your controllers in the "OFF" position and keep them there until power is again available.

22. Before closing main or emergency switches, be sure that all controllers are in "OFF" position so that the crane will not start unexpectedly.

23. If plugging protection is not provided always stop the controllers momentarily in the "OFF" position before reversing — except to avoid accidents.

(The slight pause is necessary to give the braking mechanism time to operate.)

24. Whenever the operator leaves the crane this procedure should be followed:

(a) Raise all hooks to an intermediate position.

(b) Spot the crane at an approved designated location.

(c) Place all controls in the "OFF" position.

(d) Open the main switch to the "OFF" position.

(e) Make visual check before leaving the crane.

Note: On yard cranes (cranes on outside runways), operators should set the brake and anchor securely so the crane will not be moved by the wind.

25. When two or more cranes are used in making one lift, it is very important that the crane operators take signals from only one designated person.

26. Never attempt to close a switch that has an "OUT OF ORDER" or "DO NOT OPERATE" card on it. Even when a crane operator has placed the card, it is necessary to make a careful check to determine that no one else is working on the crane, before removing the card.

27. In case of emergency or during inspection, repairing, cleaning or lubricating, a warning sign or signal should be displayed and the main switch should be locked in the "OFF" position. This should be done whether the work is being done by the crane operator or by others. On cab operated cranes when others are doing the work, the crane operator should remain in the crane cab unless otherwise instructed by the Supervisor.

28. Never move or bump another crane that has a warning sign or signal displayed.

Contacts with runway stops or other cranes shall be made with extreme caution. The operator shall do so with particular care for the safety of persons on or below the crane, and only after making certain that any persons on the other cranes are aware of what is being done.

29. Do not change fuse sizes. Do not attempt to repair electrical apparatus or to make other major repairs on the crane unless specific authorization has been received.

30. Never bypass any electrical limit switches or warning devices.

31. Load limit or overload devices shall not be used to measure loads being lifted. This is an emergency device and is not to be used as a production operating control.

NUCLEAR ENGINEERING TEACHING LABORATORY

FUEL-1, REV. 0

PROCEDURE FOR MOVEMENT
OF FUEL ELEMENTS OR CONTROL FOLLOWERS

Approvals:

Thomas L. Bauer — 7/30/91
Reactor Supervisor — Date

Bernard W. Wehring — 7/30/91
Director, NETL — Date

[signature] — 7/30/91
Chairperson, Reactor Committee — Date

[signature] — 7/30/91
Chairperson,
Radiation Safety Committee — Date

List of Pages: 1 2 3 4

Attachments: Fuel Element Log Sheet
Reactor Core Configuration

BALCONES RESEARCH CENTER
THE UNIVERSITY OF TEXAS AT AUSTIN

ORIGINAL

I. PURPOSE

The instructions of this procedure are to control the movement of reactor fuel components within the reactor core grid structure.

II. DESCRIPTION

Reactivity changes occur as fuel is added or removed from the reactor core. To assure adequate safety margins for the proper performance of the control rod system, procedural controls define the requirements and limitations for fuel movement within the reactor core. These rules include changing the arrangement of fuel components as well as fuel additions or deletions.

III. REFERENCES

IV. MATERIALS

Fuel Element Tool

Radiation Work Permit (RWP) - A RWP is required for this procedure only if fuel is to be moved outside of the reactor pool access area.

V. PROCEDURE:

1. A senior reactor operator shall supervise all movements of fuel within the reactor bay. At least one person should be available to assist with the handling of the fuel elements.

2. Verify that the pool area Radiation Monitor and air particulate or substitute monitor are operational and functioning. A gamma sensitive survey instrument shall be present and operating in the area where the fuel movement will occur. A RWP is necessary to move fuel beyond the immediate vicinity of the reactor pool access area.

3. Operate and monitor the reactor console during the movement of fuel into or out of the reactor core grid structure:
   a. Movement of an instrument element requires disconnect and reconnect of instrument connections with a functional test prior to reactor operation.
   b. Movement of control follower requires a minimum shutdown margin greater than 0.2% $\Delta k/k$ with removal of two most reactive control rods.
   c. Prevent movement of any control rod drive by removing the neutron source. Place console in the Manual Mode. Verify no rod will withdraw..
   d. A log of any event will be available as part of the ICS system electronic logging process. Save the record as for regular operation.

4. Approve by inspection and test any device other than the fuel handling tool prior to use for movement of fuel. Handle the instrument elements with the extension tubes. Handle control followers with the extension rods.

5. Test fuel handling tool on non-fuel element prior to use.

6. Maintain access control or restrict use of fuel handling tool by lock if fuel movements are not in progress.

7. Handle fuel elements carefully. Care should be taken not to bump or scrape elements. Minimize the possibility and potential consequences of an accidental drop of an element.

8. Plan fuel movement activities so as to minimize the number of individual moves required to achieve the desired result.

9. Move elements between the reactor core, storage racks, shipment casks or other locations with special fuel handling tool.

10. Restrict all fuel element arrays except the reactor core to an array limit of less than 20 elements.

    a. Store fuel elements in the fuel storage wells or in the reactor pool. 19 element hexagonal array racks; 6 or 12 element linear array racks.

    b. Elements not in storage racks or shipment casks should be in groups of three or less.

11. Record all fuel element movements in the Fuel Element Log.

12. Acknowledge by verbal response each change of fuel handling tool opened or closed status if two persons operate the tool.

13. Acknowledge by verbal response the exchange or transfer of the fuel handling tool to another person.

14. Verify excess reactivity and shutdown margin if fuel movement is to or from the reactor core. Check by measurement or calculate by conservative estimate.

15. Compare control rod critical positions before and after movement and recalibrate if a change occurs due to movement of the fuel in the core.

16. Upon completion of fuel movement, wipe down and swipe the fuel handling tool and swipe the tool for removeable activity. Restow the fuel handling tool, with cover, in its designated location.

<u>REFERENCE REACTIVITY VALUES</u>
<u>fuel vs. water</u>

location	% $\delta k/k$
Ring A	4.00
Ring B	1.07
Ring C	0.85
Ring D	0.54
Ring E	0.36
Ring F	0.25
Ring G	0.19
3 elements (1D, 2E)	1.25
6 elements (6B)	6.42

Fuel Element Log:

Date	Time	Element #	Location Old	Location New	Comments

ORIGINAL

Core Arrangement

Reference ____________
Date ____________

Configuration Number:
Control-Fuel-Space-Other
________-_____-______-______

G-26 G-27 G-28 G-29 G-30

G-24 F-21 F-22 F-23 F-24 F-25 F-26 G-32

G-23 F-20 E-17 E-18 E-19 E-20 E-21 F-27 G-33

G-22 F-19 E-16 D-13 D-14 D-15 D-16 E-22 F-28 G-34
SHM2

G-21 F-18 E-15 D-12 C-09 C-10 C-11 D-17 E-23 F-29 G-35

G-20 F-12 E-14 D-11 C-08 B-05 B-06 C-02 D-18 E-24 F-30 G-36

F-16 E-13 D-10 C-07 B-04 B-01 C-01 D-01 E-01 F-01
REG
TRNS

G-18 F-15 E-12 D-09 C-06 B-03 B-02 C-02 D-02 E-02 F-02 G-02

G-17 F-14 E-11 D-08 C-05 C-04 C-03 D-03 E-03 F-03 G-03

G-16 F-13 E-10 D-07 D-06 D-05 D-04 E-04 F-04 G-04
SHM1

G-15 F-12 E-09 E-08 E-07 E-06 E-05 F-05 G-05

G-14 F-11 F-10 F-09 F-08 F-07 F-06 G-06

G-12 G-11 G-10 G-09 G-08

Fuel Element Storage
Element Numbers - Pool Racks

Date: ____/____/____

Rack#	Position: #1	#2	#3	#4	#5	#6
R1-hi						
R1-lo						
R2-hi						
R2-lo						
R3-hi						
R3-lo						
R4-hi						
R4-lo						
R5-hi						
R5-lo						
R6-hi						
R6-lo						
R7-hi						
R7-lo						
R8-hi						
R8-lo						
R9-hi						
R9-lo						
R10-hi						
R10-lo						
T1						
T2						
T3						

ORIGINAL

Element Numbers - Storage Well Racks

Date: _____/_____/_____

Well #	Postion:		#1	#2	#3	#4	#5	#6
N1	a:	b:						
		c:						
N2	a:	b:						
		c:						
N3	a:	b:						
		c:						
W1	a:	b:						
		c:						
W2	a:	b:						
		c:						
W3	a:	b:						
		c:						

ORIGINAL

NUCLEAR ENGINEERING TEACHING LABORATORY

FUEL-2, REV. 0

PROCEDURE
FOR MOVEMENT OF EXPERIMENTS

Approvals:

Thomas L. Bauer — 7/30/91
Reactor Supervisor — Date

Bernard W. Wehring — 7/30/91
Director, NETL — Date

[signature] — 7/30/91
Chairperson, Reactor Committee — Date

[signature] — 7/30/91
Chairperson, Radiation Safety Committee — Date

List of Pages: 1 2 3

Attachments: None

BALCONES RESEARCH CENTER
THE UNIVERSITY OF TEXAS AT AUSTIN

ORIGINAL

I. PURPOSE

The purpose of this procedure is to control experiment facility or experiment movements that may cause reactivity changes to the reactor core.

II. DESCRIPTION

Setup or removal of reactor core experiment facilities and experiments can cause substantial changes in the core configuration reactivity. Knowledge of these reactivity changes, both magnitude and sign, and the measurement of these changes is necessary to approve any configuration for safe operation.

III. REFERENCE

Safety Analysis Report,
docket 50-602
Technical Specifications,
section 3.4 limitations on Experiments

IV. MATERIALS

Radiation Work Permits (RWP) - for work within the reactor pool access area, or for special experiments.

V. PROCEDURE

1. A licensed operator shall supervise all experiment facility or experiment movements in the reactor pool.

2. A careful examination of the reactivity consequences of any experiment or facility movement shall be reviewed.

3. Reactivity effects greater than $1.00 shall require supervision by a licensed senior operator; reactor startup checklist shall be performed and k-excess adjustments made as necessary.

4. Removal or replacement of experiment or facilities into or from the reactor core shall be recorded in the reactor logbook; a k-excess measurement shall be made at time of subsequent reactor criticality.

5. All experiments in the reactor tank shall be secured as required by reactivity constraints. Experiments or objects in the reactor pool that represent no reactivity effect shall be secured as necessary to prevent potential interference with reactor operation.

6. A beta-gamma survey shall be made of all objects or experiments removed from the pool; radiation tags and wipe tests should be used as necessary.

   a. Check the requirements of any extended or fixed RWP for work in the immediate area of the reactor pool access area.
   b. Special RWP's may apply to specific experiments.

<u>Reactivity Estimates</u> ($)

CTR	void vs. water	-0.50
dummy min.	graphite vs. water	+0.05
dummy max.	graphite vs. water	+0.20
thru tube	void vs. graphite	-0.45
piercing tube	void vs. graphite	-0.35
RSR	poison 40 places	-0.40
PNT-G1	poison	-0.16
PNT-A1	poison	-0.90

poison is a significant neutron absorbing material

ORIGINAL

NUCLEAR ENGINEERING TEACHING LABORATORY

PROCEDURE PLAN-0 - REV 1

CALL AND NOTIFICATION

Approvals:

[signature]	4/15/91
Health Physicist	Date
Thomas L Bauer	4-15-91
Reactor Supervisor	Date
Bernard W. Wehring	7-9-91
Director, NETL	Date
[signature]	7-9-91
Chairperson, Reactor Committee	Date
[signature]	7/13/91
Chairperson, Radiation Safety Committee	Date

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Attachments:
- A Emergency Event
- B Telephone Threat
- C Call list

BALCONES RESEARCH CENTER
THE UNIVERSITY OF TEXAS AT AUSTIN

ORIGINAL

I. PURPOSE

To provide instructions for an emergency or security event.

II. DISCUSSION

This procedure provides the instructions for call and notification to be done in the event of an emergency or security event. The actions taken are the responsibility of personnel in charge based on their assessment of the event and the circumstances. Separate procedures specify the actions to be taken for emergency or security events.

III. REFERENCES

A. UT TRIGA Mark II Emergency Plan

B. UT TRIGA Mark II Security Plan

IV. CONTENTS

V. PROCEDURE

A. Classification

1). The call list attachment to the procedure shall be available in at least two locations of the NETL Bldg. 159.

a) room 2.102 reception office

b) room 3.208 control room

The call list shall undergo an update each time a telephone # or name is known to change. An additional check will be done twice each year (January and July) to verify the list accuracy.

2). Take the actions of section B for emergency conditions or security threats. Determine that an appropriate person has taken responsibility for the event. This action will implement the procedures of the emergency or security plans.

3). Refer to section C to continue notification of management and appropriate agencies.

B. Actions to place emergency call or respond to a telephone threat.

Call Procedure:

1. Call 9-911 for Austin Fire Department or Emergency Medical Services

2. State Name, Title, Telephone Number from which call is made, state Location:
   Nuclear Engineering Teaching Laboratory,
   Balcones Research Center ← change
   10100 Burnet Road
   Building 159,

3. State the nature of the problem:

   Fire: If known state type; structure, explosion, equipment
   Injury: If known state type; head injury, conscious, illness, trauma
   Other: Describe hazard;

   Location within building (if known)
   Nuclear Reactor is (is not) affected
   Radioactive material is (is not) involved
   Emergency Director will determine the following information if radioactive material is involved, see part c.1:
   a) type release (airborne, waterborne, surface contamination); b) radionuclide(s); c) boundary dose measurement or projection.

4. Answer any questions posed by Operator.
   Request call back to verify emergency information received.

5. Call UTPD at 911 if time permits.

Security Threat

1. Refer the call immediately, if possible, to the Director, Assistant Director, or Reactor Supervisor.

2. If caller does not allow a transfer of the call listen carefully and take notes!

3. Follow the Telephone Threat attachment to record information about the telephone call and the calling person.

4. Notify UTPD immediately.

5. Notify senior ranking person in the building to initiate a site action.

ORIGINAL

C. Notification Requirements:

1. The first notification is to the senior NETL administrative person at the NETL site.
   If radioactive material, then determine by measurement or projection the conditions at the boundary of the building:
   a) type release (airborne, waterborne, surface contamination);
   b) radionuclide(s);
   c) boundary dose measurement or projection.

2. Subsequent notifications assume that the initial call for emergency (9-911) or security (911) services have been made. The following notifications are the responsibility of the NETL administrative person responsible for the event.

3. Immediate notification requirements are

   University Safety Office - any emergency event security events that might effect the safety of personnel

   University Police Dept. - any security event emergency events that require an emergency vehicle response.

   Texas Dept. Health Bureau of Radiation Control - if a release of radioactive material is possible

   Travis County, City of Austin - events that represent an actual release of radioactive material and leads to notification of TDH.

   NRC Operations Center - NRC Region IV
   Notification of Unusual Event - all events
   Threats to Security System - some conditions
   Loss of Special Nuclear Material - any case

   a). Radiological events that cause; (immediate)
   Loss of facility operation for one working week
   Facility damage exceeding $200,000
   Exposure to individual of 25 rem whole body, 150 rem to skin or 375 rem to the extremities.
   Release of average concentration exceeding 5000 times the limits of part 20.

ORIGINAL

b). Radiological events that cause (24 hours);
Loss of facility operation for one working day,
Facility damage exceeding $2,000.
Exposure to individual of 5 rem whole body, 30 rem to the skin or 75 rem to the extremities,
Release of average concentration exceeding 500 times the limits of part 20.

c). Technical Specifications-docket 50-602(24 hours)
Reactor safety limit violation
Release of radioactivity in excess of limits
Reportable occurrences

4. A review of the respective plan and parts of 10CFR20, 50, and 70 should be made to confirm follow-up notification requirements.

5. Other notifications should be considered as the event progresses, such as

Director of BRC Physical Plant
Director of BEG
Director of WRC
Chairman of Dept. of Mech. Engr.
Dean College of Engineering
Pres. Cunningham's Office
UT News and Information

Number	Title	Rev. 2
PLAN-0	Call and Notification	Date 8/93

EMERGENCY CALL LIST

Emergency Call List
For Fire, immediate Medical Aid or severe Security Threat call for the service required:

Service	Phone No.
Fire	9-911
Ambulance	9-911
UT Police	911

The UT police should be notified of any emergency to provide access control for emergency vehicles, supplemental communications and physical security.
For an emergency in the reactor facility attempt to locate a senior operator in charge and contact one person in the order of the list:

Name	Responsibility	Work Phone	Home Phone
1. T.L. Bauer	Reactor Supervisor	471-5787	345-5044
2. A.J. Teachout	Health Physicst	471-5787	
3. M.G. Krause	Manager O&M	471-5787	259-1355
4. B.W. Wehring	Facility Director	471-5787	335-5944
4. J.C. White	Radiation Safety Officer	471-3511	863-2384
6. G.L. Monroe	Safety Engineer	471-3511	346-7987

Senior Operator in Charge

1. T.L. Bauer	Senior Reactor Operator	471-5787	345-5044
2. M.G. Krause	Senior Reactor Operator	471-5787	259-1355

Building Electrical, Plumbing or HVAC Emergency

Trouble calls:	8am-4pm	7am-11pm	24 hours
	471-3600	471-3770	471-2020
	BRC Phy Plt	BRC Chill Sta	UT Phy Plt

Texas Department of Health

	Routine Business	Emergency Only
Bureau of Radiation Control Division:	(512) 835-7000	(512) 458-7460

U.S. Nuclear Regulatory Commission

	Work Hours	24 Hours
Region IV Office of Inspection and Enforcement	(817) 860-8100	(817) 860-8100
NRC Operations Center	(202) 951-0550	(202) 951-0550

ORIGINAL AUG 1993

EMERGENCY CALL LIST

Emergency Call List
For Fire, immediate Medical Aid or severe Security Threat call for the service required:

Service	Phone No.
Fire	9-911
Ambulance	9-911
UT Police	911

The UT police should be notified of any emergency to provide access control for emergency vehicles, supplemental communications and physical security.
For an emergency in the reactor facility attempt to locate a senior operator in charge and contact one person in the order of the list:

Name	Responsibility	Work Phone	Home Phone
1. T.L. Bauer	Reactor Supervisor	471-5787	345-5044
2. L.W. Hamlin	Safety Manager	471-3511	926-1391
3. M.G. Krause	O&M Manager	471-5787	259-1355
4. B.W. Wehring	Facility Director	471-5787	335-5944
4. J.C. White	Health Physicist	471-5787	863-2384
6. G.L. Monroe	Safety Engineer	471-3511	346-7987

Senior Operator in Charge

1. T.L. Bauer	Senior Reactor Operator	471-5787	345-5044
2. M.G. Krause	Senior Reactor Operator	471-5787	259-1355

Building Electrical, Plumbing or HVAC Emergency

Trouble calls:	8am-4pm	7am-11pm	24 hours
	471-3600	471-3770	471-2020
	BRC Phy Plt	BRC Chill Sta	UT Phy Plt

Texas Department of Health

	Routine Business	Emergency Only
Bureau of Radiation Control Division:	(512) 835-7000	(512) 458-7460

U.S. Nuclear Regulatory Commission

	Work Hours	24 Hours
Region IV Office of Inspection and Enforcement	(817) 860-8100	(817) 860-8100
NRC Operations Center	(202) 951-0550	(202) 951-0550

ORIGINAL

EMERGENCY CALL LIST

Latest Update ________

Emergency Call List

For Fire, immediate Medical Aid or severe Security Threat call for the service required:

Service	Phone No.
Fire	9-911
Ambulance	9-911
UT Police	911

The UT police should be notified of any emergency to provide access control for emergency vehicles, supplemental communications and physical security. For an emergency in the reactor facility attempt to locate a senior operator in charge and contact one person in the order of the list:

Name	Responsibility	Work Phone	Home Phone
1. T.L. Bauer	Reactor Supervisor	471-5787	345-5004
2. H.W. Bryant	Safety Manager	471-3511	452-6689
3. M.G. Krause	O&M Manager	471-5787	259-1355
4. R.C. Woodard	Health Physicist	471-5787	837-0830
5. B.W. Wehring	Facility Director	471-5787	335-5944
6. D.G. Decker	Safety Engineer	471-3511	345-5914

Senior Operator in Charge

1. T.L. Bauer	Senior Reactor Operator	471-5787	345-5044
2. M.G. Krause	Senior Reactor Operator	471-5787	259-1355
3.			

Building Electrical, Plumbing or HVAC Emergency

	work hours	24 hours
Trouble calls	471-3600	471-2020

Texas Department of Health

	Routine Business	Emergency Only
Bureau of Radiation Control Division:	(512) 835-7000	(512) 458-7460

U.S. Nuclear Regulatory Commission

	Work Hours	24 Hours
Region IV Office of Inspection and Enforcement	(817) 860-8100	(817) 860-8100
NRC Operations Center	(202) 951-0550	(202) 951-0550

THIS CALL LIST FOR EXAMPLE ONLY

Number	Title	Rev. 1
PLAN-0	Call and Notification	Date 6/90

WORKSHEET: Event _____ Drill _____ Date: ____________

	Time
Emergency Director: ______________________	____________
Persons in building # ______________________	____________
Evacuees from building # ______________________	____________
Emergency vehicle at site: ______________________	____________
Command post; setup location ______________________	____________

Event Description:

Event Termination: ____________

Protective Actions:

Corrective Actions:

Comments:

ORIGINAL

THREATENING TELEPHONE CALL FORM

Date________________________Received by__________________________

Time call received____________Time caller hung up _______________

EXACT WORDS ~~OR~~ OF PERSON PLACING CALL_____________________________

____

____

____

____

____

____

QUESTIONS TO ASK CALLER:

1. When will bomb explode?___________________________________

2. Where is bomb now?____

3. What kind of bomb is it?__________________________________

4. What does it look like?___________________________________

5. Why did you place the bomb?_______________________________

____

____

DESCRIPTION OF VOICE OF CALLER:

Male or Female?____

Young____________Middle Aged_______________Old_________________

Tone of voice____

____

Background Noises____

____

Is voice familiar sounding?___________________________________

If so, who does it sound like?________________________________

REMARKS:____

____

NUCLEAR ENGINEERING TEACHING LABORATORY

PROCEDURE PLAN-E - REV 1

EMERGENCY RESPONSE

Approvals:

[signature] Health Physicist	4/29/91 Date
Thomas L. Bauer Reactor Supervisor	4/26/91 Date
Bernard W. Wehring Director, NETL	7-9-91 Date
[signature] Chairperson, Reactor Committee	7-9-91 Date
[signature] Chairperson, Radiation Safety Committee	7/18/91 Date

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Attachments:

- A Emergency Classifications
- B Equipment and Supplies
- C Drill Exercise

BALCONES RESEARCH CENTER
THE UNIVERSITY OF TEXAS AT AUSTIN

ORIGINAL

I. PURPOSE

To provide for classification of emergency conditions and describe the general actions to be taken for each Emergency Classification Category.

II. DISCUSSION

This procedure provides the general guidelines for classification and actions to be taken in the event of an emergency condition. The guidance provided in this procedure is very general as each emergency is an unpredictable and unique event. The specific actions taken are left to the personnel in charge based on their assessment of the event and the circumstances.

III. REFERENCES

A. UT TRIGA Mark II Emergency Plan

B. NCRP Report #65

IV. CONTENTS

V. PROCEDURE

A. Classification

1. Use the information in Attachment A, Emergency Classification to classify the event as a

   a. Non-Reactor Specific Event
   b. Notification of Unusual Event

2. Place the call for assistance, and start the notification process (see procedure PLAN 0).

3. Follow the procedures of section B or C. If evacuation is necessary follow the procedures of section D.

B. Actions for Non-Reactor Specific Event:
Evacuation of the building would not normally be a requirement of this classification of event.

1. The reactor shall be immediately shutdown if the event or emergency has the potential to worsen such that the reactor, pool, room, experiments or instrumentation and control system are threatened.

2. Render immediate assistance to any victim.

3. Secure radioactive materials as necessary.

4. Notify all persons in the immediate areas.

5. Identify the responsible person to be designated emergency director.

6. Request assistance from appropriate emergency response organizations. (Refer to Emergency Call List).

7. Verify notification of University Safety Office. Notify NETL Director.

8. Initiate actions that mitigate the emergency situation.

9. Take actions necessary to terminate emergency condition.

C. Actions for Notification of Unusual Event:
Evacuation of the building or an area is generally a requirement of this classification of event.

1. Terminate reactor operation by shutdown or scram switch as appropriate to the conditions.

2. Notify and evacuate all persons in the immediate vicinity.

3. Specify the responsible emergency director by verbal acknowledgement.
    a. Assistant Director
    b. Supervisory Reactor Operator
    c. Director or management

4. Notify appropriate emergency response organizations. (Refer to Emergency Call List).

5. Secure appropriate emergency equipment. Locate appropriate emergency supplies. (Refer to Emergency Equipment and Supplies List).

6. Initiate actions to mitigate the emergency.

7. Identify need for emergency support.

8. Notify university safety - security personnel.

9. Provide security and access control.

10. Assess radiation levels and releases.

11. Implement controls to limit personnel exposures appropriately. Establish controls of radioactive material contamination.

12. Evacuate personnel on adjacent site areas if necessary.

13. Notify NRC, Region IV. Notify TDH Bureau of Radiation Control authority. (Refer to Emergency Call List).

14. Maintain personnel access, physical security, and radiological monitoring until event is terminated.

15. Take actions necessary to terminate emergency condition.

16. Review facility status and develop recovery procedures.

D. Area Evacuation

1. Proceed to the emergency assembly area. An alternate area may be designated if the assembly area is not considered safe.

    a) Assembly area is the health physics room (2.106). For localized emergencies that do not threaten building systems or multiple building areas.
    b) An alternate area is the equipment access driveway, several meters from the building or if this area is downwind the emergency director shall locate another site upwind of the building and verbally notify all evacuees.
    c) Account for all persons in the facility. A person should monitor the whereabouts of facility personnel at both the main and service exits to the building.
    d) Determine the person specified as emergency director. Assign a person to provide public information.
    e) NETL Emergency Director should wear a hard hat and or fluorescent vest with NETL-Emergency director designation.
    f) NETL Emergency Director should communicate with HP or staff personnel by relay via response personnel communication equipment or a runner.

2. Control spread of radioactive contamination by

    a) Immediate measurement of activity on hands and feet.
    b) Removal of contaminated clothing and wash of skin surfaces.
    c) Identification of potential problem areas.
    d) Control of access to hazard areas.

3. Remove readily accessible portable radiation survey instruments to be available for emergency activities. Issue pocket dosimeters to emergency personnel entering potential radiation areas.

4. Persons transported from the area for medical treatment shall be free of contamination or escorted by a knowledgeable person with radioactivity measurement equipment.

5. Avoid areas with potential safety hazards.

E. Emergency Plan Preparedness

1. Emergency locker radiacs

   a. Emergency locker radiacs should be response checked monthly but shall not exceed three months.
   b. Emergency locker radiacs shall be calibrated every six months but shall not exceed 1 year.

2. Emergency Locker Inventory

   a. The Emergency Locker shall be inventoried every six months but shall not exceed 1 year.
   b. Supplies removed from the inventory should be replaced promptly.

3. Emergency Plan Training/Drills

   a. Emergency plan training shall be held annually for NETL permanent staff, that includes a drill.

      On-site drills should coordinate through UTPD and the Safety Office.

   b. A full-scope drill shall be conducted biennially to include the response of offsite emergency groups.

      Off-site drills should be coordinated through UTPD and the Safety Office for the scheduling of all activities of Austin City Fire Department and Emergency Medical Services. This includes involvement of the City of Austin Office of Emergency Management.

4. Letters of agreement with the City of Austin AFD, EMS and Brackenridge Hospital shall be updated each two years.

Unit	Title	Name	Phone#
City of Austin	Director Office of Emergency Management	S. Collier	370-2608
City of Austin	Chief AFD	B. Roberts	477-5784
City of Austin	Training Coordinator EMS	D. Gruel	469-2050
UT	Director Safety Office	D. Decker	471-3511
UT	Chief UT Police Dept.	D. Cannon	471-4441
NETL	Director	B. Wehring	471-5787
NETL	Emergency Director	T. Bauer	471-5787
NETL	Health Physicist	R. Woodard	471-5787

Emergency Classification

Classify Emergency conditions as follows:

Condition	Qualification
I. Non-Reactor Specific Emergency	
Individual injury	Assistance necessary
Natural disaster	Nearby, threatening or impending
Fire in operations boundary	Lasting 15 minutes or less
Hazardous localized condition	Personnel contamination or material spill
II. Notification of Unusual Event	
Severe natural phenomenon	Damage to building reactor systems or facility utilities
Sustained fire in facility	Threat to reactor systems or radioactive materials
Civil disturbance or bomb threat	Threat of physical damage
Threat or breach of physical security	Discovery of forced entry or SNM theft
Reactor coolant leakage	Out of operations boundary
Reactor coolant loss	Exceeds makeup capability
Single fuel element failure	Release of radionuclides into operations area
Multiple fuel element failure	Release of radionuclides into operations area
Measured dose rate	> 20 mr/hr at operations boundary from unknown source
Measured or projected whole body dose	> 15 millirem in 24 hours at site boundary
Measured particulate activity	> 10MPC within operation boundary on fixed filter air sample
Measured or projected effluents	> 10MPC (24 hr avg) unrestricted areas at site boundary

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Emergency Equipment

Emergency Lights: portable flashlight in control room
ac and dc emergency lighting in hallways, stairwells, and reactor bay

Fire Extinguishers: Sprinklers in lab and office areas
dry stand pipe in stairwells
72# halon system in control room
15# halon portable
10# CO_2 Portable (8)
6# dry chemical portable (8)

Radiation Monitors: (PORTABLE)
Eberline RO-2A Ion Chamber 0-50 R/hr
Bicron Micro-Rem Scintillator 0-2000 μSv/hr
Bicron Frisk-Tech 0-500,000 cpm
Scintillator Probe (α - β)
PRS-2/NRD BF_3 Counter 0-5 R/hr
Victoreen 440 Ion Chamber 0-300 mrem/hr

Radiation Monitors: (FIXED)
Eberline 6-channel GM 0.1-10,000 mr/hr
GA Model Ar-1000 Gaseous Air Monitor 0-10^7 cpm

Emergency Supplies

Reference Materials:
Emergency Procedures
Emergency Notification List
University Radiation Safety Manual
Triga Safety Analysis Report
Health Physics Handbook
10CFR20/NCRP65

First Aid Kit:
gauze, bandaids
iodine, antiseptic
eyewash, absorbent cotton
adhesive tape, scissors, swabs,
tongue depressor, eyedropper,
ammonia inhalants

Radiation Detection:
2-γ sensitive radiation detectors with batteries
4-γ sensitive pocket dosimeters
1-pocket dosimeter charging/reading unit with battery

Control Materials:
5-Radiation Area
5-High Radiation Area
5-Radioactive Material
5-Airborne Radioactivity Area
1 roll Radioactive Material tape
≃ 20 ft magenta and yellow rope

Protective Clothing:
8 pair coveralls
8 pair gloves
8 pair shoe covers
8 filter respirators, (½ mask)
1 full mask respirator, filters

Cleanup Materials:
10 large plastic bags
1 roll lab-mat absorbent paper
1 pkg ordinary paper towels
1 bottle decontamination soap

Drill Exercise

Emergency Event Type: Exercise Date:__/__/__

_____Release of radioactive gas or airborne particulate
_____Radioactive material spill and contamination
_____Fuel element failure
_____Loss of pool coolant
_____High radiation area
_____Fire or chemical reaction
_____Civil disturbance or security breach
_____Natural disaster
_____Personnel injury

Event Scenario:

Area effected by the event ____

Specify the source of the released material ______________________

Specify the magnitude of radioactive release involved _____________

Brief description of event:

Response Evaluation:

Condition properly identified? yes _____ no _____
Assessment actions taken: ____

Responsibility identified? yes _____ no _____
Director _____________

Corrective actions taken:____

Notify support organizations: yes _____ no _____
organization _______________

Protective actions taken: ____

Termination of event specified? yes _____ no _____

Performance Comments:

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NUCLEAR ENGINEERING TEACHING LABORATORY

PROCEDURE PLAN-S - REV 1

PHYSICAL SECURITY

Approvals:

Thomas L. Bauer — 7-24-90
Reactor Supervisor — Date

Bernard W. Wehring — 8-14-90
Director, NETL — Date

[signature] — 8-21-90
Chairperson, Reactor Committee — Date

List of Pages: 1 2 3 4 5 6 [7 8 9 10 11 12]

Attachments:
- A Security Classifications
- B SNM Material Inventory
- C Access Authorization

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I. Purpose:

Requirements for access control and area monitoring to secure the use of special nuclear materials is the subject of this procedure.

II. Description:

The physical security plan defines the criteria for implementation of security requirements. The plan is sensitive material not available for general disclosure. These procedures are also not for general information since they may provide persons with information that is important to the security function.

III. References:

UT TRIGA Mark II Physical Security Plan
UTPD Standard Operating Procedures

IV. Contents:

V. Procedures:

A. Classification

1. Use the information in Attachment A, Security Classification to classify the event as a

   a. Threat to Security System
   b. Intrusion or System Failure
   c. Loss of Special Nuclear Material

2. Follow the procedures of section E thru H for normal facility operation.

3. In the event of a security condition of the type listed in part (1) go to section B, C, or D.

B. Actions for a Threat to Security System are

1. Utility failures such as power and water.

   a. Notify appropriate utility personnel.
   b. Take steps to maintain security if necessary.
   c. Take steps to minimize potential hazards as required.

2. Threat of fire or explosion.

   a. Notify Fire Department and University Police.
   b. Evacuate personnel from threatened areas of laboratory and all adjacent building areas.
   c. Notify Reactor Supervisor and Radiation Safety Officer.
   d. Take reasonable steps to minimize the possible sources or conditions of potential hazards
   e. Identify and implement temporary security measures if necessary.

3. Natural disasters or other occurrences actually effecting status of Physical Security Plan.

   a. Notify University Police and Reactor Supervisor.
   b. Determine the condition and function of the controlled access boundary and intrusion detection system.
   c. Notify NRC if changes are required to the security plan.

4. Civil threats such as demonstrations.

   a. Notify University Police and Reactor Supervisor.
   b. Secure reactor pool covers and fuel element tool.
   c. Remove nonessential materials to more secure locations.
   d. Inform other personnel in the facility.
   e. Notify Radiation Safety Officer of any event.
   f. Notify NRC of any event that impacts security.

5. Threats of explosion or sabotage

   a. Notify University Police and Reactor Supervisor.
   b. Apply established procedures for phone threats.
   c. Remove all personnel from laboratory area.
   d. Note any unusual conditions during exit.
   e. Notify Radiation Safety Officer.
   f. Notify NRC of each event and the available facts.

C. Actions for Intrusion or System Failure are

1. Unauthorized personnel entry.

   a. Report the condition immediately.
   b. Notify University Police and Reactor Supervisor.
   c. Identify reason for unauthorized entry.
   d. Determine the method of entry.
   e. Prevent possible reoccurrence.

2. Discovery of unsecured area.

   a. Correct the condition immediately.
   b. Notify Reactor Supervisor of the conditions.
   c. Visually inspect laboratory areas.
   d. Note evidence of unauthorized activity.
   e. Report unidentified objects or indication of tampering.

3. Failure of system to function in its normal mode.

   a. Notify UTPD of the problem. Notify physical plant or locks and keys to repair mechanical system failures. Notify university communications to repair failures of the intrusion monitoring system.
   b. No corrective action is necessary if either the mechanical systems or the intrusion system remains effective and the problem is temporary.
   c. If both the mechanical locks or barriers and intrusion monitoring equipment fail, a notification to NRC is necessary.
   d. Take corrective steps to assure security and access control if mechanical barriers and intrusion monitoring systems both fail.

D. Actions for a Loss of Special Nuclear Material are

1. Discovery of theft or diversion of special nuclear materials.

    a. Notify University Police and Reactor Supervisor.
    b. Confirm the theft or diversion of material.
    c. Perform an inventory of materials to identify removals.
    d. Notify NRC within 1 hours of the discovery.
    e. Reexamine security procedures to prevent further removal.

2. Discovery of missing material.

    a. Notify Reactor Supervisor of the material missing.
    b. Confirm the discovery that material is missing.
    c. Perform an inventory of all items to determine the quantity of missing material.
    d. Examine records to determine last user and identifiable location of the material.
    e. Notify NRC within 1 hour of the discovery.

Security Classification

Classify Security conditions as follows:

Condition	Qualification
I. Threat to Security System	
Utility failure	Threatens intrusion detection equipment
Threat of fire or explosion	Potential loss of intrusion detection and/or boundary integrity
Natural disaster	Actual facility damage
Civil threats	Demonstration planned or in progress
Threats of explosion or sabotage	Phone threats and bomb threats
II. Intrusion Detection Failure	
Discovery of unsecure area	Failure of both door lock and door sensors
Unauthorized personnel entry	Forced entry
III. Loss of Special Nuclear Material	
Theft or diversion	Discovery in response to an incident
Missing material	Discovery during routine inventory

The University of Texas TRIGA

Special Nuclear Material
Inventory Estimate

Material		Items	Element	%	Grams
I.	Reactor Fuel		U-235	≃20	
A.	UT elements	34			1292
B.	GA elements	58			2088
C.	NA elements	59			2182
D.	Fuel Followers	3			120
II.	Subcritical Assembly		U-235	≃20	470
A.	AJ Disks	8			
B.	AJ Pellets	35			
III.	Fission Chambers		U-235	≃20	9
A.	Reactor Core	5			
B.	Other Chambers	2			
IV.	Neutron Sources (PuBe)		Pu		318
A.	DOE owned	3			
B.	Non DOE owned	3			
V.	Miscellaneous Materials				22
A.	Reference Material		U-235	≃20	
B.	Reference Material		U-235	≃20	
C.	Reference Material		Pu		
Totals					6501
	U-235 (<20% enrichment)				6152
	Exempt Material (PuBe)				318
	Balance (Pu + U-235)				31

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Authorization Approval:

Access type 1 - Issue key and card
Access type 2 - Issue card only (all hours)
Access type 3 - Issue card only (workdays)
Access type 4 - No card or key, temporary access without escort; requires entry approval by a person with entry authorization
Access type 5 - Terminate access authorization

Person:	Reason: ______	Approval type: ___	Date __/__/__	Initial ______
Person:	Reason: ______	Approval type: ___	Date __/__/__	Initial ______
Person:	Reason: ______	Approval type: ___	Date __/__/__	Initial ______
Person:	Reason: ______	Approval type: ___	Date __/__/__	Initial ______
Person:	Reason: ______	Approval type: ___	Date __/__/__	Initial ______
Person:	Reason: ______	Approval type: ___	Date __/__/__	Initial ______
Person:	Reason: ______	Approval type: ___	Date __/__/__	Initial ______
Person:	Reason: ______	Approval type: ___	Date __/__/__	Initial ______
Person:	Reason: ______	Approval type: ___	Date __/__/__	Initial ______
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Person	Reason	Approval type	Date	Initial
Chris Lindemann	Electronics-technician work - naval reactor training	4 NETL training pending	8/16/90	JRB BWL
Scott Midget	Grad. Res. Asst. BS Nuc Eng TX A&M NETL training	4	6/6/91	JRB BWL
Carlos Rios	Grad Res. Asst. MS. Engineering Cold Source Project	4	5/29/92	JRB BWL
Chris Lindemann	Change to 3 ~~[illegible]~~ type 5 update status 5/29/92	5	5/29/92	JRB
Scott Midget	change to 5 update status 5/29/92	5	9/1/91	JRB
Joul Kim	TCNS up work	4	1/20/93	JRB
Mike Scott	HP technician part time employee	4	3/19/93	JRB
Carlos Rios	Grad Res Asst MS. Engineering End of assignment	5	12/ /94	JRB
Soul Kim	End of work	5	/ /	JRB
Mike Scott	End of appointment	5	9/ /93	JRB

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NETL SECURITY BADGE POLICY

Badging at the Nuclear Engineering Teaching Laboratory is designed to identify various levels of access and escort requirements for all personnel who use or visit the facility.

WHITE BADGE

White badges are issued to permanent facility staff members as determined by the NETL Director or Assistant Director. Personnel with white badges are granted unescorted access to primary security and restricted areas. In the event of an emergency, the instructions of personnel with white badges shall be followed. White badges shall have the name and title of the individual on the badge, and have no expiration date. They must be turned in upon termination of work at the facility.

GREEN BADGE

Green badges are issued to part-time staff members, researchers and students as determined by the Director or Assistant Director. Personnel with green badges are granted unescorted access to restricted areas. A green badge with the letter "R" allows unescorted access to the primary security area. Green badges have expiration dates, and must be periodically renewed.

RED BADGE

Red badges are issued to visiting personnel who are granted unescorted access to the facility except for restricted areas and the primary security area. Issuance of a red badge is determined by the following personnel: Director, Assistant Director, Manager of O&M, or the Health Physicist. Any person with a red badge must sign in the visitor log in order to receive a badge, and return the badge upon leaving the facility. Entry into a restricted area or the primary security area requires escort by a white badged person, or a green badged person with the appropriate clearance.

NO BADGE

Visitors who require continuous escort are not issued badges. They must sign the visitor log and be continuously escorted while in the facility. Any visitor to the primary security area not during regular working hours requires prior approval by the Director, Assistant Director, Manager of O&M, or the Health Physicist.