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Title:	Fissionable Materials Handlers Operators-Initial Training
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FISSIONABLE MATERIAL HANDLERS OPERATORS

Initial Training

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FMH INITIAL TRAINING REQUIREMENTS CHECKLIST

Use the checklist below to track the progress as you complete the Initial Fissionable Material Handler training requirements. Curriculum Assignments must come from the candidate's manager and be routed through TA55-FMH@LANL.GOV. All questions can be routed through the TA-55 Programmatic Training POC by emailing the above address or visiting the Fissionable Material Handler website. This is a progressive program and is required to be completed in the order outlined to achieve full certification as intended by your management.

PREREQUISITE (*) AND TA55 CURRCULA ASSIGNMENTS

Institutional Training *	TA-55 Specific Training
Assigned ☐ CU 115 Rad Worker II* ☐ CU 89 Nuclear Material Handler* ☐ Course 15503 General Employee Training ☐ CU 10962 LANMAS/LAMCAS (Q Clearance Required)	Assigned ☐ CU 9042 TA-55 PAA ☐ CU 9043 TA-55 MAA ☐ CU 7599 PF-4 Escorted Plutonium Worker ☐ CU 10130 TA55 FMH **Operator OR** ☐ CU 10076 TA55 FMH **Supervisor**
*Most Institutional classes are taught at the White Rock Training Center. The location of each course will be listed in UTrain upon scheduling or call 7-0059 to speak to a White Rock Registrar	*Helpful hint: You can easily view your curriculum assignments by clicking on the Pie Chart on your Utrain homepage.

**** The following Curricula must be completed in the order outlined. Once the worker completes Curricula 7599 they must notify ta55-fmh@lanl.gov for further assignments****

✓ COURSE COMPLETION CHECKLIST 7599 PF-4 ESCORTED PLUTONIUM WORKER

	Sub-curricula 117: Beryllium Worker Training Course 725: Beryllium Worker Training Live	 Register in UTrain for course 725
	Course 25997: Chemical Hazard Communication Intro	Online
	Course 25418: Chemical Hazard Communication Intro	Register in Utrain for classroom training
	Sub-curricula 2677: Respirators: Air Purifying Sub-curricula: 2689: Respirators: Air Purifying Prerequisite Course: 40723: Respirators: Air Purifying Self-Study Course: 3549: Respirators: Air Purifying Fit-Test	 Form 1465 & Resp. APR Medical Evaluation Online Self-Study Schedule with Greta Williams (7-3560)
	Sub-curricula 115: Radiological Worker II Course 20301: Radiological Worker II Classroom Course 12910: Practical Evaluation Course 12909: Radiological Worker II Examination	 Register in UTrain for course 20301 Register in UTrain for course 12910 Register in UTrain for course 12909
	Sub-curricula 10327: TA-55 PF-4 Basic Worker Program Course 37034: TA-55 PF-4 Basic Worker	 Online course
	Course 15503: General Employee Training Live	Register in UTrain for classroom training
	Course 22887: TA-55 Glovebox & Auxiliary Systems	Online course
	Course 10341: Ventilation Fume Hoods	Online Course
	Course 45900: TA-55 Contamination Monitoring Training	Register in UTrain for classroom training

	Course 8005: Nuclear Material Handler Awareness	Online course

✓ COURSE COMPLETION CHECKLIST 10130 TA55 FMH (OPERATOR)

	Non-Train 21805:FMH Education and Experience Form	Candidate submits form 1817a to the HR Generalist with supporting documentation
	Non-Train 42225 FMH Medical Surveillance Requirement	Manager registers candidate with electronic form 2134 which can be found on the FMH Website. Provide Duty Disposition Letter to ta55-fmh@lanl.gov must be "Fit for Duty"
	Course 36161: Radiological Protection	Register in UTrain for classroom training
	Course 36164: Nuclear Material Control Accountability	Register in UTrain for classroom training
	Course 36165: Material at Risk	Register in UTrain for classroom training
	Course 36166: Nuclear Criticality Safety	Register in UTrain for classroom training
	Course 36168: Criticality Safety Program	Register in UTrain for classroom training
	OJT 36169: Material Handling and Movement	Register in UTrain for OJT training
	OJT 36170: Operating Electronic Balances	Register in UTrain for OJT training
	OJT 43848: Operator Facility Walkthrough Section 1 Walkthrough Section 2 Walkthrough	Candidate/RLM/Admin contact ta55-fmh@lanl.gov for paperwork
	Test 26796: Operators Comprehensive Exam	Upon receiving notification from ta55-fmh@lanl.gov, contact the Proctor Lab (667-3405) to schedule the exam
	Test 21894: Operator Operational Evaluation and Oral Exam	Candidate/RLM/Admin contacts ta55-fmh@lanl.gov to schedule
	Non-Train 23594: Operator/Supervisor Certification Form *HRP Required for final Certification	Programmatic Training office initiates certification form to route for signatures.

✓ COURSE COMPLETION CHECKLIST 10076 TA55 FMH (SUPERVISOR)

	Sub-curricula 1607: Nuclear Supervisor Qualification Standard	Online Course
	Course 17436: Leadership	Online Course
	Course 17437: Interpersonal Communication	Online Course
	Course 17438: Motivation	Online Course
	Course 17439: Problem Analysis and Decision Making	Online Course
	Course 17440: Roles, Resp., Authorities & Accountability	Online Course
	Course 17441: Administrative Policies and Procedures	Online Course
	Course 17450: Conduct of Maintenance	Online Course
	Course 17453: Conduct of Operations	Online Course
	Course 17456: Conduct of Training	Register in UTrain for classroom training
	Course 31029: NUMAST-HR Resources Fundamentals	Online Course
	Non-Train 21805:FMH Education and Experience Form	Candidate submits form 1817a to the HR Generalist with supporting documentation
	Non-Train 42225 FMH Medical Surveillance Requirement	Manager registers candidate with electronic form 2134 which can be found on the FMH Website. Provide Duty Disposition Letter to ta55-fmh@lanl.gov must be "Fit for Duty"
	Course 36161: Radiological Protection	Register in UTrain for classroom training
	Course 36164: Nuclear Material Control Accountability	Register in UTrain for classroom training
	Course 36165: Material at Risk	Register in UTrain for classroom training
	Course 36166: Nuclear Criticality Safety	Register in UTrain for classroom training
	Course 36168: Criticality Safety Program	Register in UTrain for classroom training
	OJT 36169: Material Handling and Movement	Register in UTrain for OJT training
	OJT 36170: Operating Electronic Balances	Register in UTrain for OJT training
	OJT 43850: Supervisor Facility Walkthrough Section 1 Walkthrough	Candidate/RLM/Admin contact ta55-fmh@lanl.gov for Facility Walkthrough

	Section 2 Walkthrough Section 3 Walkthrough	paperwork. Programmatic Training will provide guidelines
	Test 26797: Supervisor Comprehensive Exam	Upon receiving notification from ta55-fmh@lanl.gov, contact the Proctor Lab (667-3405) to schedule the exam
	Test 21894: Operator Operational Evaluation and Oral Exam	Candidate/RLM/Admin contacts ta55-fmh@lanl.gov to schedule
	Non-Train 23594: Operator/Supervisor Certification Form *HRP Required for final certification	Programmatic Training office initiates certification form to route for signatures.

TA-55 Fissionable Material Handlers Operators

Initial Training

This course is required training for all initial Fissionable Material Handlers/Operators and is specific to TA-55 FMH Certification. It covers the core areas and topics in Radiological Protection, Nuclear Material Control Accountability, Criticality Safety, Material-at-Risk,TA-55 Material Handling and Movement.

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TA-55 Fissionable Material Handlers Initial Training

INTRODUCTION

These courses were designed for all Initial Fissionable Material Handlers Operators and Supervisors whose job activities will require the performance of Fissile Material Operations located within the Plutonium Facility (PF-4).

The course requirements are based on DOE order 426.2, *Personnel Section, Qualification, and Training Requirements* for Fissionable Material Handlers.

These courses are required training for all initial Fissionable Material Handlers and is specific to TA-55 FMH Certification. It covers the core areas and topics in Criticality Safety, Material-at-Risk, Nuclear Material Control and Accountability, Radiological Protection, TA-55 Material Handling and Movement.

PREREQUISITES

Prior to taking these courses candidates must complete Prerequisite Training which is

TRAINING PROCESS and Expectations

The following courses are Instructor Led Courses which are taught in a classroom setting. Courses 36161-36168 must be completed prior to registering for courses 36169 and 36170.

- Course 36161-Radiological Protection
- Course 36164-Nuclear Material Control Accountability
- Course 36165-Material at Risk
- Course 36166-Nuclear Criticality Safety
- Course 36168-Criticality Safety Program

The following courses are OJT's which are taught in the PF 39 Cold Lab Training Facility

- Course 36169-Material Handling Movement DOP-016
- Course 36170-Operating Material Balances

EVALUATIONS AND EXAMINATIONS

Successful completion of a comprehensive written examination is required for certification as an FMH to prove the candidates suitability to perform assigned duties as specified. The candidate must complete all training and Facility Walkthrough before taking the comprehensive exam. The examination contains a representation sampling of the knowledge and skills identified and derived from the learning objectives. The comprehensive exam is administered as a web-based examination using U-train. Access to the exam is granted by a designated proctor. The proctored exam is a closed book multiple choice examination. The candidate must score at least 80% to pass the exam. After one failed attempt to pass the examination, remediation is offered before a candidate can retake the exam. After two consecutive test scores of less than 80% a formal remediation plan must be developed and completed to retest. Once the candidate passes the exam, they must provide TA55 Programmatic Training with a copy of their notification of a passing grade. Please hand deliver this form to TA55, PF39, Cold Lab Training Facility, or email to ta55-fmh@lanl.gov.

FMH PROGRAM BACKGROUND

Completion of these courses and other elements within the FMH Program does not implicitly authorize a worker to perform FMH activities. Additional facility-specific and on-the-job certification requirements on unit/system operations may be required by the functional organization before and FMH candidate is authorized to perform activity-specific operations.

Workers who are in training may not make decisions independently or take actions that could affect facility safety. A FMH candidate must be under direct observation and guidance of a certified FMH who has constant control of the activities being performed.

QUALIFICATION/CERTIFICATION

Candidates will be assigned to one of the following curricula.

10130 TA55 Fissionable Material Handlers **(Operators)**
10076 TA55 Fissionable Material Handlers **(Supervisors)**

To become certified and authorize to perform the duties associated with the FMH position the following steps must be completed.

Education	
High School Diploma or equivalent	
Prerequisite Training	
Institutional Training	**TA-55 Facility Access Training**
Curriculum 115 Rad Worker II Curriculum 89 Nuclear Material Handler Course 15503 General Employee Training-Live Curriculum 10962 LANMAS/LAMCAS *must have Q Clearance	Curriculum 9042 TA-55 PAA Curriculum 9043 TA-55 MAA Curriculum 7599 PF-4 Escorted Plutonium Worker Curriculum 10130 FMH Operator OR Curriculum 10076 FMH Supervisor

Initial Training Requirements **To be completed by all candidates in the following order:**	
Item 21805	Non-Train TA-55 FMH Education and Experience Form (HR Section)
Item 42225	Non-Train TA-55 FMH Medical Surveillance Requirement
Item 36161	Course Initial FMH – Radiological Protection
Item 36164	Course Initial FMH – Material Control & Accountability
Item 36165	Course Initial FMH – Material-At-Risk
Item 36166	Course Initial FMH – Nuclear Criticality Safety
Item 36168	Course Initial FMH – TA55 Criticality Safety Program
OJT 36169	Initial FMH – Material Handling and Movement To be completed after Instructor Led Courses
OJT 36170	Initial FMH- Operating Electronic Balances To be completed after Instructor Led Courses
OJT 43848	FMH (Operator) Facility Walkthrough
OJT 43850	FMH(Supervisor) Facility Walkthrough These items are completed by/with the RLM

Test 26796 Test 26797	FMH (Operator) Comprehensive Exam FMH (Supervisor) Comprehensive Exam These exams are proctored at the RLUOB (4th floor), scheduled by contacting the TA-55 Training Coordinators at 7-3405.
Test 21894	TA-55 FMH Operator Operational Evaluation and Oral Exam Schedule in the TA-55 Training Cold Lab PF-039
Non-Train 23594	TA55 FMH Certification Form This item is initiated by the TC and completed by management

FMH OPERATIONAL EVALUATION

An Operational Evaluation or Performance Demonstration is required for a FMH candidate to complete certification. This evaluation is a demonstration of knowledge of the facility (PF-4) in which they perform FMH activities. The candidate must demonstrate an understanding of fissionable material handling operations and demonstrate the ability to perform a representative fissionable material handling operation to be considered successful in certification. The evaluation is noted as a Pass/Fail with passing requiring 100% satisfactory demonstration or understanding of the evaluation objectives.

Worker responsibilities to understand and follow:

Emergency Procedures
Integrated Work Management
Fitness for Duty
Pre-start work activities

- Integrated Plan of the day/ Plan of the week
- Pre-job briefing / Post-job review

Before entering any room or work area workers should always verify that the room or area has been released for work by checking room postings. TA55-AP-023 *Posting of PF-4 Rooms* (The following information presented refers to activities related to new operations or procedures)

Pre-job walkdown requirements

A walkdown is an on-site review of the work area to ensure that work conditions are consistent with the Integrated Work Document (IWD) and required controls are in place and functional. The PIC performs a validation walkdown of the work area and work activity.

The walkdown must include workers assigned to conduct the work, and must be conducted as close in time as reasonable to the actual performance of work, to ensure conditions in the area have not changed and the appropriate personnel, procedures, and equipment are available to start the work.

Moderate-Hazard Work, the Responsible Line Manager (RLM) or PIC must be involved in the review of an IWD as a member of the review team or the walkdown of the activity.

High-Hazard/Complex Work, the Facility Operations Director (FOD) or FOD designee and Subject Matter Experts (SMEs) appropriate to the hazards involved must be included in the validation walkdown. Subsequent walkdowns will be determined by the RLM or PIC based on the hazards and complexity of the activities.

Plan of the day/Plan of the Week, a daily/weekly meeting to plan and schedule operations and programmatic activities performed within an area under the administration of a FOD. Required attendance by the PIC and/or workers for identified activities.

Person in Charge (PIC)

The PIC is the person assigned the responsibility and authority by the RLM or designee for overall validation, coordination, execution, and closeout of a work activity in accordance with IWM.

Person-In-Charge (PIC) Roles & Responsibilities:

- Supervises the performance of work
- Performs work in accordance with approved documents.
- Has authority to control and manage activities and work based on organizational assignments.
- Accountable to line management
- Conduct pre-job briefings with all involved workers, and release the work activity
- Monitors work to ensure that it is executed in a safe, secure, and environmentally responsible manner in accordance with the IWD-equivalent technical procedures and planned activities are within the bounds of these procedures.
- Formally releases the work
- When applicable conducts a post-job review

Alternate PIC Roles & Responsibilities:

- Assumes all responsibilities of the PIC when the PIC is not present
- Signs PA-AP-01020-FM1 indicating acceptance of responsibility.

Personnel Roles & Responsibilities:

- Ensure that they are fit for duty
- Informs the RLM of any medical restrictions and any effects of medications taken in the past 72 hours
- Is responsible for actually performing the work
- Performs work in accordance with approved documents
- Is accountable to a line manager

Pre-Job Briefings

For repetitive, moderate-hazard work activities, a pre-job brief is required prior to the initial performance and weekly thereafter if the work is performed in the same location with the same workers.

Planning and Coordination

The PIC will ensure the following:

- Procedures to be used are the most current and effective revision.
- Applicable, approved governing documents are available during the pre-job briefing.
- All necessary job-related documents, required permits, references, supplies and equipment

The PIC Ensures that all personnel involved in the job are

- present
- authorized to perform the activity
- understand their job responsibilities

If necessary the PIC, obtains confirmation that the assigned, deployed workers are authorized and qualified to perform the work from their management.

The PIC and each involved worker must perform frequent reediness checks to confirm that the conditions remain within the planned and expected work parameters.

Post-Job Review

For moderate-hazard non-routine and high-hazard/complex activities, a Post-Job Review soon after completion is required to close-out the job and capture any Lessons Learned.

Additional criteria for Post-Job review considerations:

- New or special technology or techniques were used
- The activity resulted in a recordable, or other significant incident, such as regulatory noncompliance or environmental damage/harm.
- A worker was injured during the performance of work.
- Emergency work.
- When requested by anyone involved in the performance of the activity.

LESSONS LEARNED – Found on the ADPSM home page under the Safety tab

REFERENCES
P300 *Integrated Work Management*
PA-AP-01020 *Pre-Job Briefing and Post-Job Review*
TA55-AP-023 *Posting of PF-4 Rooms*

Acronyms and Terms

Term	Definition
*	Step that is important to criticality safety
$	Denotes steps that have TSR significance
ALARA	As Low As Reasonably Achievable
AP	Administrative Procedure
CAM	Continuous Air Monitors
CAS	Central Alarm System
CSE	Criticality Safety Evaluation
CSLA	Criticality Safety Limit Authorization/Approval
CVD	Confinement Vessel Disposition
DAC	Daily Administrative Check
DAC-h	Derived Air Concentrate per hour
DF	Design Feature
DOP	Detailed Operating Procedure
DPM	Disintegrations per Minute
DR	Damage Ratio
DSA	Documented Safety Analysis
Ensure	Guarantee or make certain of the outcome which requires the correction of any deficiencies
Fissionable Material Operation	A process involving fissile and/or fissionable material for which a Criticality Safety Evaluation (CSE) has been completed and a Criticality Safety Limit Approval (CSLA) has been issued. The physical boundary or location of an FMO are well-defined (e.g. a glove box, floor location, safe drawer, fixed location in an SNM transport cart, can crimper, etc.)
Fissionable Material	Isotopes that can fission easily. Examples of fissionable materials at TA-55 are: U-233, U-235, Np-237, Pu-238, Pu-239, Pu-240, Pu-241, Am-241, and, Cf-252.
FMH	Fissionable Material Handler
FMO	Fissionable Material Operation
FOD	Facility Operations Director
FOM	Facility Operations Manager
FRPR	Facility Radiation Protection Requirements

GPHS	General-Purpose Heat Source
Handling	Physically touching, manipulating, or holding staged material.
HENC	High Efficiency Neutron Counter
HEPA	High-Efficiency Particulate Air
HFM	Hand and Foot Monitor
HJEA	Hot-Job Exclusion Area
HRP	Human Reliability Program
HS-Pu	Heat Source Plutonium
IPOD	Integrated Plan of the Day
ISI	In-Service Inspection
IWD	Integrated Work Document
LAMCAS	Los Alamos Material Control Accountability System
LANMAS	Local Area Network Material Accountability System
LCO	Limiting Conditions of Operation
MAA	Material Access Area
MATL	Material (used on Accounting System)
MAR	Material-at-Risk
MBA	Material Balance Area
MC&A (old)	Material Control and Accountability
Movement	The conveyance of material
MT	Material Type
NCS	Nuclear Criticality Safety
NDA	Non-destructive Assay
NMCA	Nuclear Material Control Accountability
NRTL	Nationally Recognized Testing Laboratory
NM **Nuclear Material**	The definition of "nuclear material" for the purposes of this document is SNM, fissionable materials, and radioactive materials.
Nuclear Criticality Safety Insignificant Material	Items containing fissionable material only because of contact with fissionable material as it is processed in the glovebox line. For further guidance refer to TA55-AP-522, *Nuclear Criticality Safety*.
OC	Operations Center
ORM	Operations Responsible Manager

ORS	Operations Responsible Supervisor
OSRP	Off-Site Source Recovery Project
PA	Protected Area
Peer Check	A method of checking an operation, an act of positioning, or a calculation, in which a second knowledgeable individual verifies that the action planned by the performer is appropriate before the execution and occurs according to plan. Peer-checking involves two persons (performer and checker). A peer-check does not require documentation unless otherwise specified in the implementing document.
PF	Plutonium Facility
PIC	Person-in-Charge
PMC	Personal Contamination Monitor
PMFD	Process Monitoring Flow Diagram
PNAD	Personal Neutron Accident Dosimeter
PPE	Personal Protective Equipment
Radioactive Material	Any activated material, sealed or unsealed source, or other material that emits ionizing radiation. Any material, equipment, or system component determined to be contaminated or suspected of being contaminated is also considered radioactive material.
RBA	Radiological Buffer Area
RCA	Radiological Control Area
RCT	Radiological Control Technician
RLM	Responsible Line Manager
RMI	Routine Monitoring Instructions
RPO	Radiation Protection Observations
RPP	Radiation Protection Program
RWP	Radiological Work Permit
SB-PF	Safety Basis group
SME	Subject Matter Expert
SNM	Special Nuclear Material — Plutonium, uranium-233, uranium enriched in the isotope 235, and any other material which, pursuant to Section 51 of the Atomic Energy Act of 1954, as amended, has been determined to be SNM, but does not include source material; it also includes any material artificially enriched by any of the foregoing, not including source material.

SC	Safety Class
SS	Safety Significant
SSC	Structures, Systems and Components
SST	Safe and Secure Transport
Staging	The storage of material in a fixed or well-defined location. Material staging begins and ends as a result of handling/and or moving material.
SUB-MBA	Process/Status within an MBA
TID	Tamper Indicating Device
TLD	Thermoluminescent Dosimeter
Transfer	An NMCA term used to identify a two-part inventory change process as described in TA55-RD-585, *Nuclear Material Control and Accountability Requirements.* An NMCA transfer is a type of movement
TSR	Technical Safety Requirement
TRU	Transuranic
Verify	For the activities governed by this procedure, verification is conducted by performing a peer- check.
WG-Pu	Weapons-grade plutonium

TA-55 Fissionable Material Handlers Initial Training

READING REFERENCE MATERIAL- Employees should gain access to EDRMS in order to review most of the documents shown below. Instructions for obtaining access to EDRMS are at the bottom of the page. It is a good idea to keep a copy of these documents in your "favorites" folder in EDRMS. Institutional documents can be found by performing a search of the LANL Website.

- P300 *Integrated Work Management*
- SD-130 *Nuclear Criticality Safety Program*
- P121 *Radiation Protection Handbook*
- PA-AP-01032 *Material at Risk Requirements for TA55*
- PA-AP-01020 *Pre-Job Briefing and Post-Job Briefing*
- TA55-RD-585 *Nuclear Material Control and Accountability*
- TA55-RD-555 *Radiation Protection Requirements*
- TA55-AP-522 *TA-55 Nuclear Criticality Safety Program*
- TA55-AP-010 *Integrated Plan-of-the Day and Integrated Plan-of-the Week Meetings*
- TA55-AP-127 *TA-55, PF-4 Safeguards Two-person Rule Implementation Procedure*
- TA55-DOP-016 *TA-55 Material Staging, Handling, and Movement*
- TA55-DOP-026 *Operating Electronic Balances*
- TA55-STP-002 *Control and Execution of TA-55 Safety System LCOs and Surveillances*
- PA-PLAN-01010 *PF-4 Emergency Procedures*
- DOE O 474.2 *Nuclear Material Control and Accountability*
- PA-RD-01009*TA55 Criticality Safety Requirements*
- TA55-AP-118 *Daily Administrative Check*
- TA55-AP-023 *Posting PF-4 Rooms*

Instructions for obtaining access to EDRMS:

FLM can request access for the student by notifying ta55documents@lanl.gov, with Name, Z#, and confirmation of purchasing the Documentum user license from esd.lanl.gov. A DCC will notify the FLM, and the student that they have access to EDRMS and the ADPSM Cabinet.

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TA-55 Radiological Protection Requirements

Course Objective

- Objective - Perform FMH activities according to RP requirements
- To help meet the objective, the following topics are covered in this presentation:
  - Working in RCAs at TA-55
  - CAMs and Contamination Monitors
  - Contamination Control Philosophy at TA-55
  - External Radiation Control Philosophy at TA-55
  - As Low As Reasonably Achievable (ALARA)

Course Objective

- As fissile material handlers you should already know the RP requirements for TA-55 pretty well, but may not know the reasoning or why the requirements are established the way they are!
- The real objective is to help explain the reasoning and/or purpose of RP requirements at TA-55
- Hopefully, if you know the reasoning behind the requirements, it will help you implement the them on a day-to-day basis.

Working in RCAs at TA-55

- High Hazard Radiological Work
  - Requires a work authorizing document approved by an RP SME **AND** an RWP
  - Definition from P121
    - Work that could contaminate uncontrolled areas or the environment
    - Work in (or likely to create) a high contamination area
    - Work in (or likely to create) an airborne radioactivity area with levels >40 derived air concentration (DAC)
    - Work in areas where the dose rate >1 rem/hr
    - Work expected to create uncharacterized radiological conditions including:
      - Working outside engineered controls
      - Breaching engineered containment systems

Working in RCAs at TA-55

- Moderate Hazard Radiological Work
  - Requires a work authorizing document approved by an RP SME
  - Definition from P121
    - Work in areas where the dose rate is >5 mrem/hr and <1 rem/hr
      - Definition of a Radiation Area? High Radiation Area?
    - Work in a contamination area or performing activities that could likely result in creating a contamination area
    - Work in an airborne radioactivity with levels <40 DAC or performing activities that could likely result in such conditions

Working in RCAs at TA-55

- What is the hazard grading for the below work?
  - Window Changes?
  - Glovebox Glove Changes?
  - Bagouts?
  - Push thru HEPA filters?
  - Opening an unapproved container of RAM outside an open front hood or glovebox?
  - Working in a Radiation Area?
  - Maintenance on Wet Vac System?
  - Glovebox work
  - Retrieving Items from the vault?
- Examples of Moderate and High Hazard work are given in TA55-RD-555

Working in RCAs at TA-55

- An RWP shall be used for entry into the following areas, irrespective of the work to be performed:
  - Radiation areas exceeding 75 mrem/h
    - Do you remember the definition of a High Radiation Area
  - High contamination areas
  - Airborne radioactivity areas
  - Hot-job exclusion areas (except when being used during the response to a radiological emergency)
  - When indicated as a requirement on radiological entry posting

Working in RCAs at TA-55

- Summary – You should have a better understanding of:
  - The differences between Moderate and High Radiological Work and the requirements for each?
  - When an RWP is required?
  - Why you need an RWP at TA-55 at >= 75 mr/h?
  - Definitions of a Radiation Area and High Radiation Area?

CAMs and Contamination Monitors

- Air Monitoring - the best field indicator that there is a radiological problem (my opinion)
  - ~260 Continuous Air Monitors (CAMs)
    - RCTs verify operability daily
    - Filters changed weekly
    - Alarm set point – 3 DAC-h
    - Set up to measure Pu-239, Pu-238, and Np-237 simultaneously
      - These isotopes represent the alpha energies encountered at TA-55

CAMs and Contamination Monitors

- Air Monitoring (cont.)
  - 1600 Fixed Air Samplers (FAS)
    - Filters changed daily or weekly depending on the area
  - On a monthly basis we change ~ 7200 CAM/FAS filters

CAMs and Contamination Monitors

- As a worker, you should become familiar with the indications of the Alpha-7L CAMs operating in your area, including:
  - A green light is “normal” indication for the CAM
  - An orange light is “trouble” indication for the CAM
    - Still operational, but an RCT is required to be contacted
  - Flashing green, orange, and blue light – CAM Failure
  - A red light – CAM alarm
  - Normal display of the CAM?

CAMs and Contamination Monitors

- Elevated Alpha-7L CAM Display
  - Normally < 1.0 DAC-h
  - Any other reading indicates an elevated CAM
    - Why do we care if a CAM is elevated?
    - What do you do if a CAM is elevated?

Air Monitoring Review – Pu-239

Given/Miscellaneous Information			Units
Volume of a sphere = 4/3 π r^3	denity =	5	g/cm^3
AMAD ≈ diameter *sqrt of ρ	AMAD (1) =	1	(um)
Specific Activity = 0.0622 Ci/g	AMAD(2) =	5	(um)

Only the density can be input

Yellow highlighted cells

are the results of the changing the density of the material.

		Units
Particle Radius (1)	0.223606798	um
Particle Radius (2)	1.118033989	um
Vol (Particle 1)	4.68321E-14	cm^3
Vol (Particle 2)	5.85401E-12	cm^3
Acitivity of Particle (1)	1.45648E-14	Ci
Acitivity of Particle (2)	1.8206E-12	Ci

Effective Dose Coefficient
(mrem/dpm)

	1 um	5 um
M-Class	7.80E-02	5.33E-02
S-Class	2.50E-02	1.38E-02

DAC (S-class)	6.00E-11uCi/ml
DAC (M-class)	5.00E-12uCi/ml

M-Class: Unspecified compounds
S-Class: Insoluble Oxides

Inhalation of 1 Particle Will Deliver a Dose in mrem

	1 um	5 um
M-Class	2.52E-03	2.15E-01
S-Class	8.08E-04	5.58E-02

Number of Particles in 1 m^3 of Air that Equates to 1 DAC
(1 DAC-h = 2.5 mrem of dose delivered to the body)
(1 DAC = Airborne Radioactivity Area)

	1 um	5 um
M-Class	1.55E+02	1.24E+00
S-Class	1.86E+03	1.48E+01

Therefore if an individual was in an area for 1 hour that contained the number of particles /m^3 in the above table, he or she would receive 2.5 mrem. Note: this scales lineraly therfore 10 hours would be 25 mrem OR if 10 times the amount of particles were present an individual would receive 25 mrem in 1 hour.

Air Monitoring Review – Pu-238

Given/Miscellaneous Information			Units
Volume of a sphere = 4/3 π r^3	denity =	5	g/cm^3
AMAD ≈ diameter *sqrt of ρ	AMAD (1) =	1	(um)
Specific Activity = 0.0622 Ci/g	AMAD(2) =	5	(um)

Only the density can be input

Yellow highlighted cells

are the results of the changing the density of the material.

		Units
Particle Radius (1)	0.223606798	um
Particle Radius (2)	1.118033989	um
Vol (Particle 1)	4.68321E-14	cm^3
Vol (Particle 2)	5.85401E-12	cm^3
Acitivity of Particle (1)	1.45648E-14	Ci
Acitivity of Particle (2)	1.8206E-12	Ci

Effective Dose Coefficient
(mrem/dpm)

	1 um	5 um
M-Class	7.80E-02	5.33E-02
S-Class	2.50E-02	1.38E-02

DAC (S-class)	6.00E-11uCi/ml
DAC (M-class)	5.00E-12uCi/ml

M-Class: Unspecified compounds
S-Class: Insoluble Oxides

Inhalation of 1 Particle Will Deliver a Dose in mrem

	1 um	5 um
M-Class	2.52E-03	2.15E-01
S-Class	8.08E-04	5.58E-02

Number of Particles in 1 m^3 of Air that Equates to 1 DAC
(1 DAC-h = 2.5 mrem of dose delivered to the body)
(1 DAC = Airborne Radioactivity Area)

	1 um	5 um
M-Class	1.55E+02	1.24E+00
S-Class	1.86E+03	1.48E+01

Therefore if an individual was in an area for 1 hour that contained the number of particles /m^3 in the above table, he or she would receive 2.5 mrem. Note: this scales lineraly therfore 10 hours would be 25 mrem OR if 10 times the amount of particles were present an individual would receive 25 mrem in 1 hour.

CAMs and Contamination Monitors

- Response to a CAM alarm with no respirator protection includes the following actions :
  - Immediately exit the area to a safe haven
    - 1st floor laboratory – corridor
    - Basement – opposite side of the basement
    - Corridor
  - Remain in the safe haven until RCTs respond to the CAM alarm and release all personnel involved.
  - If in a first floor laboratory is it OK to exit into another laboratory space? Why or why not?

CAMs and Contamination Monitors

- If a CAM alarms while wearing respiratory protection, then follow RCT directions.
  - Scenarios!

CAMs and Contamination Monitors

- Actions to take for radiological instrumentation not working correctly
  - If a CAM is inoperable or its performance is suspect, immediately contact radiation protection and the Operations Center, monitor and leave the area.
  - If a contamination monitor is inoperable or its performance is suspect, contact radiation protection personnel. If radiation protection personnel are not readily available, place a note on the faulty contamination monitor or probe indicating *out of service*.

CAMs and Contamination Monitors

- Responding to a personnel contamination monitor alarm includes the following actions:
  - Remain in the immediate area if safe to do so
  - Have another worker notify radiation protection (typically, the facility or area RCT) and the Operations Center
  - Minimize cross-contamination by avoiding movement or touching any surfaces
  - Do not leave the RCA unless it is an emergency

CAMs and Contamination Monitors

- In the previous slide did you notice it did not state, “Recount Yourself”
  - This is a huge problem with HFM-8 alarms
- Reasons for not counting yourself again?
  - Hint – think of how RCTs respond to HFM-8 alarm.
- What if your contamination monitor is not working correctly, i.e. sporadically alarming.
  - Is this acceptable?

CAMs and Contamination Monitors

- Summary
  - Importance of CAMs and the workplace and how to recognize potential problems with CAMs
  - The proper response for CAM alarms and why we respond in this manner
  - The proper response to a contamination alarm and the reasoning why
  - What to do if a CAM or contamination monitor is not working properly and the reasoning why.

Contamination Control Philosophy at TA-55

- Any contamination control philosophy should simply reduce the risk of:
  - Intake of radioactive material
  - Spread of radioactive material to uncontrolled areas
  - Limit the buildup of radioactive material in the workplace
  - Limit/reduce source material that is out not contained in an engineered barrier.
- Our contamination control philosophy is easily conveyed in one simple statement?
- Ideas?

Contamination Control Philosophy at TA-55

- **Philosophy, "Detect the contamination closest to the source as possible!"**
- Our contamination control philosophy primarily is achieved by the following RP requirements:
  - **Personnel Monitoring Requirements**
  - Glovebox Sharp Requirements
  - Routine Monitoring Instructions (RMIs) & Radiation Protection Information Notifications (RPINs)

Contamination Control Philosophy at TA-55

- Personnel Monitoring Requirements
- Whole body survey of personnel required to be performed by RCT:
  - Exiting from posted Contamination, High Contamination, or Airborne Radioactivity Areas
  - Completion of “hot jobs” e.g. window change, glove change, etc.
  - Outer set of PPE surveyed with hand-held instrument (Ludlum Model 139)

Contamination Control Philosophy at TA-55

- Personnel Monitoring Requirements
  - Whole body survey performed by the operator on his or her PPE is required when prior to exiting RBA *after*:
    - Performing work in glovebox gloves
    - Performing “hands-on-work” on the exterior of gloveboxes
    - Work involving handling or opening radioactive material, handling containers of radioactive material, handling contaminated items or equipment
    - *Any* work that required kneeling, leaning against or sitting on surfaces in the RBA (except chair)
    - Survey is performed by a with Ludlum Model 214 or Model 215

Contamination Control Philosophy at TA-55

- Personnel Monitoring Requirements - Summary
  - If an individual enters an RBA, the minimum monitoring requirements are
    - Twice on automated HFM-8 with booties on
    - Once on the PCM-2 with anti-c coveralls or labcoat on
    - IF work performed in an RBA, THEN a full body frisk is also required
  - If an individual enters an RCA, the minimum requirements are
    - Once on automated HFM-8 with booties on
    - Once on the PCM-2 with anti-c coveralls or labcoat on

Contamination Control Philosophy at TA-55

- TA-55's exit monitoring requirements are different than a number of sites for one reason:
  - *PPE is required to be surveyed prior to exiting an area to another area*
- Vital personnel monitor correctly out of areas in order to help achieve our contamination control philosophy,
  - **"Detect the contamination closest to the source as possible!"**

Contamination Control Philosophy at TA-55

- Importance of frisking correctly with a 2000 dpm source demo!

Contamination Control Philosophy

- Personnel Monitoring Requirements - Quiz
  - When is a full body survey required when exiting an RBA?
    - What is the allowable frisking speed and distance when using the hand-held detector to perform
  - When are you only required to monitor your hands and feet when exiting an RBA?
    - Can you use a hand-held detector to survey your hands and feet prior to exiting if an automated HFM is available?
  - Is a second person *required* to observe an individual perform a full body survey?
    - Why / why not?
  - If you know that you pressed down to hard on the foot pedestal on the HFM-8 – it is allowable to recount yourself if you get an alarm?
  - Why do we survey our anti-c's?

Contamination Control Philosophy at TA-55

- Our contamination control philosophy primarily is achieved by the following RP requirements:
  - ~~**Personnel Monitoring Requirements**~~
  - **Glovebox Sharp Requirements**
  - Routine Monitoring Instructions (RMIs) & Radiation Protection Information Notifications (RPINs)

Glovebox Sharp Requirements

- Glovebox breaches are one of the primary reasons why personnel become contaminated
- Glovebox breaches increases the chance of an intake of radioactive material
- 3 primary means to receive an intake of radioactive material :
  - Inhalation
  - Absorption
  - Injection

Injection of RAM

	Dose Coefficient (Sv/Bq)	# of grams for a 5 Rem Dose	# of Nano grams for a 5 rem dose	# of grains of salt (1 grain = 5.85e-5 g)	dpm
Pu238	4.44e-4	1.78e-10	1.78e-1	3e-6	6.8e7
Pu239	4.89e-4	4.44e-8	44	7.6e-4	6.1e9

Injection of RAM

- From the previous slide – it does not take very much radioactive material injected to reach the legal limit of 5 Rem.
- Recently we had an injection of RAM where there was no visible wound only skin contamination associated with the glove breach
  - –RP procedures have been updated to account for this
- In addition, TA55 requires over-gloves for all work with sharps unless there is a variance approved by the Division Leader

Contamination Control Philosophy at TA-55

- Our contamination control philosophy primarily is achieved by the following RP requirements:
  - ~~**Personnel Monitoring Requirements**~~
  - ~~**Glovebox Sharp Requirements**~~
  - Routine Monitoring Instructions (RMIs) & Radiation Protection Information Notifications (RPINs)

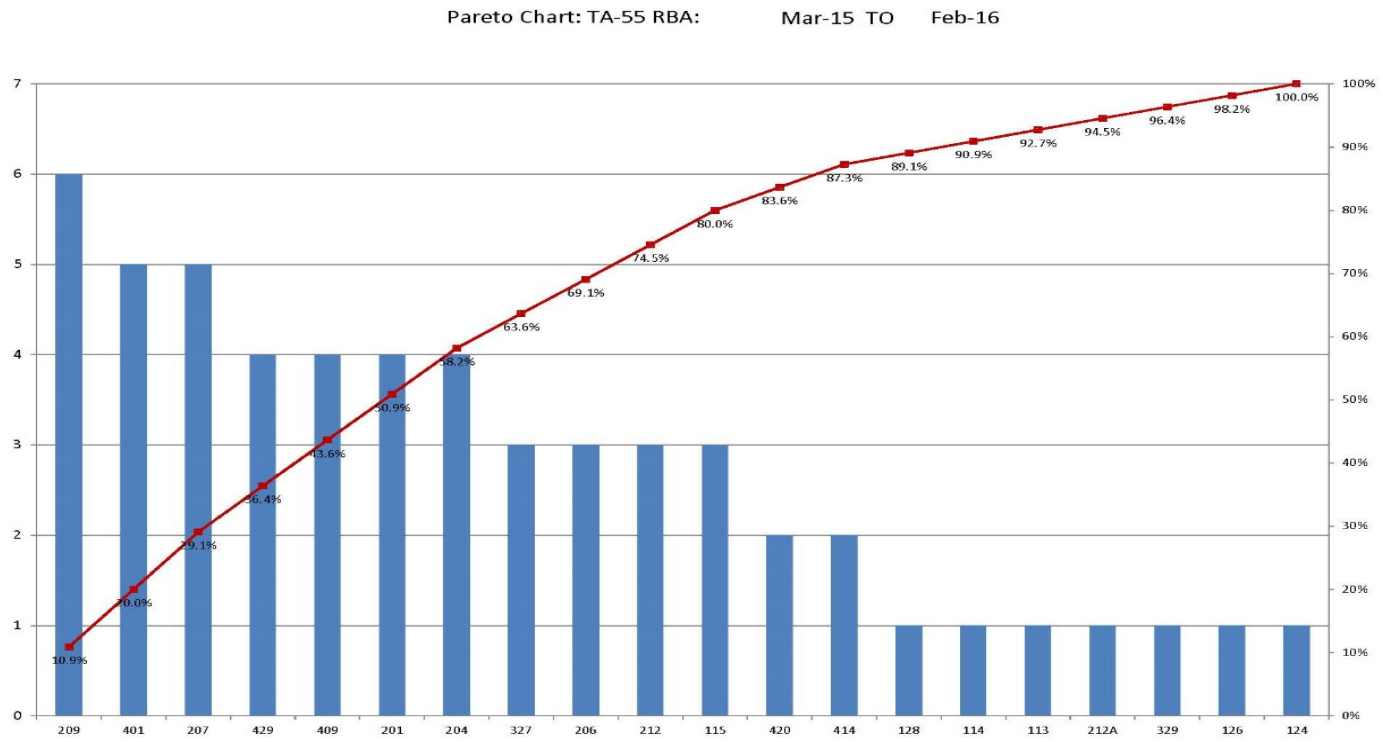
Contamination Control Philosophy at TA-55

- RMIs are completed at specific frequencies to meet compliance requirements
  - Graded approach used to determine frequencies
  - Philosophy on frequency – focus on the radioactive material source and work out
- Reviewed and approved annually
  - During annual review, Radiation Protection Information Notifications (RPINs) are reviewed to determine if revisions in frequency are required

Contamination Control Philosophy at TA-55

- RPINs
  - Electronic system that tracks radiological incidents or occurrences.
  - Ability to organize data by event type, location, or time.
  - Used primarily to generate RadCon Performance Metrics and establish RMI frequencies

Contamination Control Philosophy at TA-55



Contamination Control Summary

- Very good idea on what our contamination control philosophy is and why self-monitoring is so important
- Microscopic amounts of Radioactive Material injected into the body can result in large doses
- How RMIs and RPINs are used to help implement the contamination control philosophy
- Why we monitor our anti-c's when other sites don't!

External Radiation Control Philosophy

- PF-4 is posted as a radiation area – Why?
- Laboratory spaces on the first floor that contain radiation areas have a map on the main entrance into the space that denotes the radiation areas within the room and the associated dose rates.
- Radiation areas ≤ 75 mrem/h at 30 cm are denoted with stanchion and Radiation Area Posting that denotes the highest dose rate in the area
- Radiation areas ≥75 mrem/h at 30 cm are denoted with physical barrier in addition to the stanchion and radiological posting. In addition an EPD is required to enter these areas.

External Radiation Control Philosophy

- A map with the dose rates associated with the vault are posted in the vault vestibule area and are required to be reviewed prior to entering the vault to perform work.
- Future improvements: Color coded system that delineates dose rate ranges.

External Radiation Control Philosophy

- It is every workers' responsibility to know
  - The dose rates he or she are working in and
  - If RAM is moved that potentially could create a new radiation area or significantly change a radiation area that is already posted – *contact an RCT.*
- If you are not sure of the dose rates you are working in – contact an RCT

As Low As Reasonably Achievable (ALARA)

- We all know the basic tenants of ALARA and how we implement:
  - Time, Distance, and Shielding
  - In regards to implementation, everyone of us can improve.
  - For example, have you ever seen 2 people carrying on a conversation in a laboratory space in a posted Radiation Area that had nothing to with work or the task at hand.
    - Examples: Recent CRA's .

As Low As Reasonably Achievable (ALARA)

- ALARA Working Team
  - Members of AMPP, NPI, PT, MST-16 and C–AAC
  - Charter is on EDRMS
  - The purpose of the AWT simply put is to review operations out in the field and make recommendations on how to keep doses ALARA.
  - Who is your ALARA coordinator?

Done at Last!

Questions?

Los Alamos
NATIONAL LABORATORY
EST. 1943

TA-55
Nuclear Material Control and Accountability

(Updated 16-Jan-2019)

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Why Am I Here?

- **Operators and supervisors are considered NM Handlers because they perform the following types of Fissile Material Handler (FMH) activities with nuclear material:**
  - Move or transport
  - Process
  - Store
  - Support or oversee activities

Prerequisite

- **FMH Operators and Supervisors**
  - Complete Nuclear Material Handler training
  - UTrain course #8005
  - Provides basic overview of nuclear material handing requirements

Co-Requisites

- **FMH Operators and Supervisors**
  - Register for LANMAS User Orientation
  - UTrain course #50337
  - Provides hands-on computer learning experience with the nuclear material accounting system
    - ✓ Los Alamos Material Control and Accountability System (LAMCAS)
    - ✓ Local Area Network Material Accounting Software (LANMAS) software

Co-Requisites

- **FMH Operators**
  - Register for Tamper Indicating Device (TID) training
  - UTrain course #50112
  - Provides classroom and hands-on training in the application and removal of TIDs

What Is NMCA?

- **Nuclear Material Control and Accountability (NMCA) is a security program that is important to you**
- **The NMCA program has only one goal:**
  - To detect and deter the theft and diversion of nuclear material (NM)
    - ✓ Theft = stealing
    - ✓ Diversion = putting the NM in an unauthorized location

NMCA Program Elements

- **Program Management**
  - Program documentation
  - Training and qualification
  - Performance assurance
- **Nuclear Material Control**
  - Control
  - Access controls
  - Material Surveillance
- **Measurements**
  - Measurements
  - Measurement control

NMCA Program Elements, cont

- **Material Accounting**
  - Accounting system (LAMCAS)
  - Accounting data and records
  - Accounting reports
- **Physical Inventory**
  - Scheduling and planning
  - Performance
  - Reconciliation

Why Is NMCA Important to Me?

- **One of several layers of protection**
- **If the program is not implemented and executed correctly, bad things can happen:**
  - Nuclear material operations may be paused
  - Laboratory programs may loose funding
  - The size of the Laboratory workforce may be reduced
    - ✓ Recession vs. Depression
  - **You may not be able to go home**

How is NMCA Implemented?

- **NMCA is implemented in a "graded" manner**
  - Graded = A system that provides the greatest relative amount of control and effort to the types and quantities of special nuclear material that can be most effectively used in a nuclear explosive device

“Graded” Manner In Action

	Attractiveness Level	Pu or U-233 (kg)				U-235 or Separated AM-241/Am-243/Np-237 (kg)				All Attractiveness Level E Materials Category IV
		I	II	III	IV	I	II	III	IV	
WEAPONS Assembled weapons and test devices	**A**	All	N/A	N/A	N/A	All	N/A	N/A	N/A	N/A
PURE PRODUCTS Pits, buttons, ingots, recastable metal…	**B**	≥2	≥0.4 <2	≥0.2 <0.4	<0.2	≥5	≥1 <5	≥0.4 <1	<0.4	N/A
HIGH-GRADE MATERIALS Carbides, oxides, solutions (≥25g/l)…	**C**	≥6	≥2 <6	≥0.4 <2	<0.4	≥20	≥6 <20	≥2 <6	<2	N/A
LOW-GRADE MATERIALS Process residues, Pu-238…	**D**	N/A	≥16	≥3 <16	<3	N/A	≥50	≥8 <50	<8	N/A
ALL OTHER MATERIALS Uranium <20% U-235, Solutions (<1g/l)…	**E**	N/A	N/A	N/A	Reportable Quantities	N/A	N/A	N/A	Reportable Quantities	Reportable Quantities

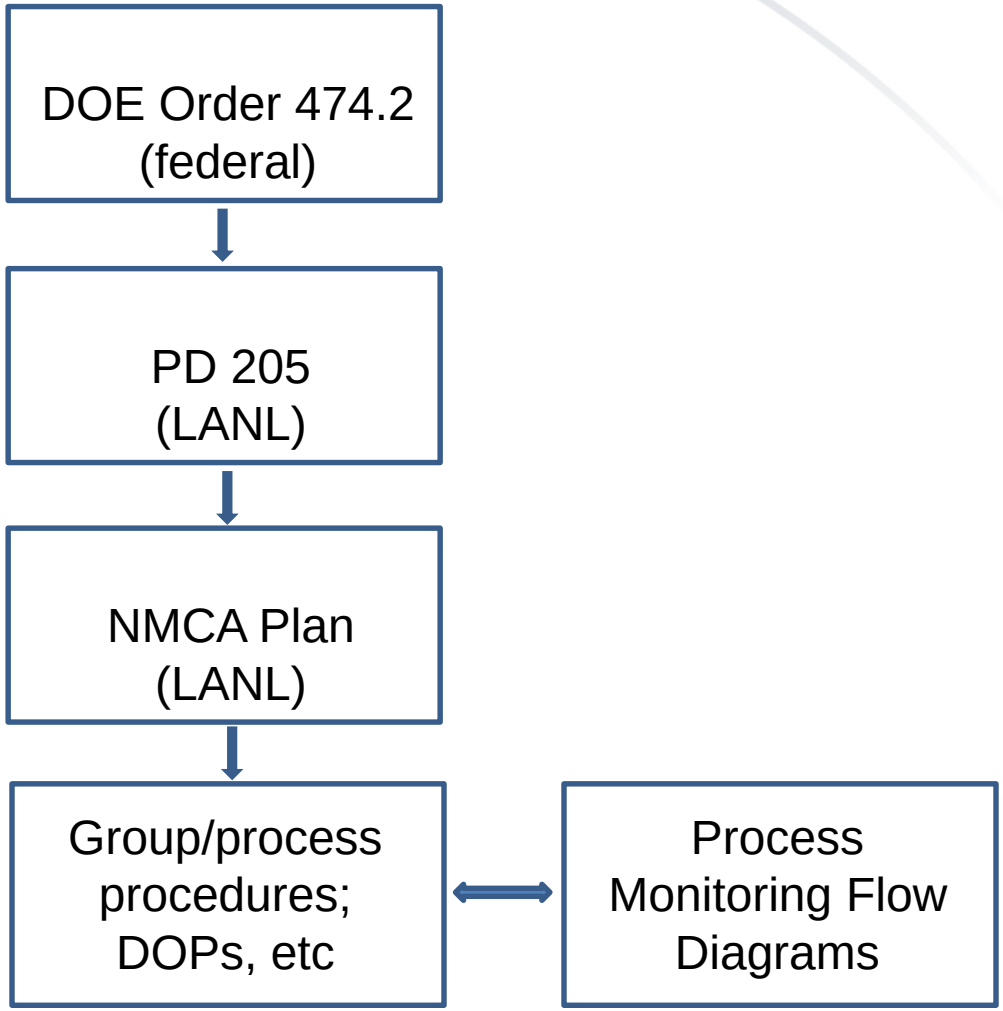
What Materials Are Of Concern?

Element/Isotope	Type	Reportable Quantity
Americium 241	SNM	gram
Americium 243	SNM	gram
Berkelium	Other	microgram
Californium 252	Other	microgram
Curium	Other	gram
Deuterium	Other	tenth of a kilogram
Lithium (enriched Li-6)	Other	kilogram
Neptunium 237	Other	gram
Plutonium 238	SNM	tenth of a gram
Plutonium 239-241	SNM	gram
Plutonium 242	SNM	gram
Thorium	Source	kilogram
Tritium	Other	gram
Uranium 233	SNM	gram
Depleted Uranium (<.7% U-235)	Source	kilogram
Enriched Uranium (>.7% U-235)	SNM	gram
Normal Uranium (=.7% U-235)	Source	kilogram
Uranium in Cascades	SNM	gram

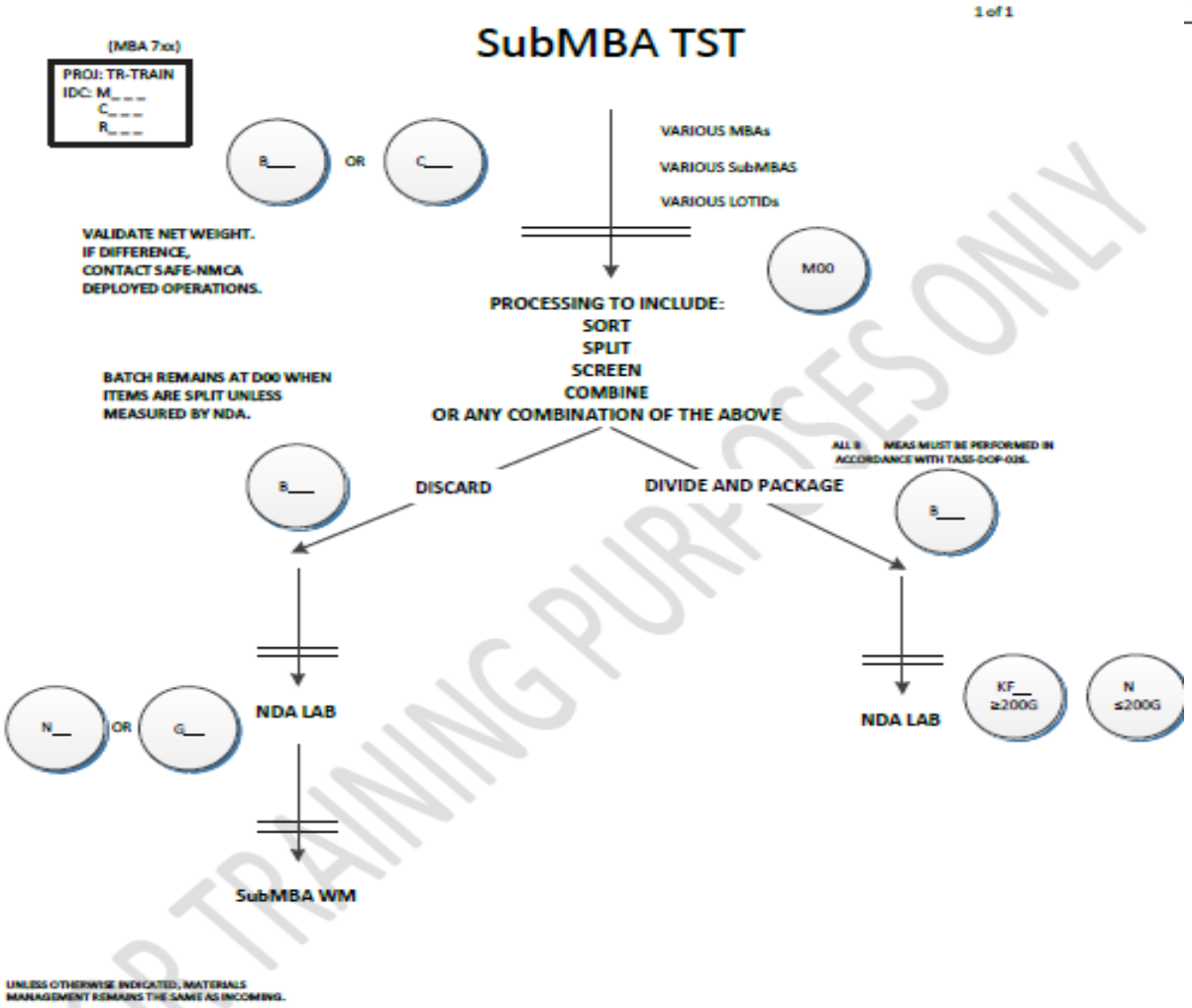
NMCA Importance

- **Compliance is a key to success**
  - Performance Based Incentives
  - Vulnerability Assessment
  - DOE Order 474.2
    - ✓ To ensure that we don't lose the material
    - ✓ To ensure that our products meet specifications

NMCA Requirements Hierarchy



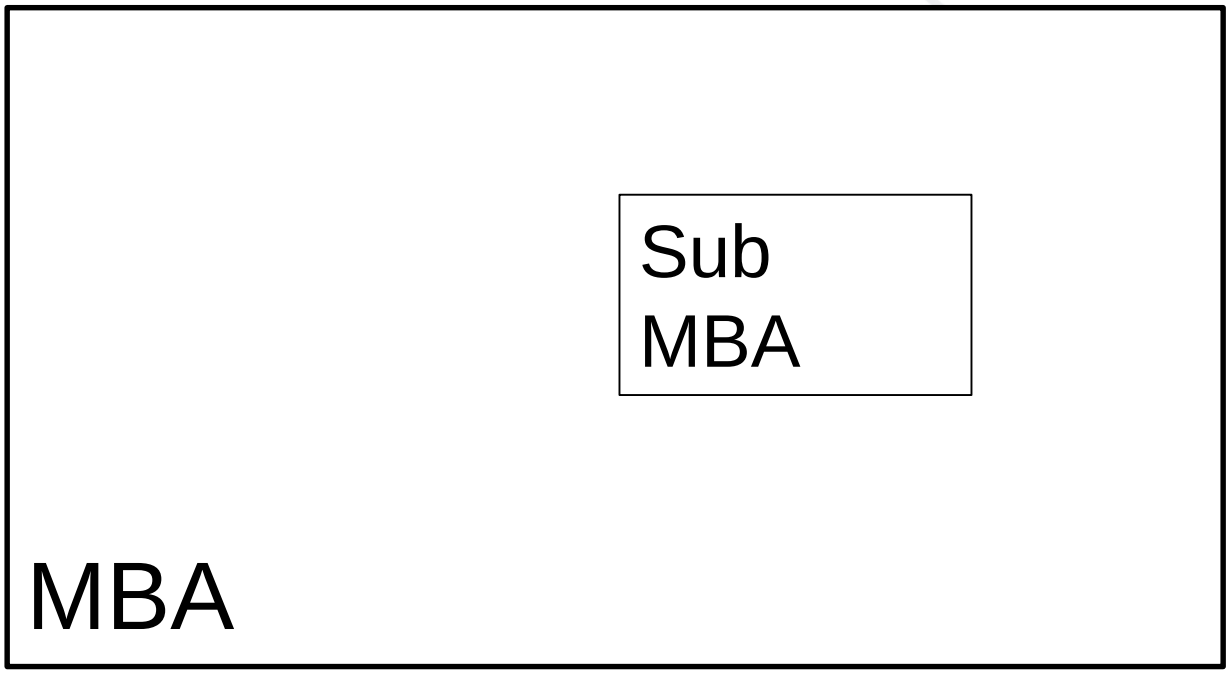
PMFD



NMCA Implementation At TA-55

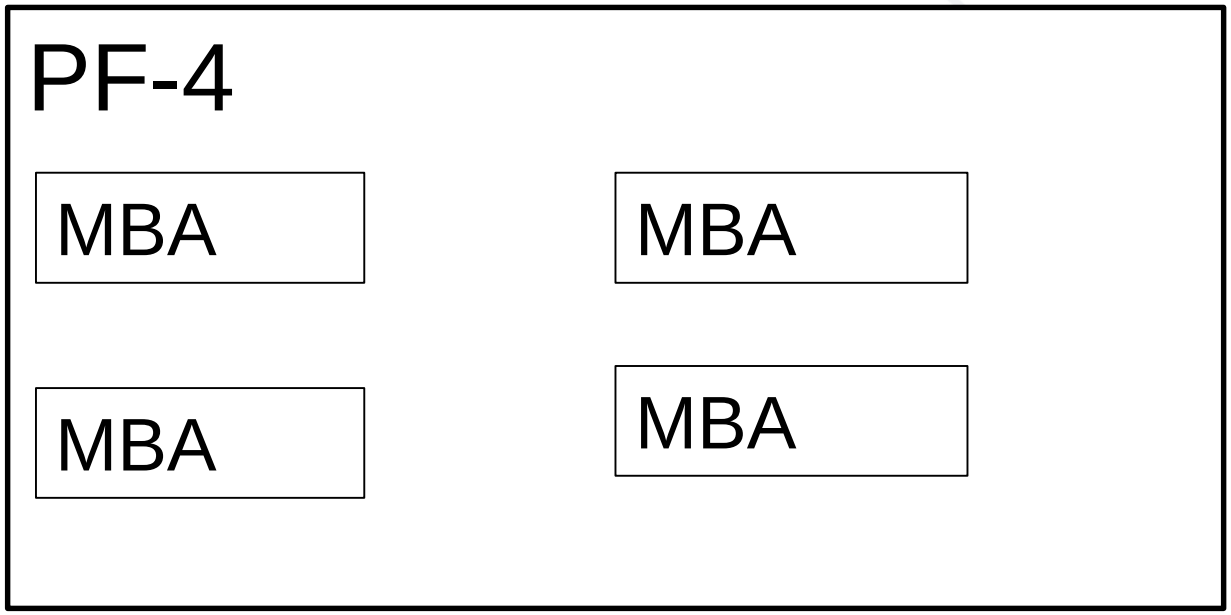
- **Implementation of NMCA at TA-55 is unique at LANL for several reasons:**
  - PF-4 is LANL's only Category I nuclear material facility
  - Number and diversity of nuclear material forms and processes
  - Frequent changes in processes and procedures required to fulfill the varied missions
  - Shared use of Material Balance Areas (MBAs) by multiple users or operations groups at TA-55
- **As a Category I facility, all of the NMCA program elements and requirements apply**

Material Balance Area (MBA)

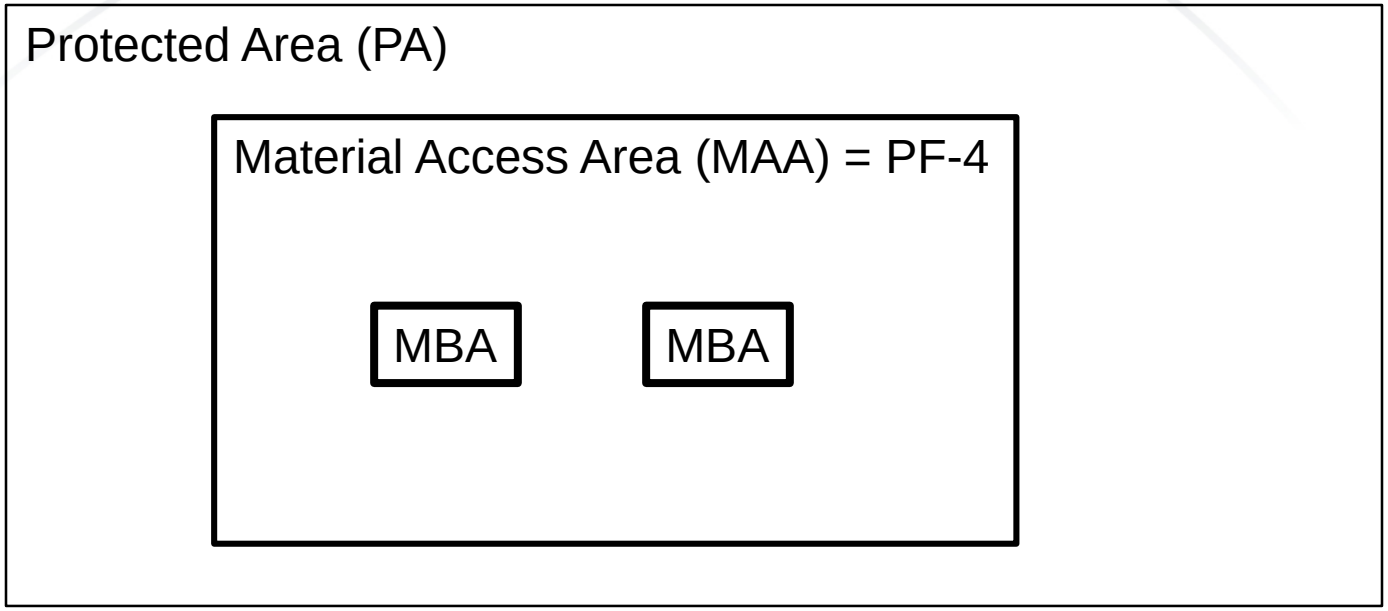


Keeping good records and transactions keeps track of the material

Material Balance Area (MBA)



Category I Security Areas



TA-55 was designed with a defense-in-depth concept. As you move closer to higher attractiveness-level material, you have to pass through more and more physical barriers (security areas).

MBA Custodian

- **Roles and Responsibilities**
  - The MBA Custodian leads the inventory team
  - Approving transfers between MBAs, and general oversight of all activities related to nuclear materials.
  - Perform Daily Administrative Checks DACs
    - ✓ Ensure that locks on safes, waste containers, drop boxes, and other required NM repositories are used as prescribed in the MBA

MBA Custodian

- **Roles and Responsibilities**
  - The MBA Custodians perform weekly Item Monitoring
  - Ensure that inventory action forms are resolved with the assigned MBA and within the prescribed time frame
  - Aid in ensuring that Safeguards & Security rules are followed
    - ✓ Safeguards two-person
    - ✓ Safeguards modified two-person

Operator Responsibilities

- **Enter accounting system transactions as soon as possible**
- **Notify the NM Custodian immediately of any abnormal situation**
  - Some situations require face-to-face notification
- **Ensure safeguards two-person or modified two-person rule is implemented and followed within applicable areas**
- **Support physical inventories**

Attention Needed

- **Each Nuclear Material Item Must Be Labeled**
  - Labels can be anything you want
    - ✓ Tape and Sharpie marker
    - ✓ Etched plate
    - ✓ Etc.
  - Labels must be legible
    - ✓ If you can't read it, nobody else can either
  - At a minimum the label must include:
    - ✓ Material Type (MT),
    - ✓ Material Name
- **Empty Containers**
  - At a minimum must be labeled empty and should have the lid off

Attention Needed Here Too

- **NMC&A Floor Location Restrictions**
  - Items allowed to be stored on floor locations are limited to Attractiveness Level D and E items only

Reporting

- **Preventing Occurrences**
  - FMH workers are the first line of defense
    - ✓ You are expected to report occurrences as well as any suspected mishandling of NM
- **Notification Guidance**
  - Contact the TA-55 Operations Center
  - Contact SAFE-NMCA
  - A missing or potentially missing item of NM is a reportable incident
    - Reportable incidents are a Potential Process Deviation

Contact Information

Contact Information for TA-55 Operators

- SAFE-NMCA personnel are located in PF-3 Room 121 (Hardened Room) and are available to assist you with any NMCA questions:
  - ✓ 24-hr. and emergency NMCA pager: 664-5616.
  - ✓ Isotope injection or other MC&A questions, please call the SAFE-NMCA Group Office @ 667-5886
  - ✓ For other questions, consult the SAFE-NMCA home page: http://int.lanl.gov/security/safeguards/nmca/index.shtml

Technical Safety Requirements (TSR): TA-55 Material At Risk and Container Requirements

Learning Objectives

- What is MAR and what are your responsibilities to ensure the facility stays within those limits
- How do container types impact MAR limits

What is MAR?

- Formal definition
  - **Material-At-Risk (MAR)**

    is the amount of radionuclide (in grams or curies of activity for each radionuclide) available to be acted on by a given physical stress.
    - ✓ Earthquake
    - ✓ Fire
    - ✓ Explosion

How are MAR Limits Derived?

- MAR Limits
  - Chapter 3, *Hazards and Accident Analyses* of the TA-55 Documented Safety Analysis (DSA)
    - Ch.3 analyzes processes within the facility and all potential hazards/accidents in order to derive controls to mitigate material release, accidents, etc.
  - Imposed on the facility to ensure that the quantities assumed in the accident analysis are not exceeded, which would put the facility in a formally unanalyzed condition.

Why do we have MAR Limits?

- MAR Controls
  - are a Specific Administrative Control (SAC) in the form of an Limiting Condition of Operations (LCO) to mitigate potential onsite and offsite consequences in the event of a release accident.
    - LCO – limits that represent the lowest capability or performance level of a system (in this case material limits) required for safe operations
  - MAR LCO 3.7.1 (HS-Pu) and LCO 3.7.2 (MAR All Material Types)

Controlling MAR limits

- MAR limits are controlled
  - with Limiting Conditions of Operation (LCO) via Surveillance Requirements and other safety basis controls to ensure that the MAR is within its defined bounds, for which the DOE accepts the operational risk.
  - Examples:
    - a total limit of ### kg of Pu-equivalent in all of the first floor
    - a total limit of ### g of WG-Pu equivalent in the aqueous plutonium recovery solvent extraction process

Following MAR Limits

- When a MAR limit is greater than a criticality safety mass limit
  - the criticality safety limit is more conservative that the MAR limits, therefore it implements the MAR, and a MAR posting is NOT REQUIRED.
  - Follow the limits on the Criticality Safety Posting (CSP)

Following MAR Limits

- **When a criticality safety mass limit is greater than a MAR mass limit**
  - MAR postings will be established and MAR is administratively controlled via PA-AP-01017, Control of Equipment and System Status, through the TA-55 Operations Center.

Posted Limits

- **MAR and Criticality Limits**

  Must be adhered to at all times

Containers

- What you need to know:
  - Assist in reducing the overall MAR limit in the facility (i.e., the 1st floor total limit)
  - What Damage Ratio (DR) is
  - Container performance criteria requirements required for applying “CERT” (i.e., container certification) to a given container

What is Damage Ratio?

- A percent reduction applied to a certified container (“CERT” in LANMAS) that reduces the MAR limit within that container
  - Ex: 100 g x 1% DR (DR=0.01) = 1 g
- Containers are tested (drops, fire, water ingress, etc.) to be allowed to be certified.

Damage Ratio (DR) of Containers

TA-55 Containers in the Safety Basis and Associated Damage Ratios (DR)

Container	Welded	DR	OK inside GB	OK outside GB	Certified LANMAS Designation	Must be overpacked by DR<1 Container in GB for MAR Credit	When it is credited on LANMAS
Fire rated transfer container (HS-Pu transport & storage) Safety-Class (DF 6.1.11)	N	0.01	Y	N	Cert-FRTC	N	Whenever the lid is on inside the GB and ≤ 4 ft. from the laboratory floor (e.g. cannot be on a shelf and currently credited)
Modified Slip Lid Safety-Class (Not Implemented, DF 6.1.11)	N	0.01	Y	N	N/A (Modified Slip Lid is not currently implemented)	Y (for MAR credit)	NA
Fire Rated Conflat Safety-Class (DF 6.1.11)	N	0.01	Y	N	CERT-CFLT	N	Whenever the lid is on inside the GB and ≤ 4 ft from the laboratory floor (e.g. cannot be on a shelf and currently credited)
Ball Mill Jars for HS-Pu Safety-Class (DF 6.1.11)	N	0.01	Y	N	Cert01-BMJ	N	Whenever the lid is on inside the GB and ≤ 4 ft. from the laboratory floor (e.g. cannot be on a shelf and currently credited)
EP 60 Not Credited	N	1	Y	N	Not certified	Y (for MAR credit)	NA
FSI Not Credited	N	1	Y	N	Not certified	Y (for MAR credit)	NA
Fuel Storage Can Not Credited	N	1	Y	N	Not certified	Y (for MAR credit)	NA
Slip lid Not Credited	N	1	Y	N	Not certified	Y (for MAR credit)	NA

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Damage Ratio (DR) of Containers

TA-55 Containers in the Safety Basis and Associated Damage Ratios (DR)

Container	Welded	DR	OK inside GB	OK outside GB	Certified LANMAS Designation	Must be overpacked by DR<1 Container in GB for MAR Credit	When it is credited on LANMAS
Pressure Cooker and Type A's defined in ADWEM-AB:06-049 Safety-Significant (DF 6.2.5)	N	1	Y	Y	Not certified	N/A	NA
Slip Lid Vented Not Credited	N	1	Y	N	Not certified	Y (for MAR credit)	NA
GPHS[1] Safety-Class (DF 6.1.2)	Y	0	Y	Y	Cert-GPHS	N	As soon as it passes leak check and ≤ 11 ft. from the floor -May be credited inside or outside the GB line unless degraded (i.e. bulging)
FCA Safety-Class (DF 6.1.2)	Y	0	Y	Y	Cert-FCA	N	As soon as it passes leak check and ≤ 11 ft. from the floor -May be credited inside or outside the GB line unless degraded
FSO Safety-Class (DF 6.1.9)	Y	0	N	Y	Cert-FSO	N	Once leak checked-May be credited outside the VWB or inside/outside a GB
EP 61 Safety-Class (DF 6.1.9)	Y	0	N	Y	Cert EP61	N	Once leak checked-May be credited outside the VWB or inside/outside a GB

Damage Ratio (DR) of Containers

TA-55 Containers in the Safety Basis and Associated Damage Ratios (DR)

Container	Welded	DR	OK inside GB	OK outside GB	Certified LANMAS Designation	Must be overpacked by DR<1 Container in GB for MAR Credit	When it is credited on LANMAS
LWRHU Safety-Class (DF 6.1.9)	Y	0	Y	Y	Cert RHU	N	As soon as it passes leak check and ≤ 11 ft. from the floor -May be credited inside/outside the GB Line
3013 Safety-Class (DF 6.1.11)	Y	0	Y	Y	CERT-3013	N	As soon as it passes leak check and ≤ 29.5 ft. from the floor - May be credited inside/outside the GB line
Certified Type B [3] Safety-Class (DF 6.1.8)	N	0	N/A	Y	Cert-XXX (XXX is tVol. of Container)	N/A	within certification and closed
Fire-Rated Safes Safety-Class (DF 6.1.12)	N	0	N/A	N/A	N/A	N/A	DR=0 At all times; must be attended if safe door is open
SAVY-4000 Safety-Class (DF 6.1.11)	N	0.01	Y	Y	Cert01-S(XXX)	N	Closed per DOP-091 and ≤ 12 ft. from the floor - May be credited inside/outside the GB line
Hagen Safety-Class (DF 6.1.11)	N	0.05	Y	Y	Cert05-H(XXX)	N	Closed per DOP-091 and ≤ 12 ft. from the floor - May be credited inside/outside the GB line
POC Safety-Class (DF 6.1.11)	N	0.10	N/A	Y	Cert10PCT	N/A	First Floor, Basement waste locations and HENC pad, after packaging and ISI is completed

Damage Ratio (DR) of Containers

TA-55 Containers in the Safety Basis and Associated Damage Ratios (DR)

Container	Welded	DR	OK inside GB	OK outside GB	Certified LANMAS Designation	Must be overpacked by DR<1 Container in GB for MAR Credit	When it is credited on LANMAS
LWRHU product can [2] Not Credited	Y	1	N	N	Not certified	Y (for MAR credit)	NA
Milliwatt [2] Not Credited	Y	1	N	N	Not certified	Y (for MAR credit)	NA
MWG/RTG Not Credited	Y	1	N	Y	Not certified	Y (for MAR credit)	NA
RPC [2] Not Credited	Y	1	N	N	Not certified	Y (for MAR credit)	NA
Ta impact can Not Credited	Y	1	Y	Y	Not certified	Y (for MAR credit)	NA
Ta sample vial Not Credited	Y	1	Y	Y	Not certified	Y (for MAR credit)	NA
Unique cont/standards Not Credited	Y	1	N	N	Not certified	Y (for MAR credit)	NA
55 gallon drum (Type A) Safety Significant (DF 6.2.5)	N	1	N/A	N	Not certified	N/A	NA
Containers for Nuclear Material outside of GBs (not including pits and residue HS-Pu) Must be inspected prior to leaving the Vault [Safety-Significant (DF 6.2.5)]	N	1	Y	Y	Not certified	N/A	NA
Containers used in RoboCal Safety-Significant (DF 6.2.5)	N	1	Y	Y	Not certified	N/A	NA

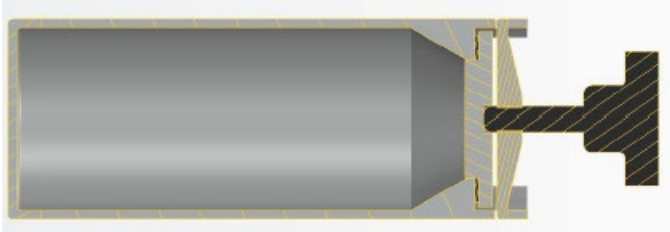
Damage Ratio (DR) of Containers

TA-55 Containers in the Safety Basis and Associated Damage Ratios (DR)

Container	Welded	DR	OK inside GB	OK outside GB	Certified LANMAS Designation	Must be overpacked by DR<1 Container in GB for MAR Credit	When it is credited on LANMAS
Containers holding MOX Fuel Safety-Significant (DF 6.2.5)	N	1	Y	Y	Not certified	N/A	NA
Individual Packaged Shipping Container for Non-Residual Quantities of TRU Waste Safety-Significant (DF 6.2.5)	N	1	Y	Y	Not certified	N/A	NA
Individual Packaged Shipping Container (IP-1 or equivalent) for Residual Quantities of MAR Safety-Significant (DF 6.2.5)	N	1	Y	Y	Not certified	N/A	NA
Fire-Rated Safes Safety-Significant (DF 6.2.5)	N	1	Y	Y	Not certified	N/A	NA

DR<1 Container Illustrations

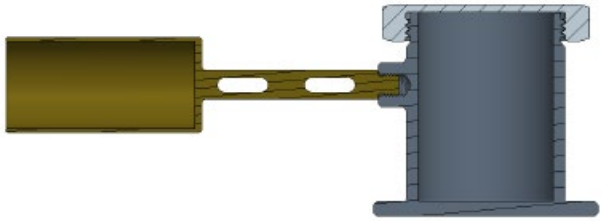
Ball Mill Jar: The HS-Pu ball mill jar, damage ratio of 0.01 when on the floor of the GB or in the Ball Mill with the container top secured (<4 ft. from the lab floor).



Conflat: The Conflat container provides a damage ratio of 0.01, when on the floor of the GB with the top secured (<4 ft. from the lab floor).

DR<1 Container Illustrations

HS-Pu Storage and Transport Container:
The HS-Pu storage and transport container (FRTC) container provides a damage ratio of 0.01 when on the floor of the GB with the top secured (<4 ft. from the lab floor).



Modified Slip Lid: The Modified Slip Lid container provides a damage ratio of 0.01 (not currently implemented at TA-55).

DR<1 Container Illustrations

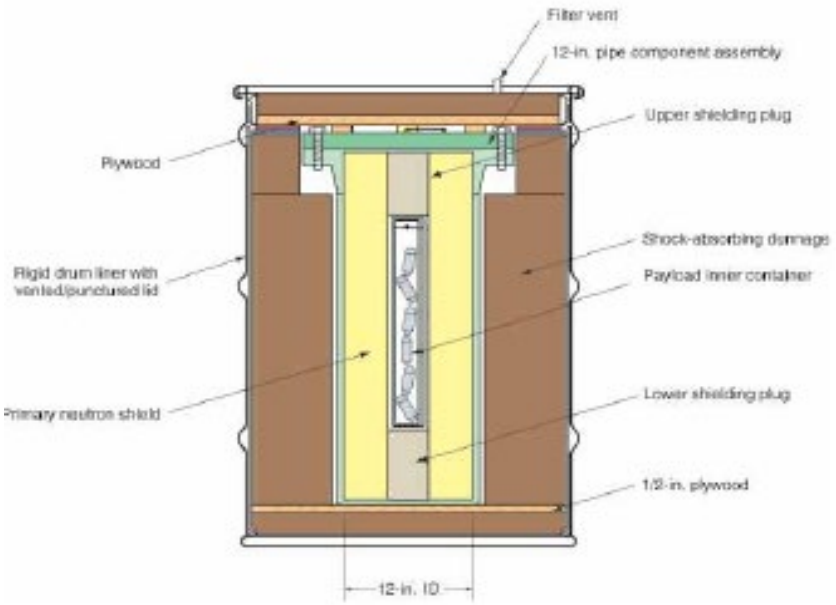
SAVY-4000: The SAVY-4000 container provides a damage ratio of 0.01, when the top is secured (<12 ft. from the lab floor).

Hagan: The Hagan container provides a damage ratio of 0.05, when the top is secured (<12 ft. from the lab floor)

DR<1 Container Illustrations

3013: The 3013 package provides a damage ratio of 0, when the top is secured (<29.5 ft. from the lab floor)

Pipe Overpack Container (POC): The POC package provides a damage ratio of 0.10, when the top is secured, and the ISI has been completed upon final container packaging (up to the 5th tier in a stacked array)



DR<1 Container Illustrations

Certified Type B: The certified Type B package provides a damage ratio of 0. There are many different shapes and forms of U.S. Department of Transportation (DOT) containers. The packages are certified, designed and tested in accordance with 10 CFR 71. As long as the Type B package is within its certification it is considered Safety Class, DR=0. No Illustrations Available

Encapsulated Heat Sources: The encapsulated heat sources provide a damage ratio of 0 (<11 ft from the lab floor):

- Example: Light-Weight Radioisotope Heater Unit (LWRHU)

DR<1 Container Illustrations

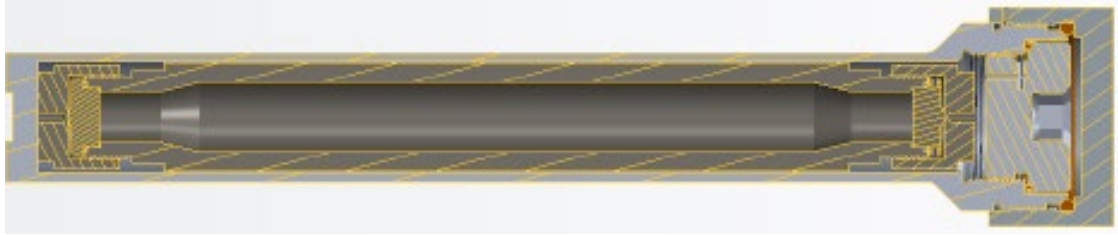
General Purpose Heat Source (GPHS): A damage ratio of one (DR=1) is applied to the non-vented, degraded GPHS-FCs. Only one non-vented degraded GPHS per Hagen or SAVY container is permitted. Transfers will be handled in accordance with current approved controls.

All non-vented, non-degraded GPHS-FCs will be stored in a configuration that has been demonstrated, through thermal analysis, to limit the internal HS-Pu pellet temperatures. May be credited as DR=0 when $\leq$ 11 ft. from the floor inside or outside the GB line unless degraded (i.e. bulging)

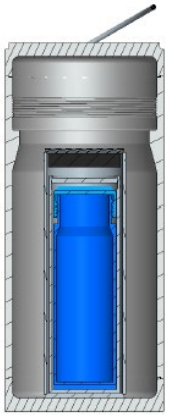
DR<1 Container Illustrations

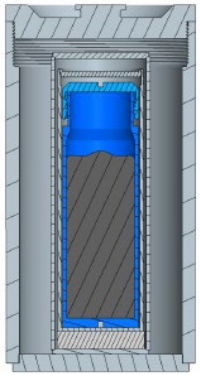
Vault Water Bath Containers: The vault water bath containers provide a damage ratio of 0. This includes Fuel Storage Outer (FSO) and EP-61's. The K2 Containers are NOT considered DR<1. VWB containers may be credited Outside the VWB and Inside/Outside GBs.

EP-61:



Fuel Storage Outer (FSO) Container: The following are the New and Old Generation FSO, respectively.





Information to consider when crediting containers on LANMAS, i.e. “CERT”

- Containers may only be considered CERT When the lid is secured and within the specific Performance Criteria. For example, if a SAVY is being credited on LANMAS as CERT it must have it’s lid secured and be ≤ 12 ft. from the laboratory floor
- There are many containers that may currently be credited for DR<1. Please contact the Cognizant System Engineer, Operations or Safety Basis for any questions

MAR Surveillance

- MAR is reviewed frequently to ensure compliance with the TSRs via the performance of TA55-STP-702, *TA-55 Material-At-Risk Surveillance Procedure*
- **REFERENCES**
  - PA-AP-01032, Material at Risk Requirements for TA55
  - PA-AP-01017, Control of Equipment and System Status

What to remember at TSRs and MAR

- MAR controls change frequently and may be located in other Safety Basis Change documents outside of the TA-55 TSRs (i.e., ESS, temporary modifications)
- Containers are continually being tested, therefore the performance criteria and DR may change over time
- The 2018 TSRs will change all MAR limits and will change containers from a Design Feature in the TSRs to and LCO.
- The SBDL, located on the Safety Basis Division website, contains the overall safety basis documents in place for TA-55

Los Alamos NATIONAL LABORATORY EST.1943

Fissile Material Handler Criticality Safety Training

NCS Division

Quinton Beaulieu

James Bunsen

Alicia Salazar-Crockett

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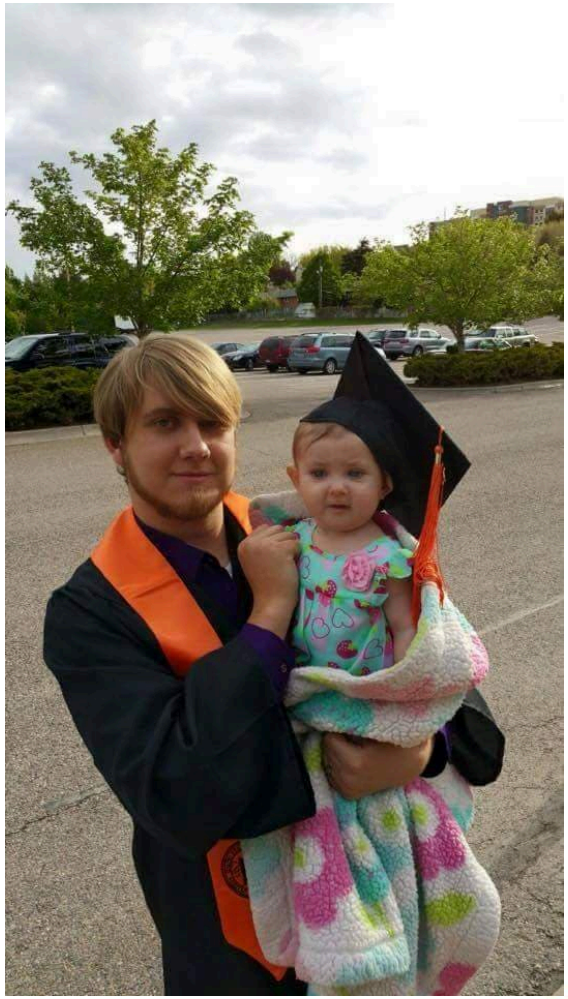
Alicia Salazar-Crockett

- Born and Raised in Española, NM
- New Mexico State University – Undergraduate
- University of Michigan – Masters
- Avid golfer,

  AKA Boss Lady

Quinton Beaulieu

- Grew up in Clovis
- Idaho State University - Undergraduate & Masters
- AKA Papa Q Town
- D&D Dungeon Master!



James Bunsen

- Grew up in Colorado
- Texas A&M - Undergraduate
- AKA J Buns
- Volunteer with BSA Troop 22

Course Objectives

Terminal Objective: Learn the fundamentals of Nuclear Criticality Safety to enhance safe working practices in fissionable material operations at LANL by:

- Understanding the principles of the fission process
- Identifying factors that can be controlled to maintain subcritical conditions
- Identifying the characteristics that lead to a criticality accident and the resulting consequences
- Understanding the importance of a criticality alarm and what the proper actions are if one sounds
- Understanding lessons learned from previous accidents and the circumstances behind those accidents

Overview of FMH Training

- First Half
  - *Introduction*
  - *Atom Structure*
  - *Important Terms*
  - *Neutron Basics*
  - *Fission/Chain Reaction*
  - *Criticality and Critical Mass*
  - *Criticality Parameters*
- Second Half
  - *Criticality Safety*
  - *Good Practices/Rules*
  - *Reading CSPs/CSLAs*
  - *Generic Accident*
  - *Accident Examples*
  - *NCS Non-Compliances and Emergency Response*

General Safety Guidance

- Nuclear criticality safety differs in no intrinsic way from industrial safety
- Integrated Safety Management
  - *Define the Scope of Work*
  - *Analyze the Hazards*
  - *Develop and Implement Hazard Controls*
  - *Perform Work within Controls*
  - *Provide Feedback and Continuous Improvement*
- Safety at the “Floor Level” implemented by
  - Employing people with the right safety attitude
  - Effective training
  - Effective procedures
  - Seeking guidance from the appropriate safety professionals

Introduction to Criticality Safety

- Nuclear Criticality Safety: protection against the consequences of a criticality accident *preferably* by prevention of an accident

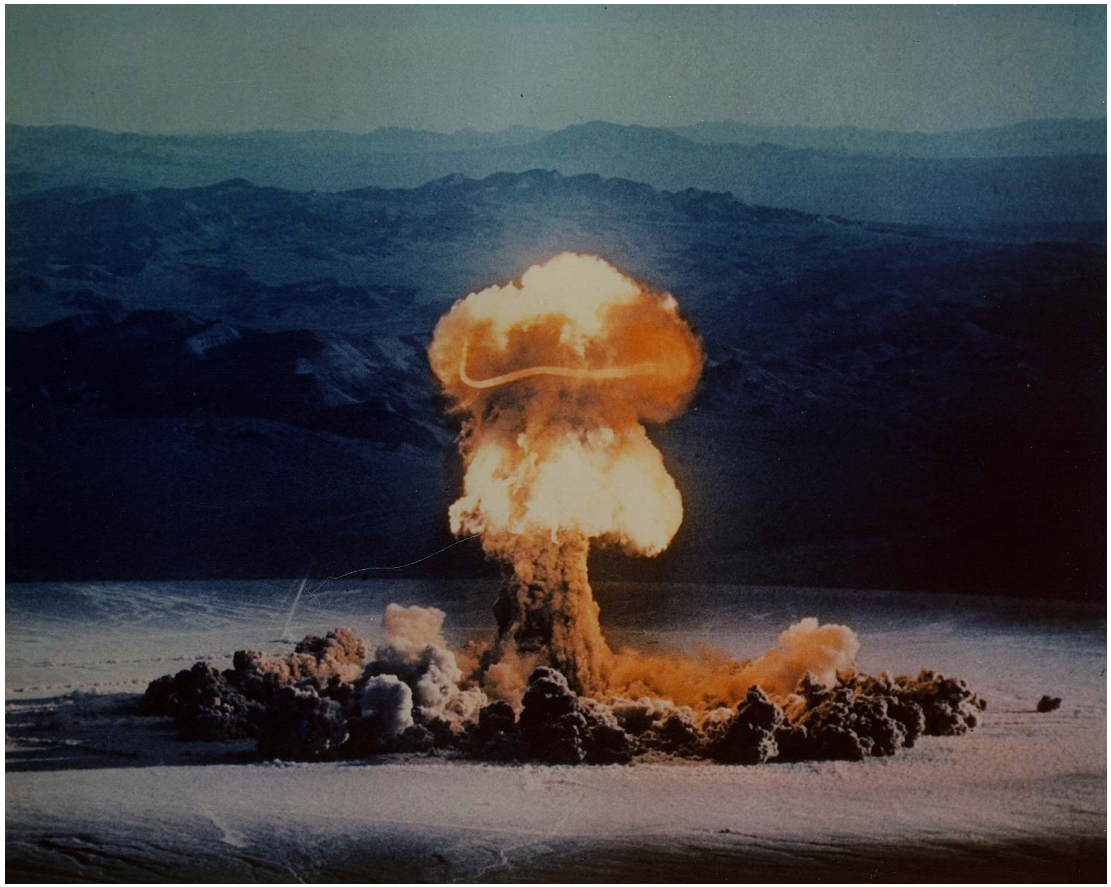
- Why is it **SO** important?

  Required by DOE and LANL policy….but more importantly…

*It is for **YOUR** safety when handling fissionable materials!*

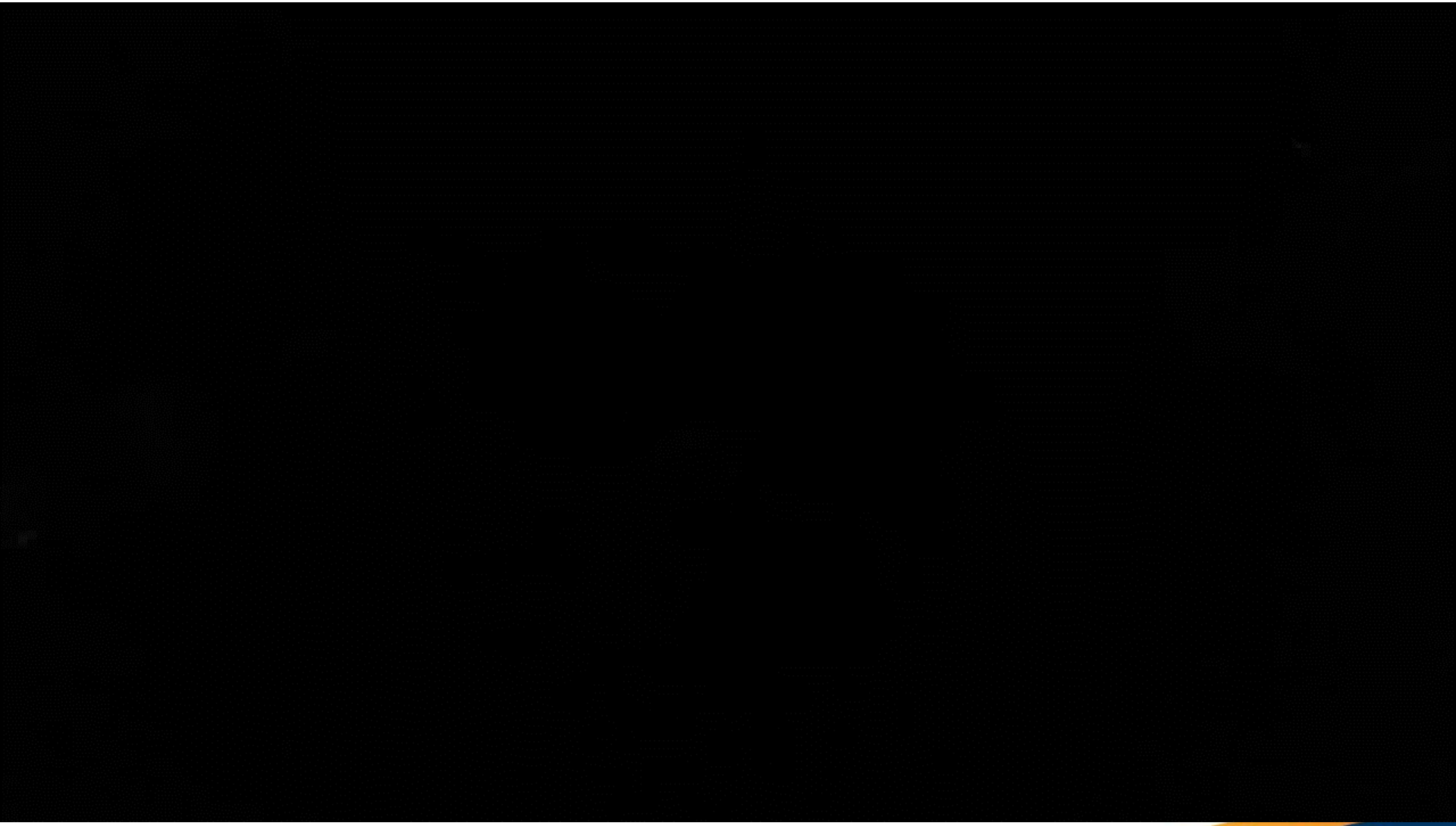
- What is a criticality accident anyway?

A criticality accident is not…

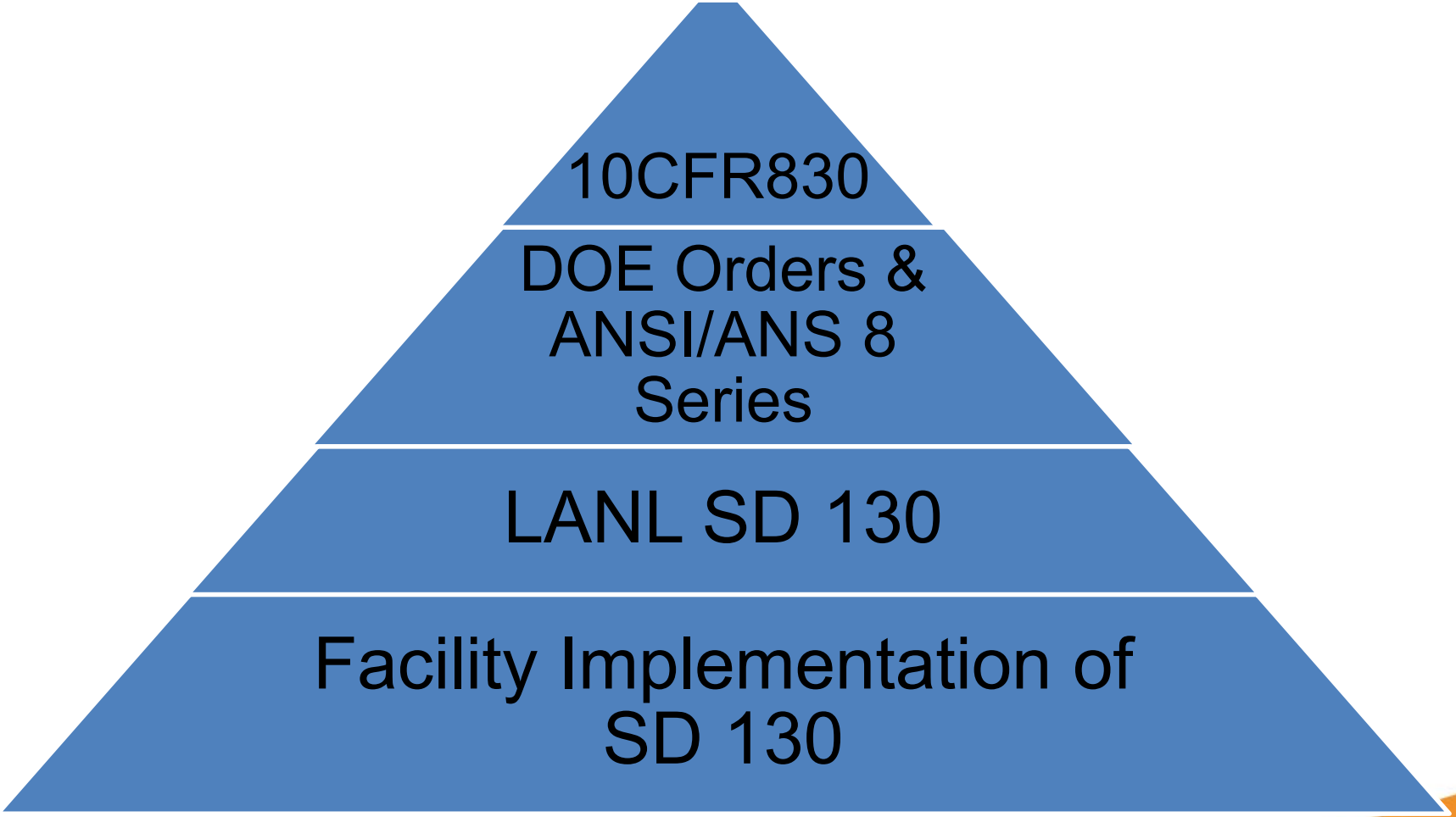


A criticality accident is…

Uncontrolled and unshielded



Flow Down from 10 CFR 830 Regulatory Framework



NCSD Policy Statement from SD-130

- It is the policy of the Los Alamos National Laboratory and the Nuclear Criticality Safety Program (NCSP) that Nuclear Criticality Safety (NCS) hazards be comprehensively addressed and objectively reviewed, and that management authorizes work so that adequate protection is provided to the public, workers, and the environment.
- ***Criticality safety must not be compromised for production or expediency.***
- The NCSP is designed to minimize the consequences of a criticality accident by reducing the risk to acceptably low likelihoods.

Important Nuclear Terms

Nuclear fission: The splitting of the nuclei of atoms accompanied by conversion of part of the mass into energy

Criticality: A chain reaction of fissions caused by neutrons born of previous fissions

Reactivity/k_{eff}: Both terms used to describe how close to, or how far over criticality a system is

SNM/Fissionable Material: Used to describe Pu-239 or U-235 most often

Absorption: The ability for an isotope to capture neutrons from the system

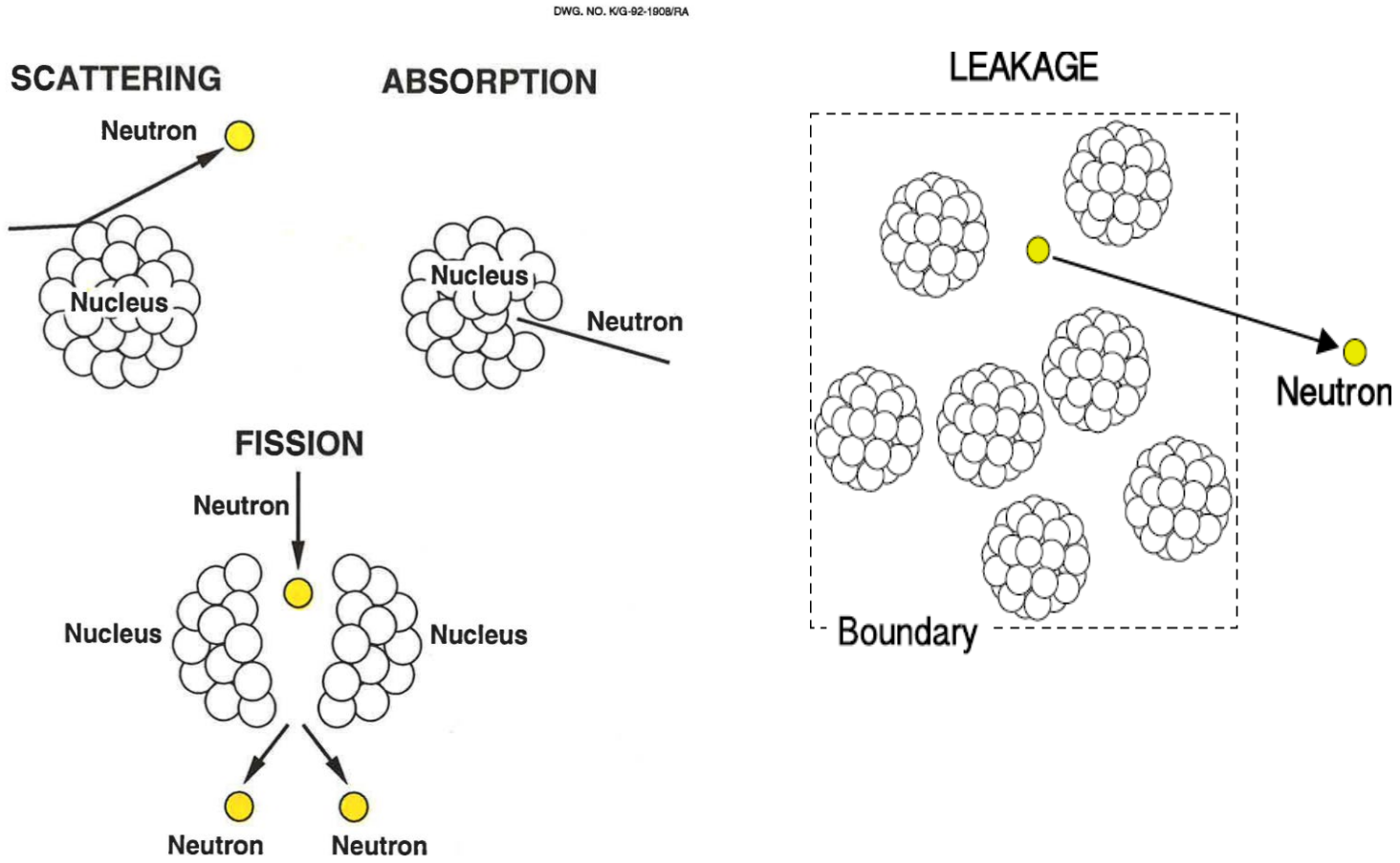
Minimum Critical Mass: The smallest amount of SNM required to make a system go critical

Moderation: The ability for a material to slow down neutrons through collisions (from fast to thermal neutrons)

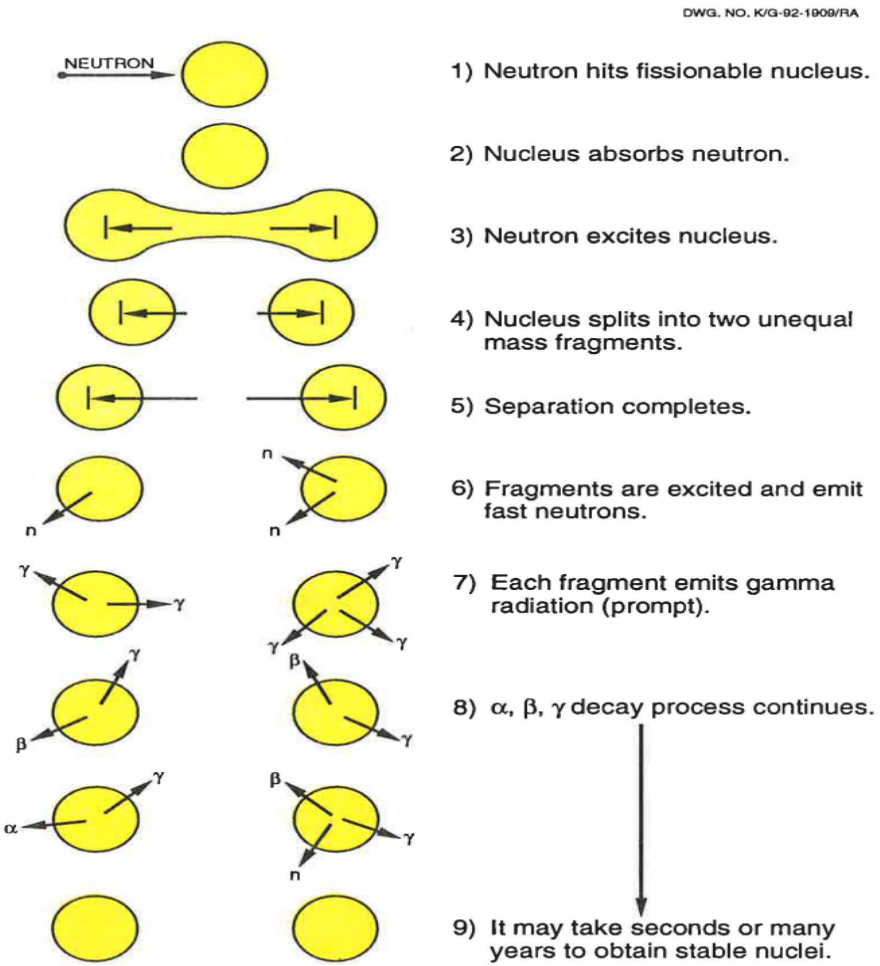
Reflection: The ability for a material to send neutrons back into the system through collisions

Leakage: Describes the idea of neutrons escaping from the system with no way to reenter

Different Neutron Interactions with an Atom



Overview of Fission Process



Neutron Fission Chain Reaction

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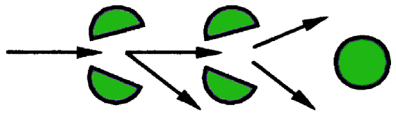
Definition of Criticality

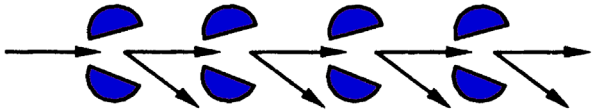
If the number of fissions occurring per second:

SUBCRITICAL



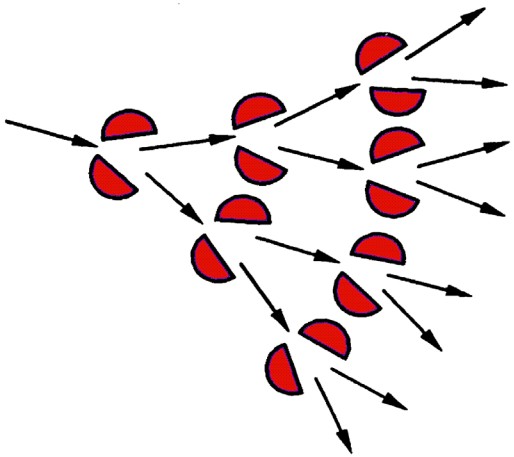
- Is Decreasing: it is ***subcritical***

CRITICAL



- Is Constant: it is ***critical***

SUPER-CRITICAL



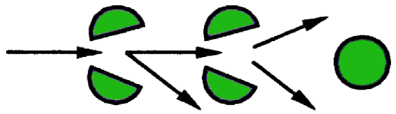
- Is Increasing: it is ***supercritical***

How k_{eff} and Criticality are Related

$$k_{eff} = \frac{\text{neutron population in current generation}}{\text{neutron population in last generation}}$$

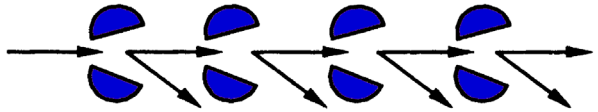
k_{eff} is the neutron multiplication factor

SUBCRITICAL



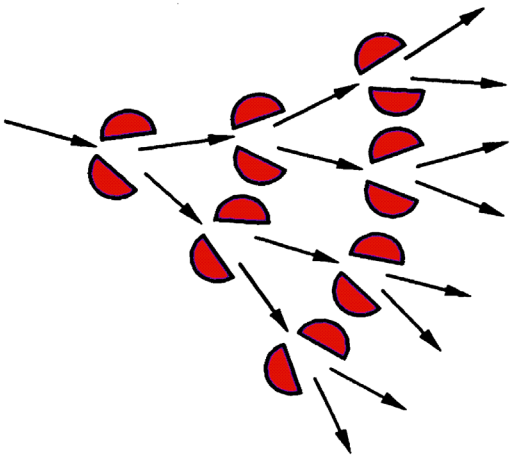
$k_{eff} < 1$

CRITICAL



$k_{eff} = 1$

SUPER-CRITICAL



$k_{eff} > 1$

UNCLASSIFIED

NCS Parameters – MAGIC MERV

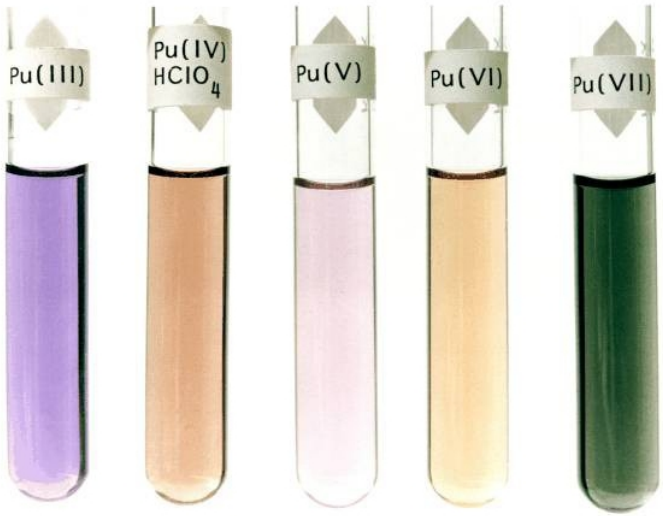
Remember: They are INTERDEPENDENT

Mass
Absorption
Geometry
Interaction
Concentration/Density

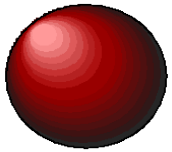
Moderation
Enrichment/Assay
Reflection
Volume

Mass & Critical Mass

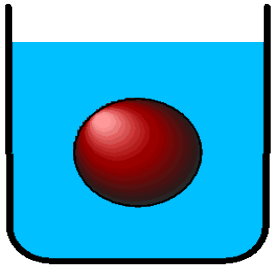
- Controlled by limiting the quantity of fissionable material
- Critical mass = quantity of fissionable material that will support criticality
- Critical mass is different for different elements and isotopes
- Different depending on the material form (metal, solution, or compounds)



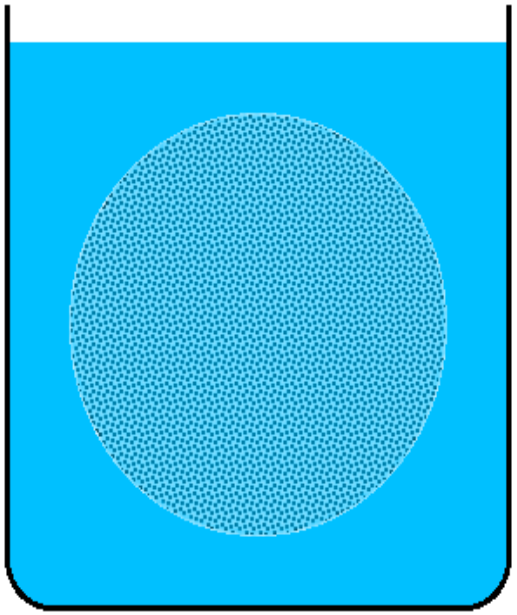
Critical Masses of Plutonium



- 9.9 kg solid α-phase metal ^{239}Pu sphere in air (no reflection)



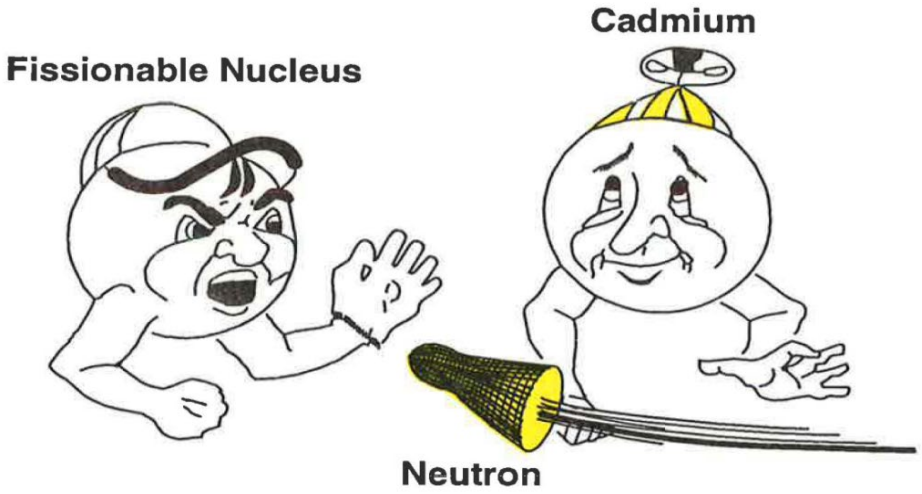
- 5.4 kg solid α-phase metal ^{239}Pu sphere in water



- 0.5 kg ^{239}Pu as small particles suspended in water

Absorption

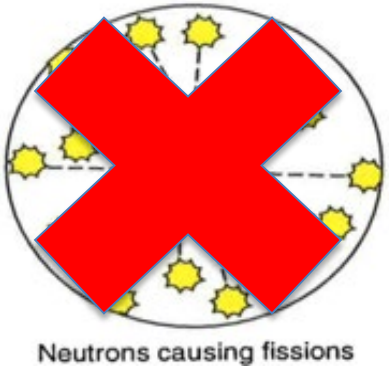
- Materials effective at capturing thermal neutrons
- Absorption reduces the reactivity of the system
- NCS discourages absorbers as a control
- Common absorbers (aka neutron poisons): boron, cadmium, and gadolinium
- Example of a neutron absorber: Raschig Rings

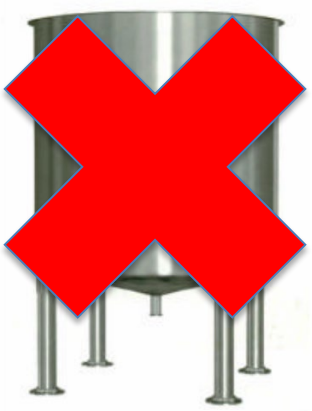


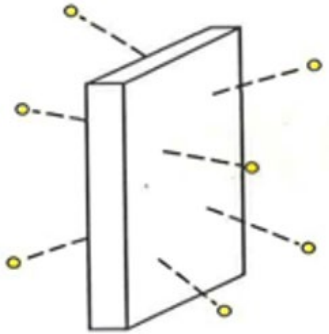
Geometry

- Geometry is the size and shape of the material or container
- Leakage is neutrons escaping from the system
- Higher surface area to volume ratios leads to higher leakage

What are some favorable geometries?

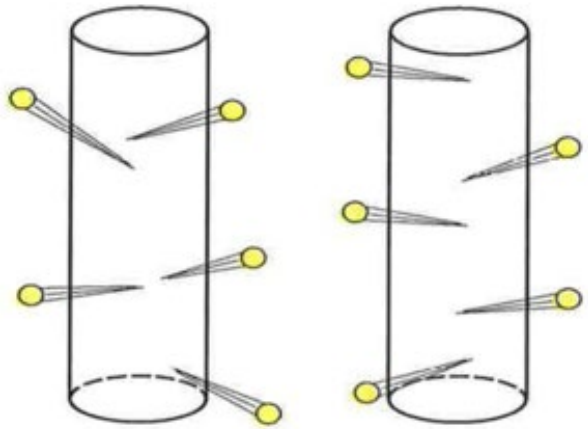




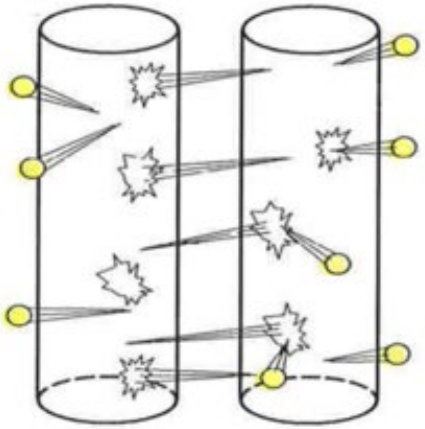


Interaction

- Interaction occurs when neutrons from one unit reach and enter another unit
- When two or more units are moved closer to each other, the reactivity of the system increases



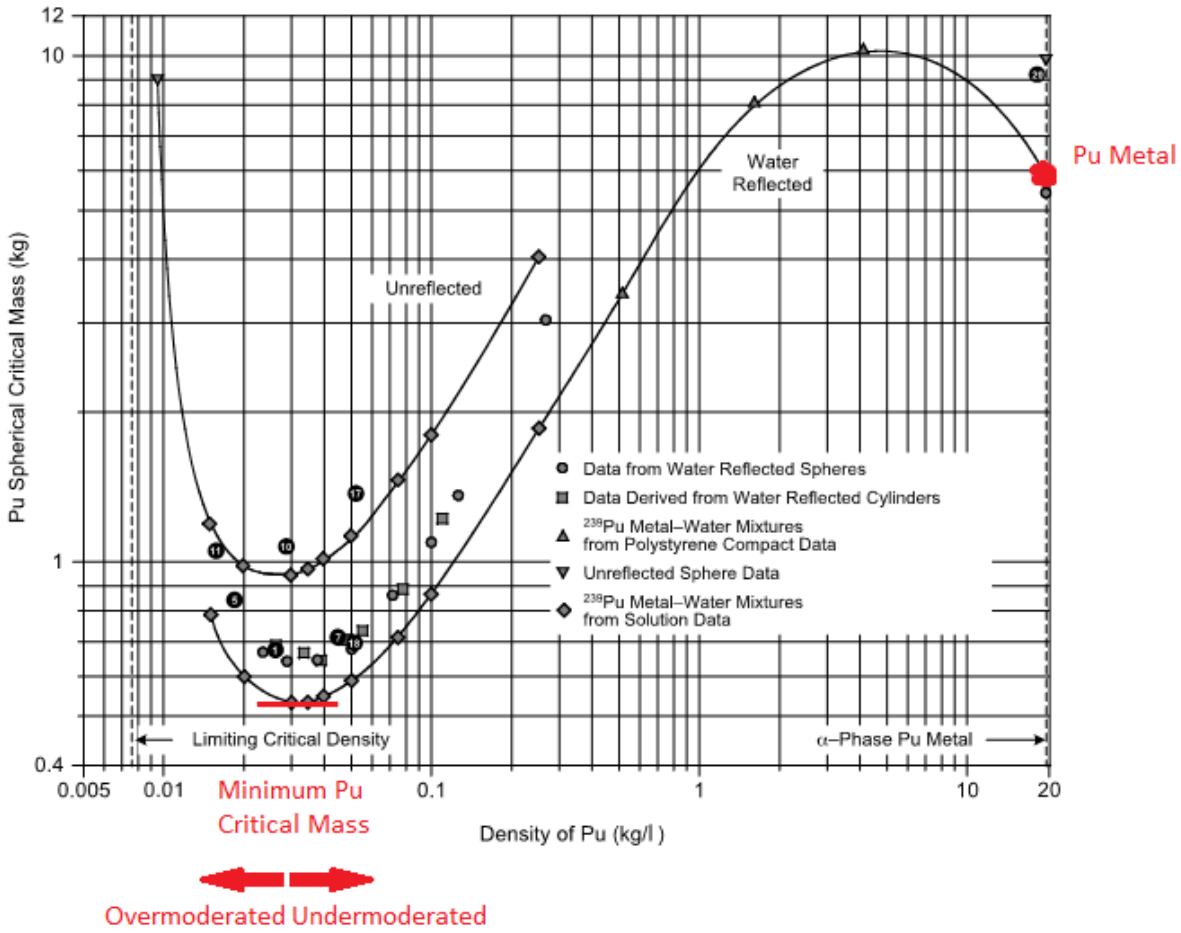
Greater Distance = Less interaction



Less Distance = More interaction

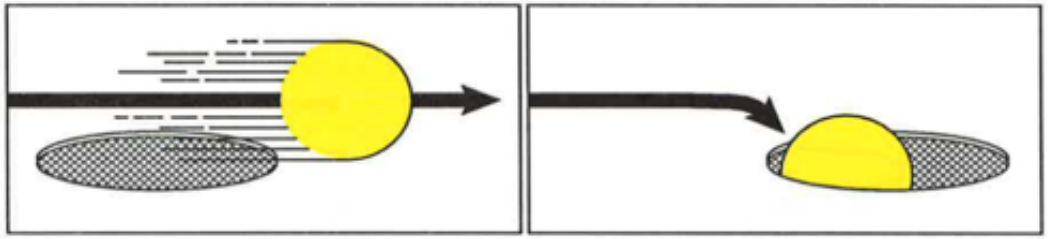
Concentration/Density

- Concentration and density are the amount of material per volume
  - Concentration = solutions
  - Density = solids
- Decreasing concentration decreases the number of fissionable atoms per unit volume
- Decreasing concentration does not necessarily reduce reactivity (see graph)
- Favorable geometries may make high concentrations safer



Moderation

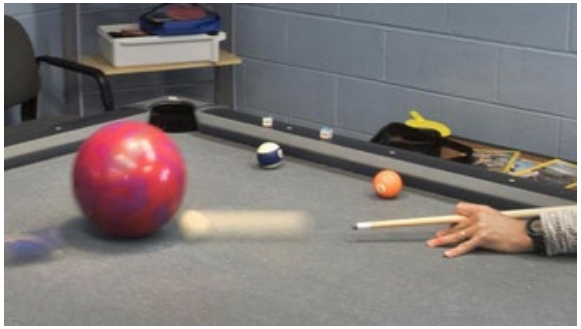
- The slowing down a neutron
- Harder for fast moving neutrons to cause fission
- Slowing down neutrons increases the probability to cause fission
- The fissile atom can “catch” a slow neutron easier than a fast neutron



If the ball is moving too fast, it will just pass over the top of the hole.

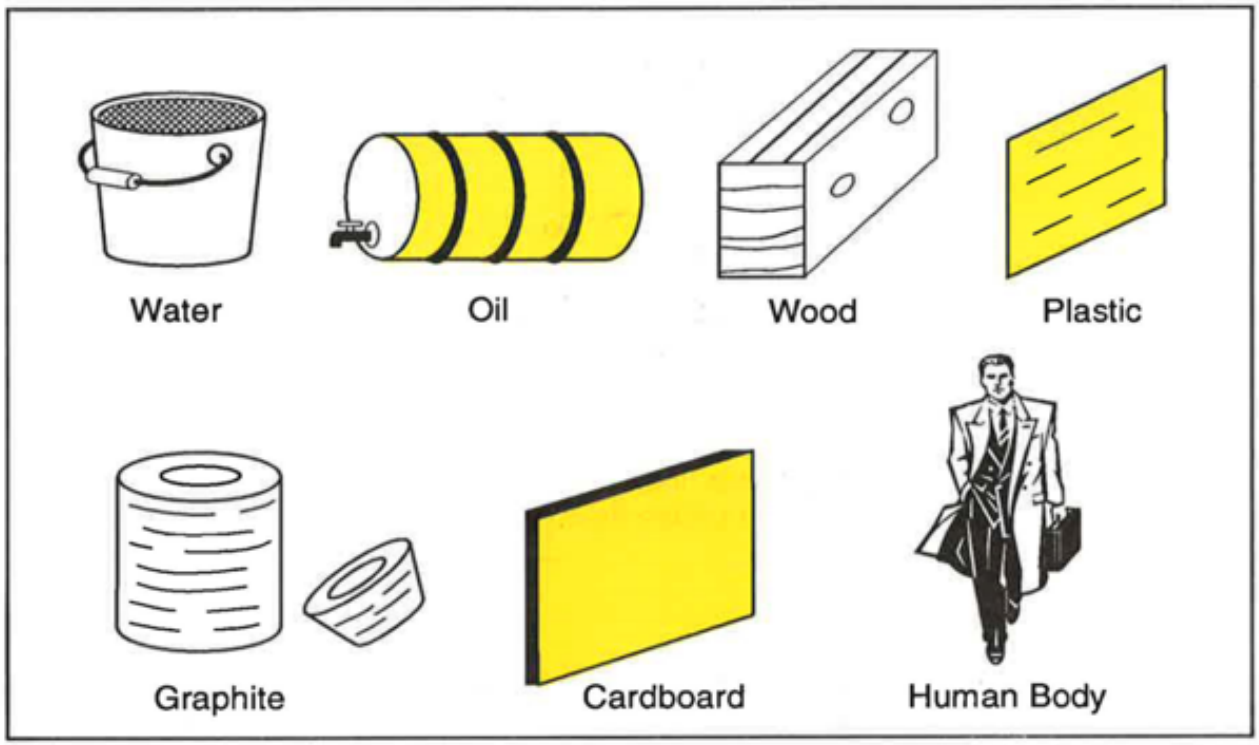
If the ball is moving at just the right speed, it will drop in.

- Lighter nuclei slow neutrons more per collision
- Heavier nuclei slow neutrons less per collision



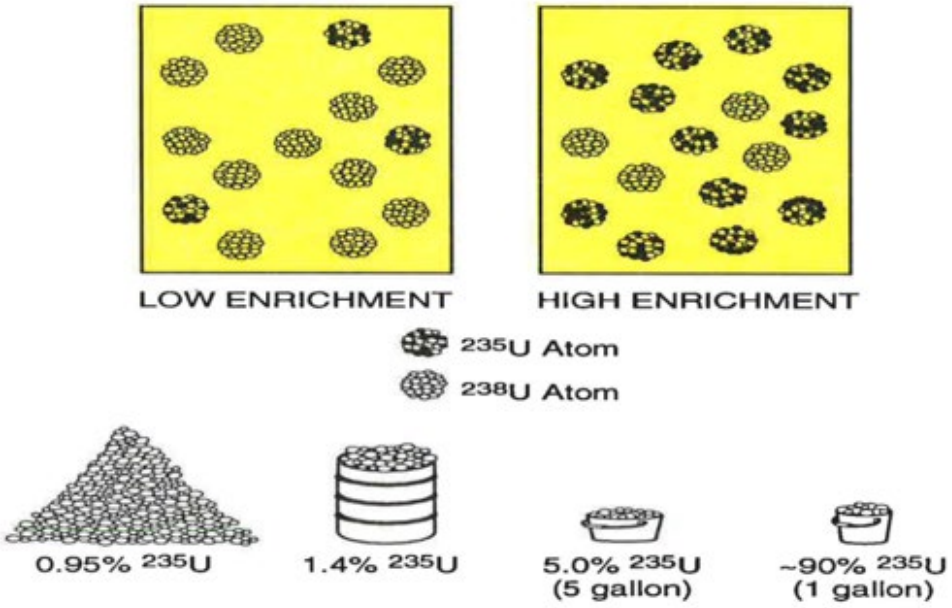
Moderation

- Hydrogen nuclei and carbon nuclei are similar in mass to neutrons
- Most good moderators contain hydrogen and/or carbon



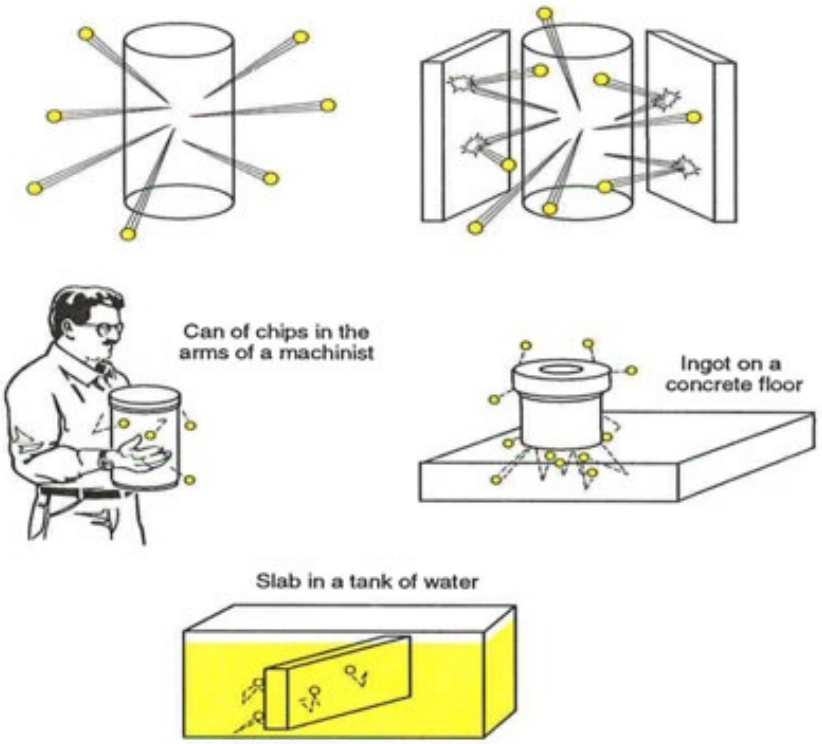
Enrichment (U-235/U-238) & Assay (Pu-239/Pu-240)

- When more $^{235}U/^{239}Pu$ atoms are present, fission is more likely
- Higher enrichment/Lower Assay means smaller critical mass

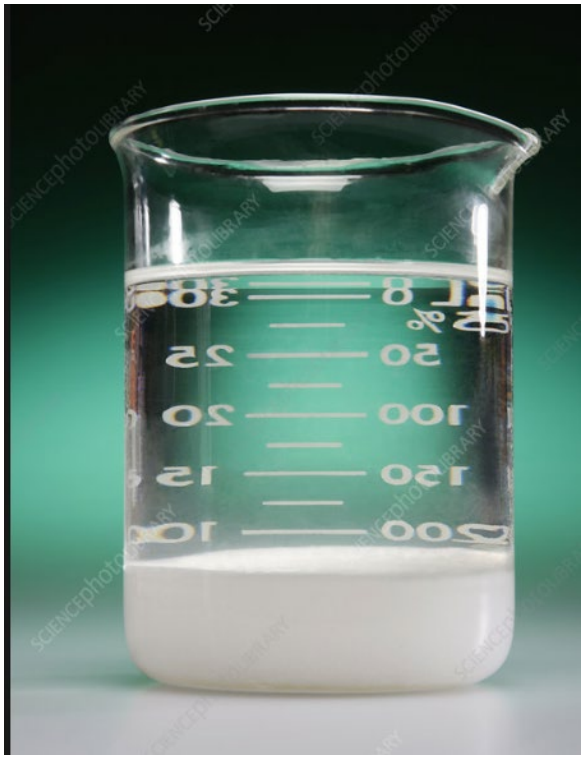


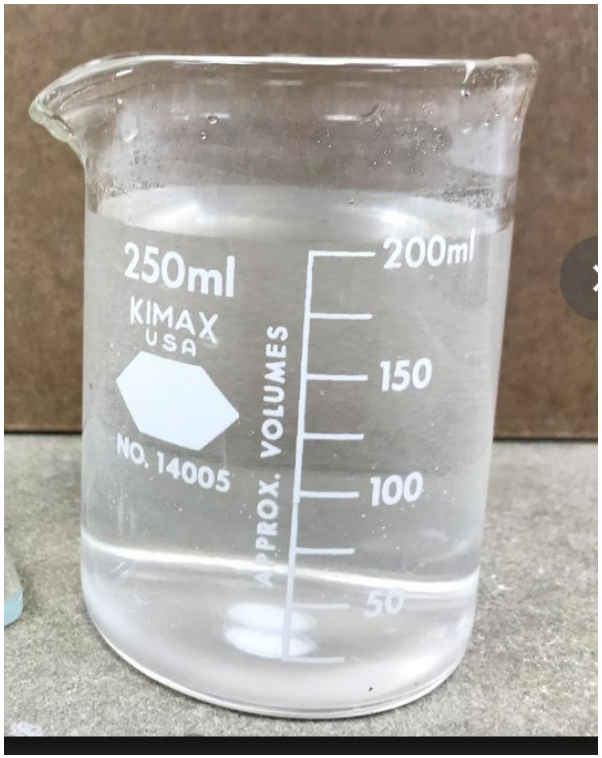
Reflection

- Escaped neutrons leave the system
- Reflected neutrons are bounced back into the system
- Most construction materials reflect: steel, concrete walls & floors
- Water is also a good reflector of neutrons.
- **The human body is primarily water**



Moderation or Reflection





Volume

- Volume used to control solutions
- Limits apply to containers available in an area
- Smaller containers allow neutrons to escape
- Containers are individually favorable for material

Examples of Containers for Fissionable Material

- Favorable bottle (favorable diameter)
- Hagan/SAVY container (water-tight, favorable volume)
- Beakers
- Cans

Questions So Far?

Break

Summary of MAGIC MERV

M - amount of material, minimum critical mass

A - removing neutrons from the system

G - shape of material

I - distance away from other material

C - how much material is in solution

M - effects of slowing down neutrons

E - ratio of fissionable isotopes present

R - effects of non-SNM on reactivity

V - size of the material or container

Reading CSPs/CSLAs

- Administrative Controls
  - Controls that are implemented via actions by the operator (confirming mass values, meeting container requirements, spacing between items)
- Engineered Controls
  - Controls that are already in place and are not affected by operators' actions, but confirmed to be present before start of operation
- Additional Restrictions
  - Items that are also necessary as identified in the CSED to defend assumptions made or draw boundaries around the operation considered for analysis

Example CSP

Criticality Safety Posting

Activity/Task Title
Transport of Waste Containers in PF-4

TA	GB #	MC&A Location	References
55	N/A	N/A	Level 1: NCS-CSED-15-080 Level 1: NCS-CSED-12-104 Level 3: NCS-CSED-12-096
Building	**Room**	**FMO ID**	
4	N/A	PF4-CARTS-04	

CRITICALITY SAFETY REQUIREMENTS
Transport of Waste Containers in PF-4

Operational Process Requirements

Material Limits

- 55-gallon or larger waste drums ≤ 200 FGE ^{239}Pu each
- Standard Waste Boxes (SWBs) ≤ 325 FGE ^{239}Pu each

NOTE: The ≤ 200 FGE ^{239}Pu and ≤ 325 FGE ^{239}Pu limits per container may be read as ≤ 200 g Pu and ≤ 325 g Pu, respectively; plutonium isotopes shall be treated as ^{239}Pu on a gram-for-gram basis, provided the ^{241}Pu content does not exceed the ^{240}Pu content.

Additional Restrictions

- Stack containers no more than two high.
- Waste containers shall have lids in place.

Engineered Features

- Standard 55-gallon drum dimensions (≥22.6 inches in diameter and ≥34.75 inches tall)

Process Description:

- Movement of 55-gallon or larger waste drums and SWBs in PF-4.
- Unattended staging of waste containers during transient operations is allowed except in FMO floor locations (e. g. floor locations with posted limits).
- Radiological shielding (e.g., lead blanket) allowed on waste containers during movement.
- Drum dollies, pallet trucks, forklifts, etc., allowed for movement of drums and SWBs.

Process Deviation (actual or suspected)

- A process deviation for criticality safety is defined as any deviation from NCS controls for the operation that affects or may affect the criticality safety of any activity involving fissionable materials.
- If a non-compliance with a criticality safety control or limit is found or suspected:

- Suspend all affected activities immediately.
- Leave the immediate area and prevent others from entering within 15 feet.
- Report the suspected violation to the appropriate supervisor and the operations center .

Who Ya Gonna Call?

Ops Center

- Control set violated
- Discrepancy between procedure and CSP on the box

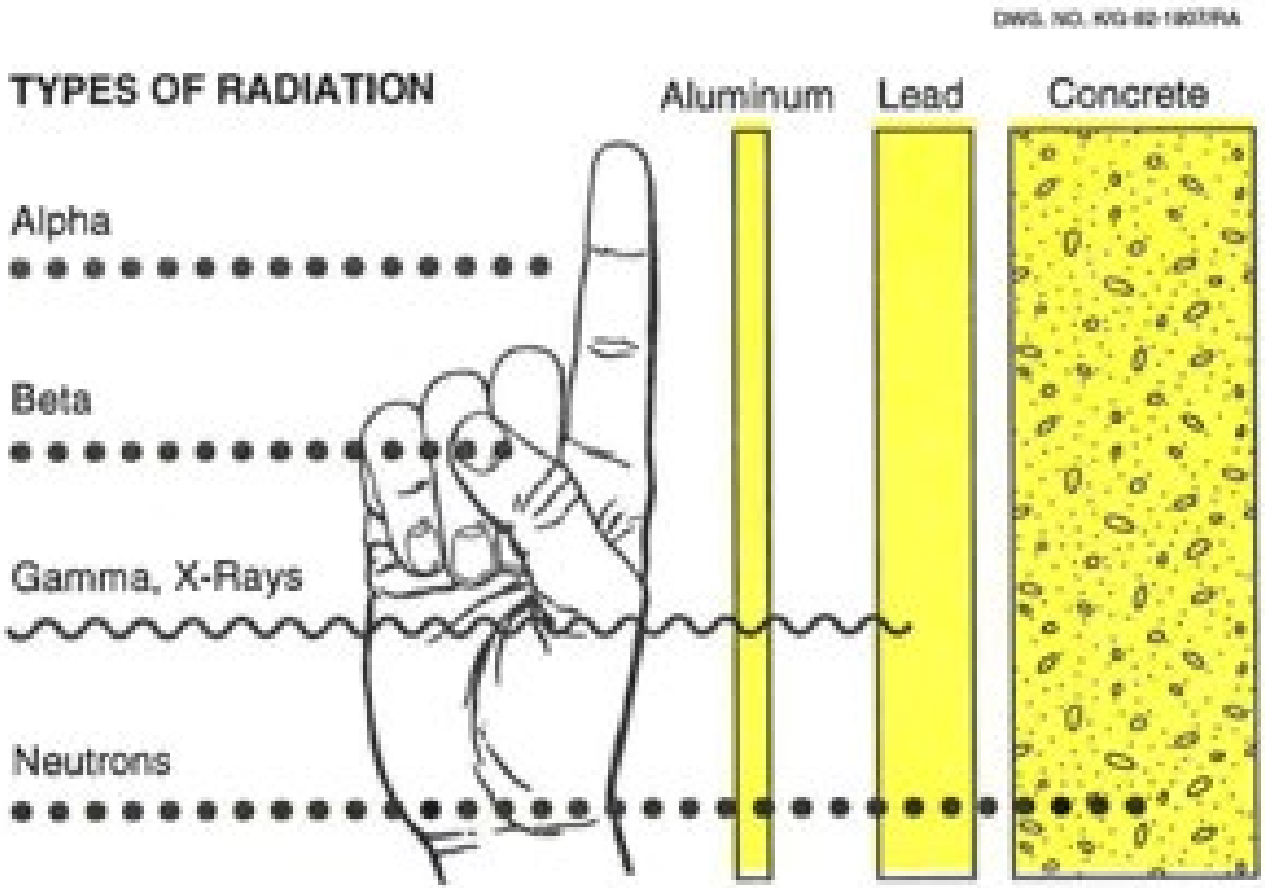
CSO/ORS

- Something doesn't feel right
- Unsure of the language in a CSP

NCS

- Question about an evaluation
- Feedback on difficulty of controls

Rad Protection 101 - Shielding



Rad Protection 101 - Distance

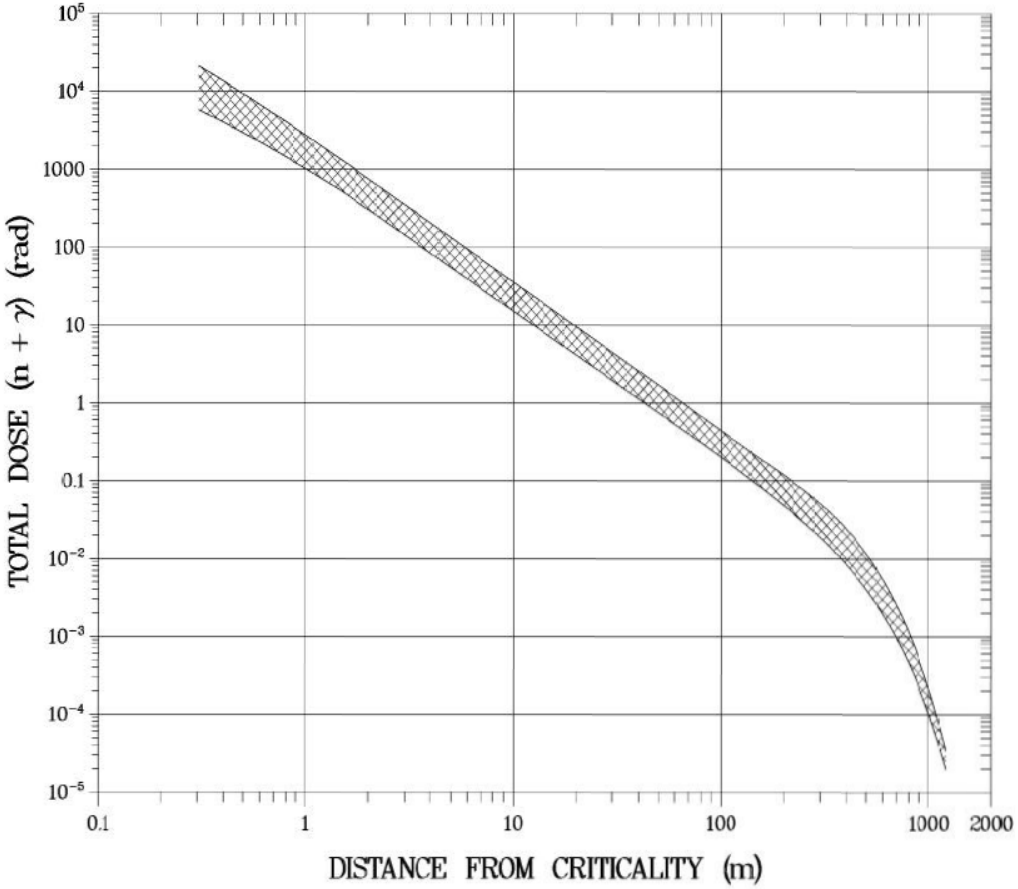


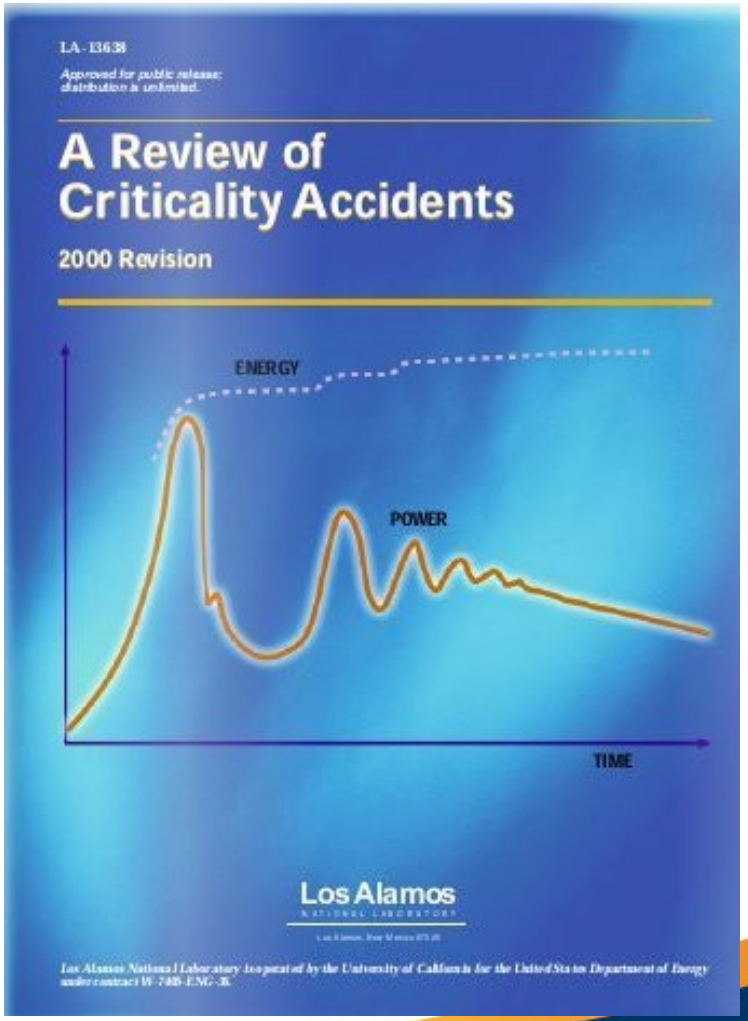
Fig. 1. Approximate correlations of dose with distance from excursions normalized to 10^{17} fissions. This was adapted from Ref. 68 and incorporates the doses received upon evacuation as given in this chapter.

Dose and Health Effects of Radiation

Dose (rad*)	Effects
25-50	First sign of physical effects (drop in white blood cell count)
100	Threshold for vomiting (within a few hours of exposure)
320 - 360	~ 50% die within 60 days (with minimal supportive care)
480 - 540	~50 % die within 60 days (with supportive medical care)
1,000	~ 100% die within 30 days

Criticality Accidents

- LA-13638
- A Review of Criticality Accidents
- 22 Process Accident Descriptions
- Accident Reconstructions
- 33 Experiment Accidents
- Lessons Learned



Accident Circumstances

Criticality accidents have occurred when …

- Equipment or processes were modified but not evaluated
- Procedures were not followed
- Performing non-standard operations
- Communications have failed
- Working late at night or off-normal shifts
- Working alone

Generic Criticality Accident

- Indications that a criticality accident has occurred may include:
  - A **Blue** Flash
  - The smell of ozone
  - A sharp clap or bump
  - A splash or boiling in systems with liquids
  - The Criticality Accident Alarm System (CAAS) activates

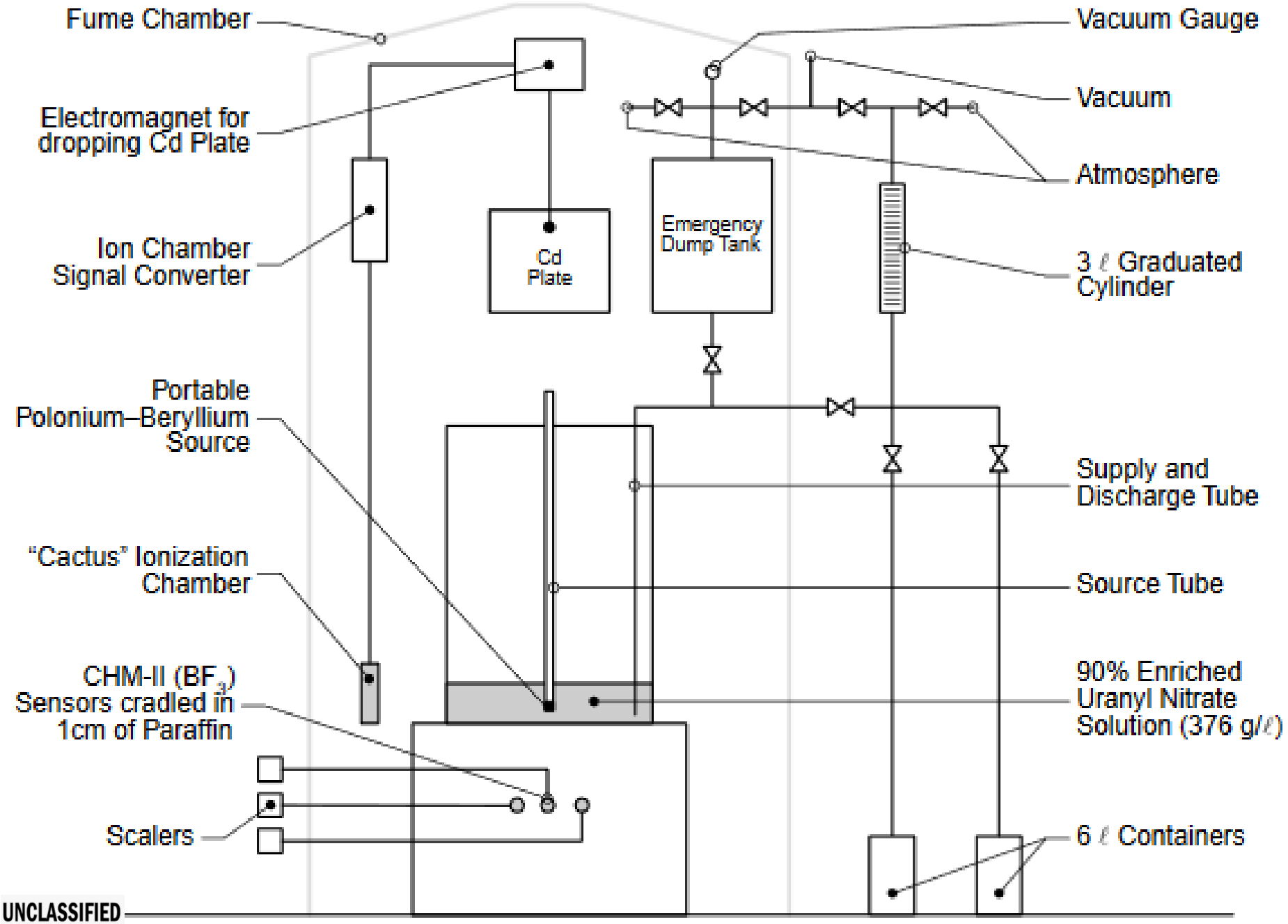
- Criticality safety: protection against accident consequences through (preferably) prevention

Generic Criticality Accident Cont.

- Timing
  - Initial burst less than 1 second in duration
  - Depending on the system, a sustained power may be achieved (solution accidents): that means the reaction continues
  - No advance warning of accident, no ability to react quickly enough to get away
- Radiation Dose
  - Dose is directly related to the fission yield (number of fissions) and distance from criticality accident

1958 Mayak Accident

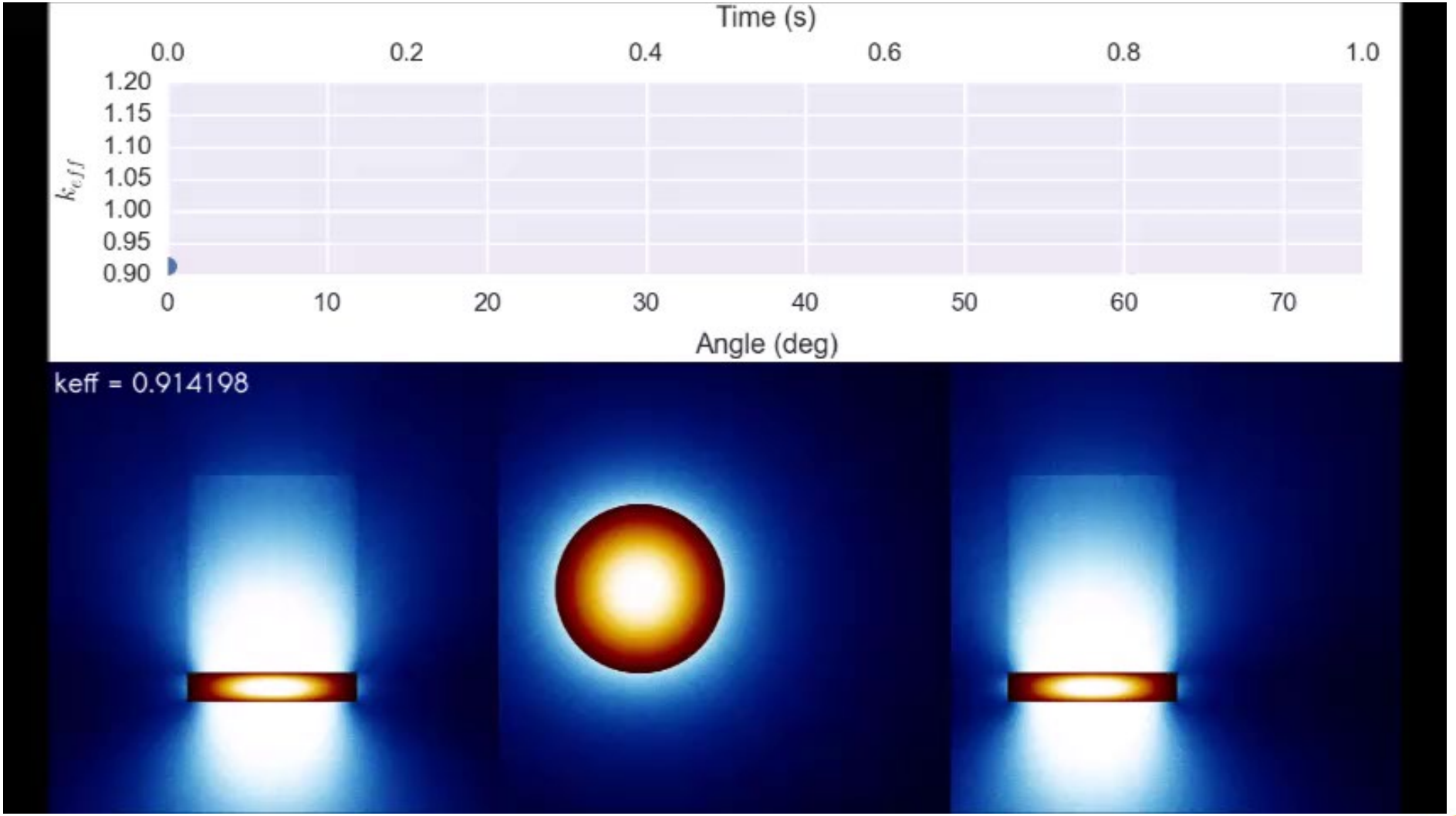
- Mayak USSR January 2nd 1958
- Uranyl Nitrate Solution
- HEU U(90) Vessel Critical Experiments
- First Shift of the new Year
- First Experiment with Large Vessel
- Vessels Drained Into 6 L Containers



UNCLASSIFIED

The Accident

- 418 g U(90) / L, 400 L Vessel, ~62 L
- Three Operators Circumvented Draining
- Vessel Tipped on Edge to Drain
- Consequences
  - ~6,000 rad Dose, Death Within 6 Days
  - ~600 rad Dose, Loss of Sight



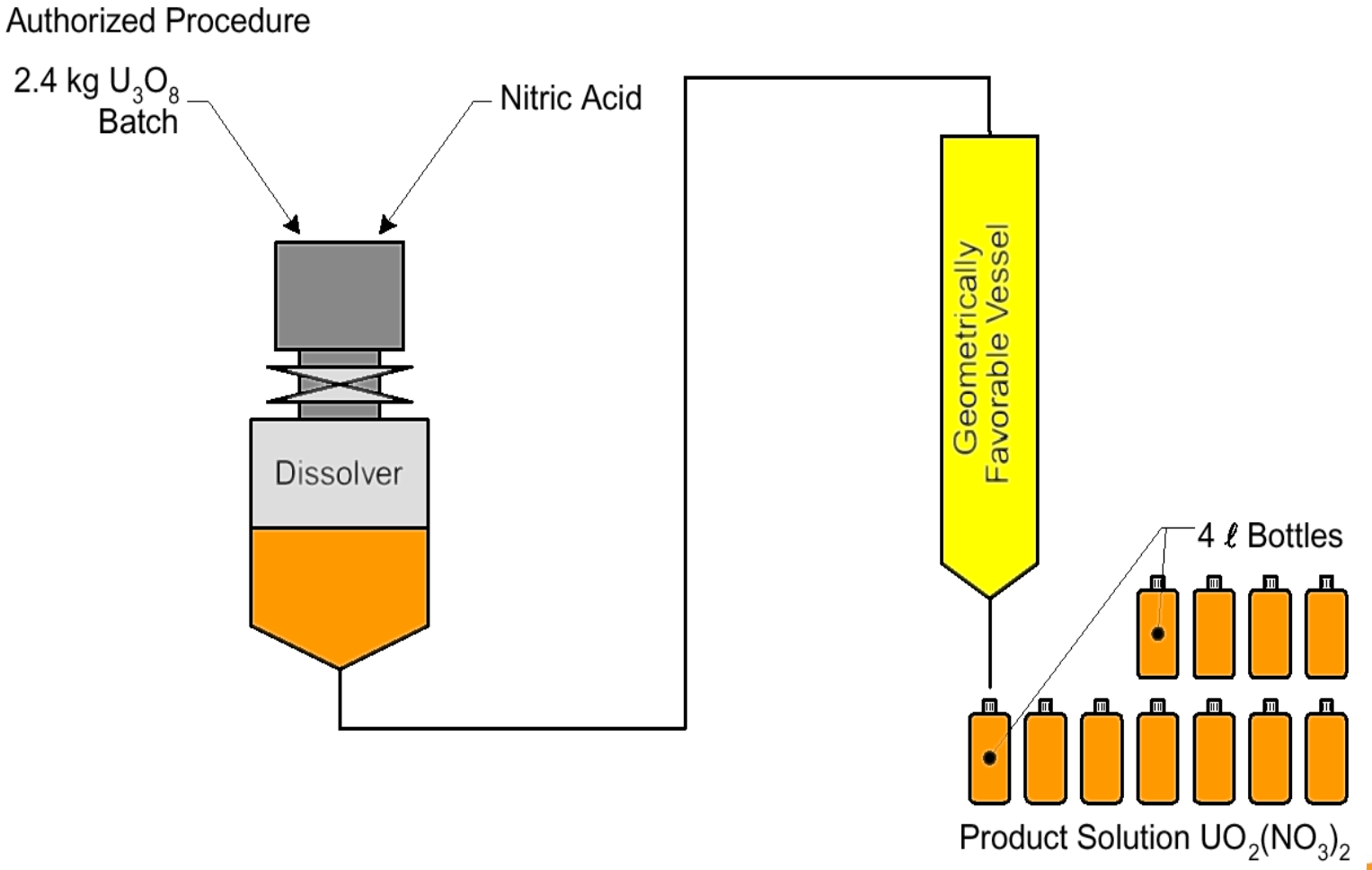
Quiz Time!

- Which parameters were effected?
- What could have been done for prevention?
- Lessons learned?

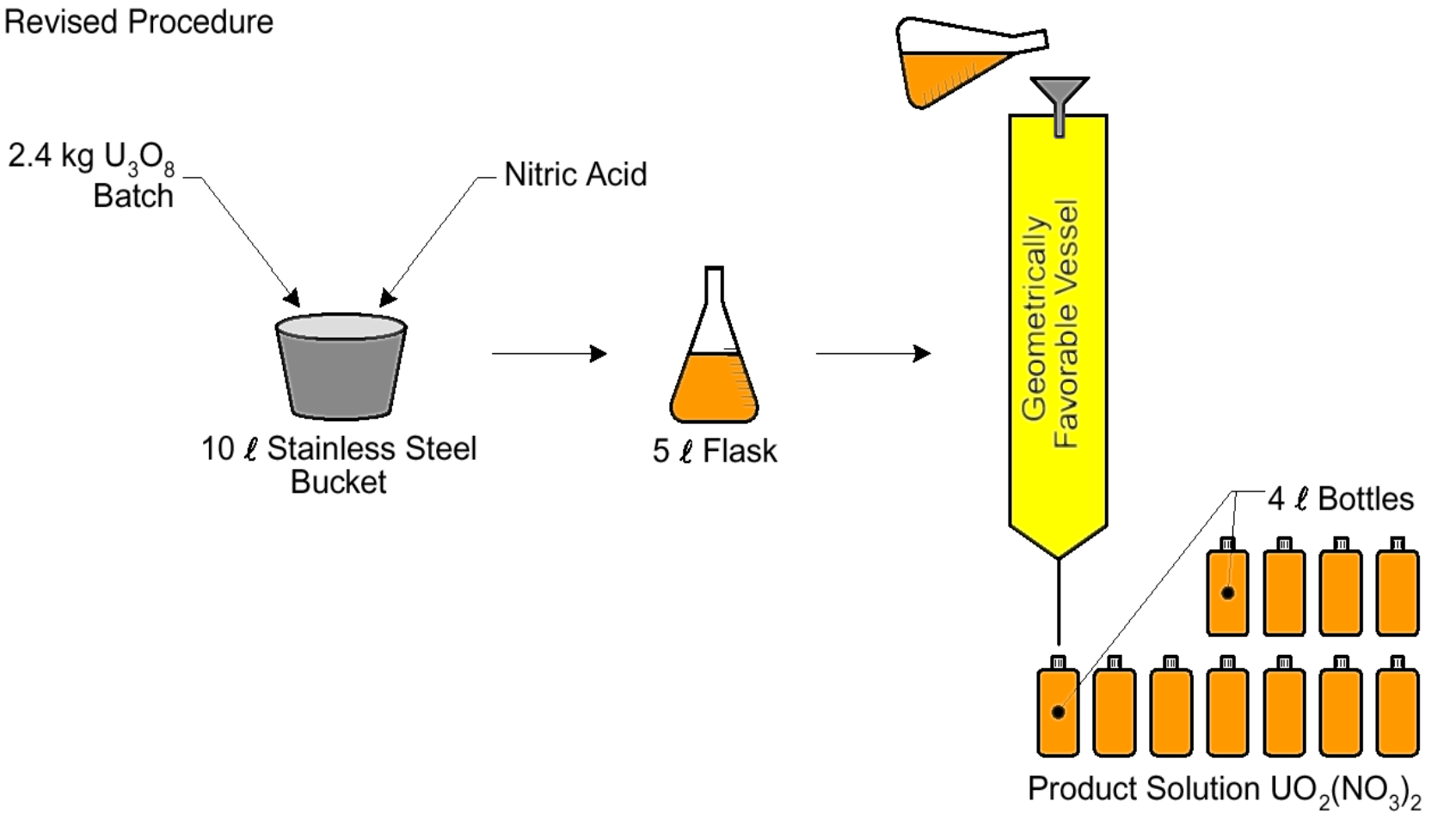
1999 Tokaimura Accident - Background

- JCO Tokai Works processes reactor fuel
- Normal operations with LEU (< 5 wt% ^{235}U)
- Occasional operations with IEU (< 20 wt% ^{235}U)
- Original process approved by Japan's Science and Technology Agency (STA)
- No manual operations in approved process
- 2.4 kg Uranium mass limit (16 - 20 wt% ^{235}U)

1999 Tokaimura Accident



1999 Tokaimura Accident

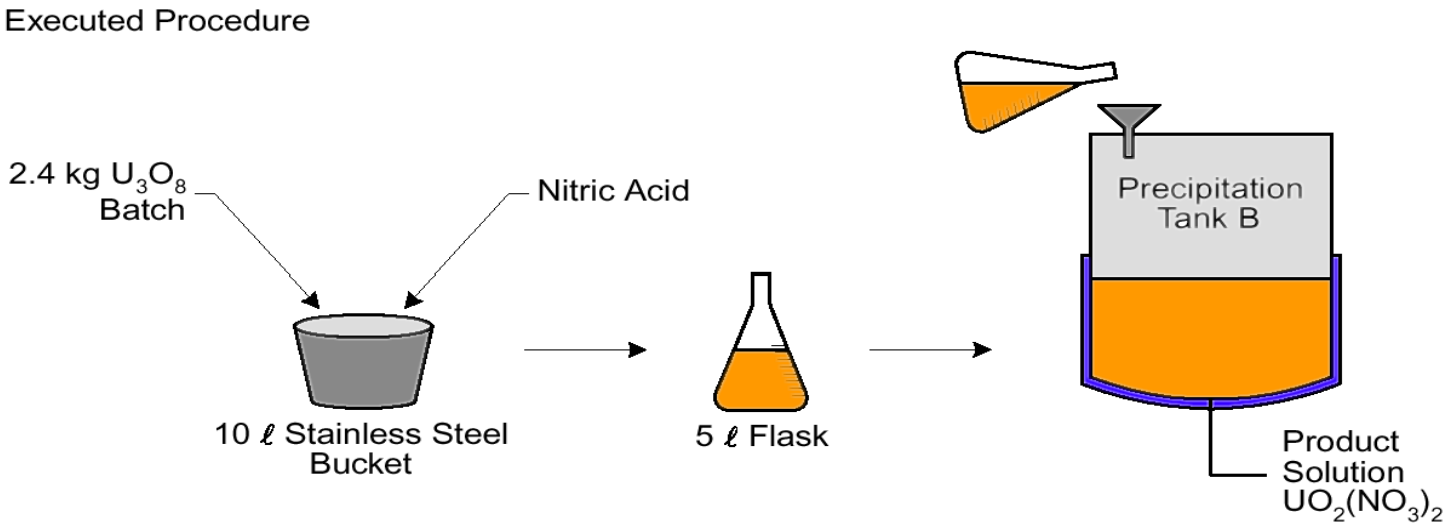


1999 Tokaimura Accident

- JCO approved a change to speed up process
- Allowed manual mixing and transfer of concentrated U_3O_8 - HNO_3 solution in a 10 liter bucket to the buffer tank
- U_3O_8 weighed to verify 2.4 kg mass limit
- Reports of processing multiple batches
- Modified procedure was not reviewed or approved by STA
- First operations with IEU in three years
- *Serious* delay in operations
- **Team leader** directed workers to directly transfer U_3O_8 - HNO_3 solution to the precipitation tank (instead of the buffer tank) AND to process multiple batches

1999 Tokaimura Accident – Actual Operation Performed

- 16.1 kg uranium added to tank over 2 days
- Last batch added ~10:35 a.m



Precipitation tank went supercritical!

1999 Tokaimura Accident – Major changes to process without review

- Dissolving uranium oxide, making uranium nitrate solution
- Originally no manual operations
- Process was approved
- Many factors led to changes
- Small changes together make large impact on safety

1999 Tokaimura Accident Details

- Reaction oscillated (multiple pulses)
- Chain reaction continued for ~ 20 hours
- Chain reaction eventually stopped by draining water from cooling jacket (removed reflector)
- Boric Acid injected into tank to poison solution (neutron poison)
- 3 workers received very high radiation doses
  - Worker #1 received fatal dose (1600 to 2000 rad)
  - Worker #2 received fatal dose (600 to 1000 rad)
  - Worker #3 was a few meters away and received 100 to 400 rad, but survived

Quiz Time!

- Which parameters were effected?
- What could have been done for prevention?
- Lessons learned?

1978 Tomsk Accident

- Union of Soviet Socialist Republics
  - Siberian Chemical Combine (Tomsk)

- Only process criticality accident in history involving solid material
  - α-phase Pu metal ingots in storage containers within gloveboxes

1978 Tomsk Accident

- 16 gloveboxes for oxide to metal conversion
  - Produced ingots
- 7 operators per shift
  - Operators were trained on each process in the department, but assigned only one process per shift
  - Written procedures prohibited
  - Switching of operations during a shift

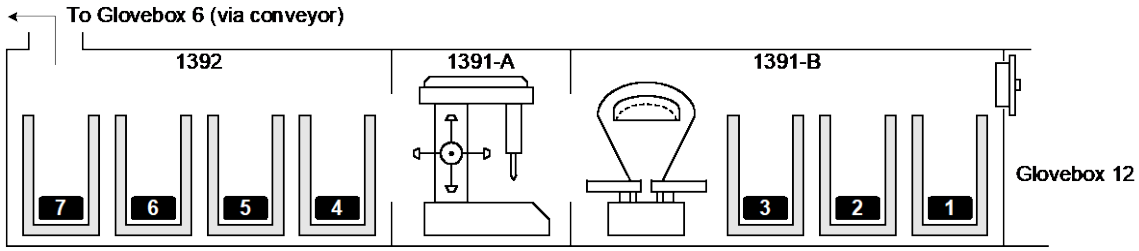
1978 Tomsk Accident - Overview

- Administrative requirements per location

  ≤ 2 ingots AND ≤ 4 kg total mass

- Inadvertent over-mass, i.e., > 8 kg was considered an incredible abnormal condition based on operator training and oversight
- BUT, internal volume of containers did not preclude this overloading
- Containers were limited to a single ingot regardless of mass
- Ingots were to be removed, handled, and returned to original container (but design was such that ingots could not be seen by operators)

1978 Tomsk Accident – Initial Configuration



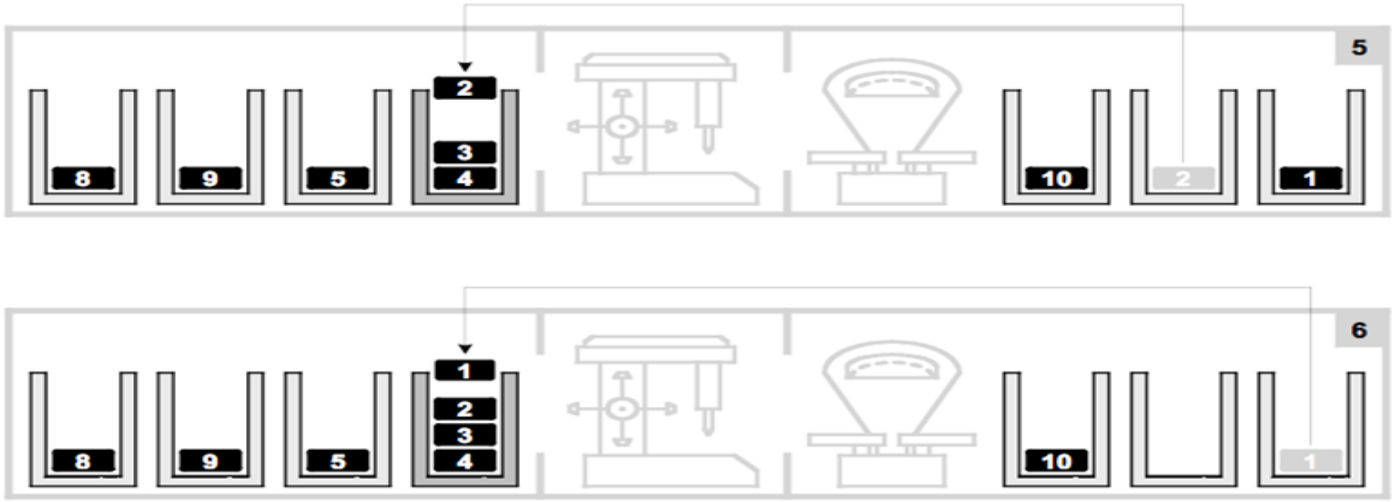
Three workstations:

1391-A	Sample extraction (0.1gram samples, impurity analysis)
1391-B	Weighing and staging
1392	Dimensional measurements

Each location had one ingot in it to start and was in compliance with the limits

1978 Tomsk Accident - Details

- Operator A asked Operator B for help in moving ingots from other gloveboxes and between containers
- Operator A then left the area to perform other tasking
- Operator A returned, but did not confirm that Operator B had completed tasks as requested (L.T. A. communication)
- Operator A moved ingots into configuration below



1978 Tomsk Accident - Details

- While placing the 4th ingot a criticality accident occurred
- An ingot was ejected or immediately removed by Operator A
- Operator A sensed a flash of light and heat to his hands and arms and removed two or remaining three ingots from the container
- Total mass in the one container approx. 10.68kg
  - 4 Ingots

1978 Tomsk Accident - Results

- Estimated 3×10^{15} fissions
- Operator A
  - 250 rad whole-body
  - 2000 rad to hands and arms
    - Amputation of both arms up to the elbows
    - Eventually developed vision problems
- 7 additional personnel received doses from 5 to 60 rad
- Total failure of conduct of operations
  - **An engineered feature could have precluded the possibility**

Quiz Time!

- Which parameters were effected?
- What could have been done for prevention?
- Lessons learned?

1994 Rocky Flats Near Miss - Background

- Rocky Flats shutdown in 1989 due to FBI raid
- Plant Management tried to restart in early 1990s, but plant was eventually scheduled for D&D in 1993/1994
- Cleanup began, but management rushed efforts and were more concerned with RCRA (Resource Conservation and Recovery Act) than criticality safety (prevent spills by catching them: BAD IDEA for criticality safety)
- CONOPS culture was bad, procedures not being followed, criticality accident believed to be not possible
- Tank draining operations had started in a building (771) with both high-equity and low-equity solutions
- During a walkdown, a glovebox with light green and dark green bottles were noticed – questions were asked

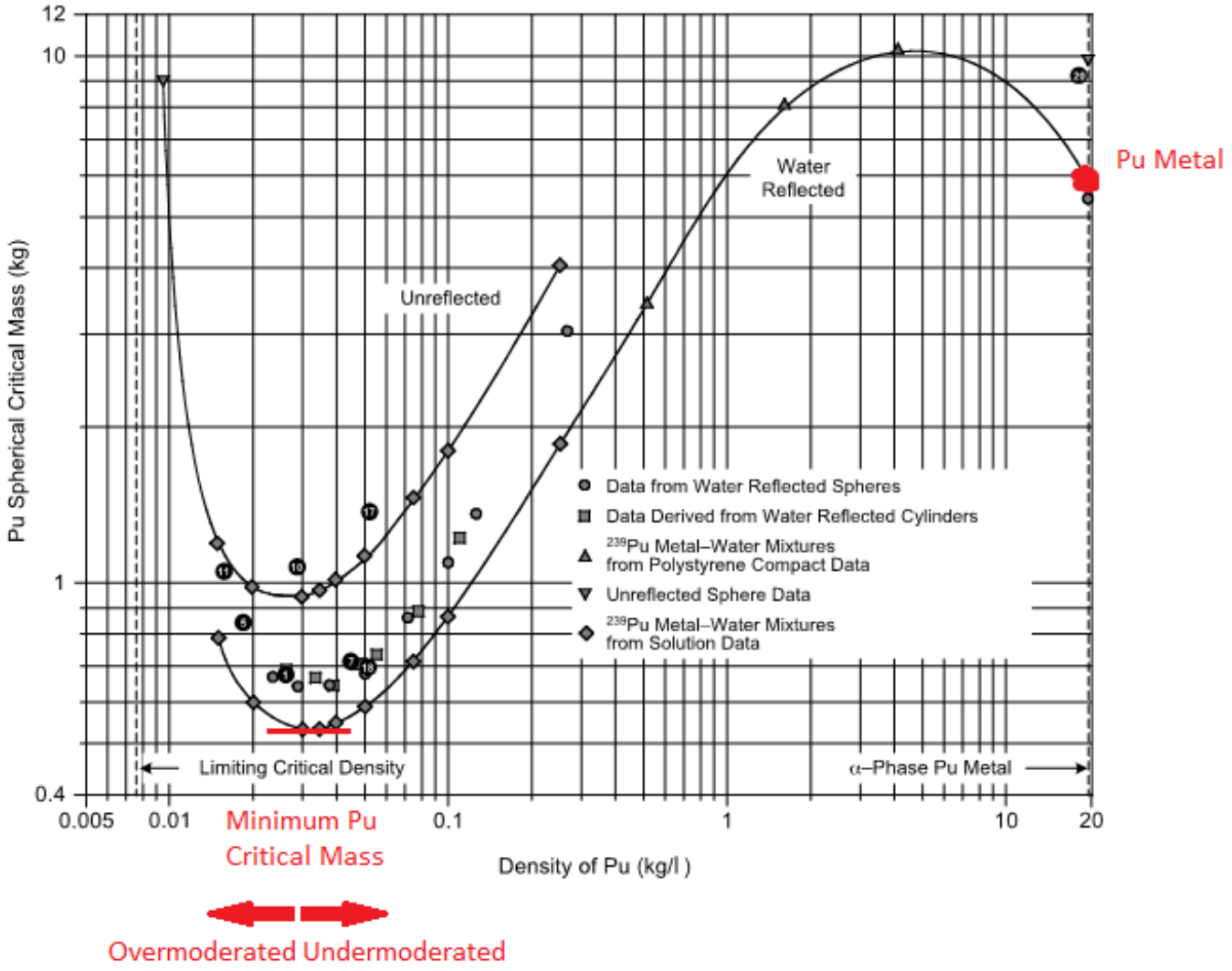
1994 Rocky Flats Near Miss – Details

- Operators had been draining low-equity solution (as approved), but finished early in the shift
- Since equipment was available and pumps running, wanted to continue working (company had $$$ incentive for completing work)
- Operators drained the next tank (not knowing it was high-equity solution), then realized it looked different than the other solutions
- After draining this tank, operations stopped, only because tank was empty
- Operators began to blend the high- and low-equity solutions to make it look consistent in appearance (but not consistent enough)
- ***Why a near miss? Because….***

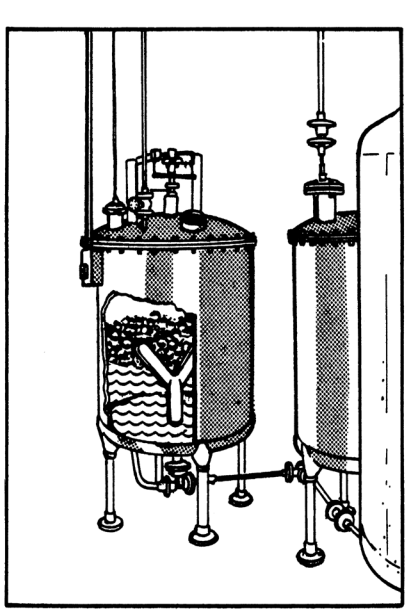
1994 Rocky Flats Near Miss – Details

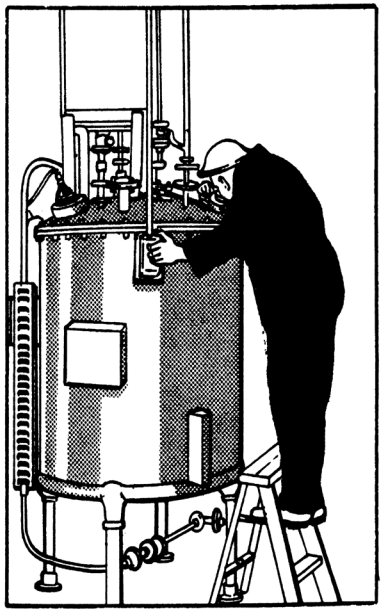
- ***…. the extra tank just did not have enough solution in it***
- If three more bottles had been collected (about 12 liters) it would have gone critical
- Solution was concentrated enough to sustain criticality (and actually passed through the optimal concentration point during dilution, see figure next slide – dilution is NOT the solution)
- Operators did not know what they were draining, did not know about the effects of dilution, and did not know how close they came to a criticality accident!
- The fact that the extra tank did not have enough solution in it was strictly luck, not according to a work plan

1994 Rocky Flats Near Miss



1958 LANL Accident

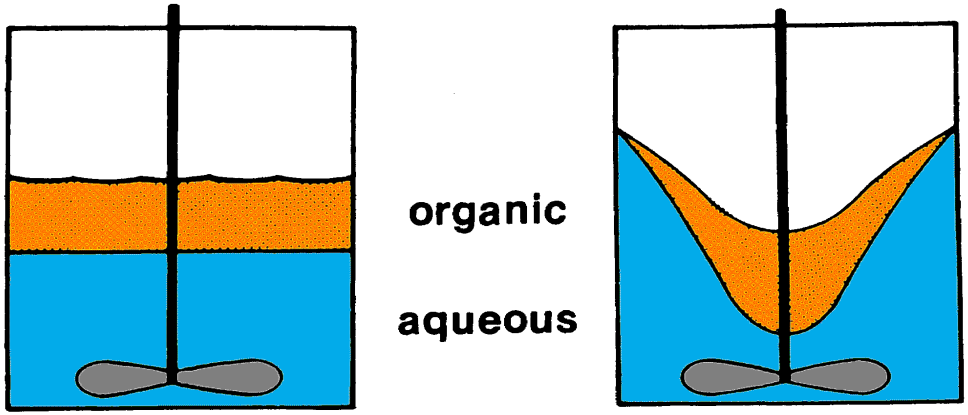




- December 30th, 1958 end of year plutonium clean out underway
- 3.33 kg of plutonium in solution (unknown to worker)
- Worker turned tank stirrer on
- Tank went supercritical (more reactive geometry)

1958 LANL Accident

What happened



- Plutonium was in two layers
  - 60 grams in bottom aqueous layer
  - 3.27 kg in top organic layer
- Stirrer caused top layer to thicken sufficiently to become supercritical within 1 second

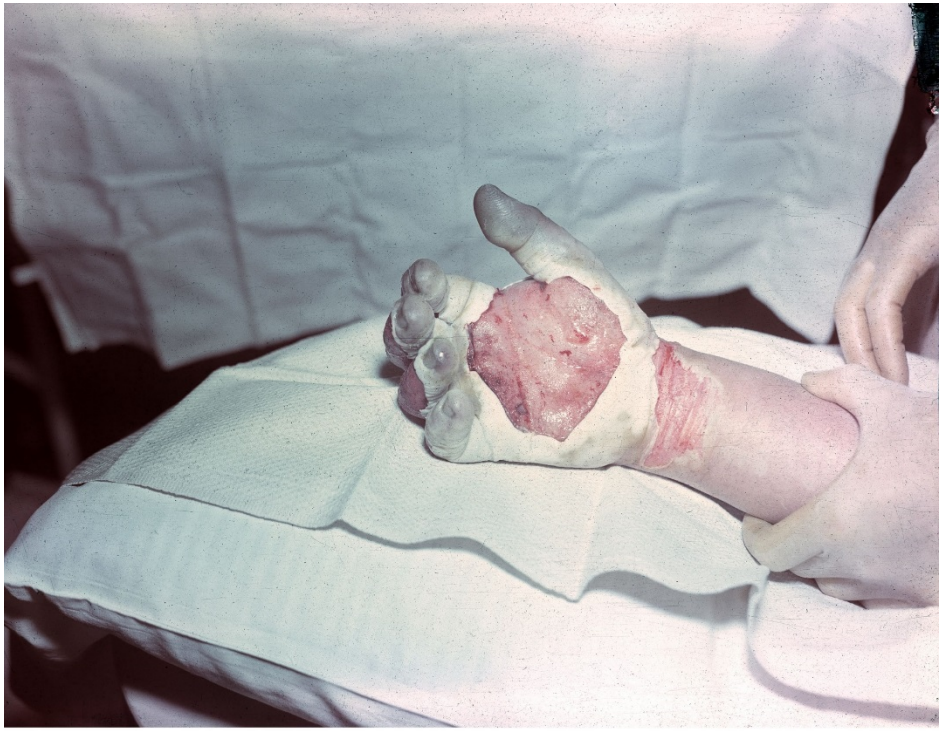
- Stirrer agitation rendered system sub-critical within 2-3 seconds
- Tank was known to be an unfavorable geometry!

1958 LANL Accident & Pictures

- 1.5×10^{17} fissions
- 3 people exposed (53, 134 & 12,000 rad)
- 1 fatality (36 hours)
- **WARNING!**
- **Graphic pictures of accident victims!**

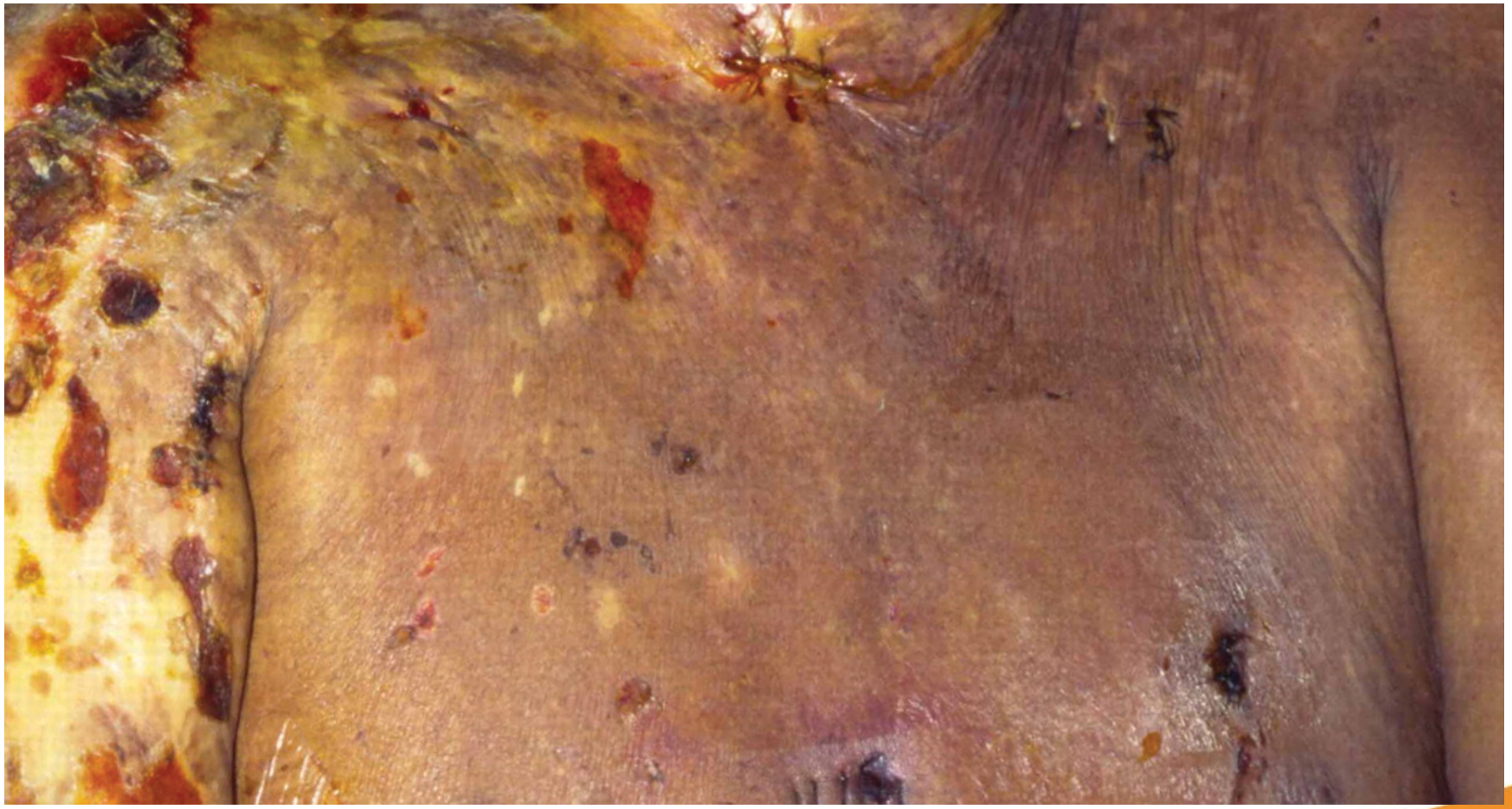
Picture 1

Criticality Incident (Omega) Aug. 24, 1945
10:15 A.M.



Criticality Incident (Omega) Aug.30, 1945
11:00 A.M.

Picture 2



Quiz Time!

- Which parameters were affected?
- What could have been done to prevent the accident?
- Lessons learned?

Emergency (Alarm Notification)

- PF-4 and other LANL facilities are sites where a criticality accident alarm has been determined to reduce the overall risk to the worker
- They are equipped with a criticality alarm system
- ANYTIME you hear this alarm, EVACUATE PROMPTLY because a criticality accident may have occurred!
- Be aware of any indications (noted above) of a criticality accident or of any unusual circumstances

Response to Criticality Accident Alarm System

- A criticality accident may have a single burst, multiple bursts or may achieve a steady state power level.

- There will be dangerously high radiation levels near the accident location due to the fission products that have been produced.

ALWAYS:

Get Out and Stay Out!

Conclusion

- **NEVER** underestimate the potential for criticality
- **ALWAYS** follow your procedures
- **REMEMBER** NCS Parameters (MAGIC MERV)

Whenever something unusual or unexpected is noticed:

- Stop Work
- Back off at least 15 feet (preferably leave the room and secure it)
  Not for Rad Protection: to keep a known subcritical configuration subcritical
- **Declare a potential process deviation**

QUESTIONS?

Contact us with Questions!

- Alicia Salazar-Crockett - 230272
  - aliciasa@lanl.gov
  - 667-3755
- Quinton Beaulieu - 318848
  - qbeaulieu@lanl.gov
  - 665-3829
- James Bunsen - 321625
  - jbunsen@lanl.gov
  - 665-2816

Los Alamos
NATIONAL LABORATORY
EST. 1943

TA-55 Fissionable Material Handlers

Nuclear Criticality Safety Program at TA-55

UNCLASSIFIED

Policy

The policy of the Los Alamos National Laboratory (LANL) and the Nuclear Criticality Safety Program (NCSP) is stated in Section 1.2 of TA55-AP-522.

Please open your copy of TA55-AP-522 and read this section.

What are the four components of the Policy?

Nuclear Criticality Safety Program at TA55

The Criticality Safety Program is designed to protect personnel, the public, and the environment from the consequences of a criticality accident, by preventing criticality accidents using:

- Conduct of Operations
- criticality safety evaluations
- criticality safety controls (engineered features & administrative requirements)
- other programmatic features, such as the periodic review of operations by responsible management

Conduct of Operations

Procedure execution is governed by LANL P315, PA-RD-01026, and PA-SO-01053.

Three necessary components prior to starting work:

- **Work must be Authorized**
  - Approved procedure
  - IPOD approval
- **Worker must be Authorized**
  - By Manager
  - Through training and Qualification
- **Work must be Released**
  - By PIC
  - Consider System Status, NMC&A, RadCon, MAR, Criticality, etc.

Conduct of Operations Manual (P315)

16.4.1 Usage Levels

The management expectations, called “usage expectations,” for using procedures, sections, or attachments vary depending upon a variety of characteristics, including complexity of the work activity, frequency of execution, and potential for negative impact of improper execution. To determine the appropriate usage level, “determination criteria” has been established.

Determination Criteria

If one or more of the following determination criterion are true, then the correct usage level for the procedure, section, or attachment is **UET:**

- has potential high consequence of error
- is complex
- is infrequently performed
- has stringent quality or regulatory documentation requirements
- is used to capture data
- is used as a record
- requires placekeeping or sign-off (see Section 5.13, *Placekeeping and Sign-off Steps*, of FSD-315-16-001, *Technical Procedure Writer's Manual*)

Use Every Time (UET)

The following are the operator usage expectations for UET procedures, sections, or attachments. All are to be applied.

- The procedure revision, including IPCs, must be confirmed to be the latest approved version prior to execution of the procedure.
- The procedure must be at the jobsite and open to the page containing the step being performed.
- The procedure must be executed as written and in the sequence written, unless the procedure allows otherwise (see Section 5.3, *Non-sequence Steps*, of FSD-315-16-001).
- The completed procedure must be reviewed by the worker to confirm that all steps were executed and appropriately documented.

Reference

All of the following usage expectations for Reference procedures, sections, or attachments must be applied.

- The procedure revision, including IPCs, must be confirmed to be the latest approved version prior to execution of the procedure.

Note: For purposes of this attachment, **"readily available"** means a copy can be **obtained within 15 minutes**.

- The procedure must be readily available to workers at the jobsite.
- The procedure must be executed as written and in the sequence written, unless the procedure allows otherwise.
- The individual step may be executed from memory, but frequent confirmation is recommended.
- The completed procedure must be reviewed by the worker to confirm that all steps were executed and appropriately documented.

Usage Levels

- What is the difference between a procedure that has been designated as a Reference procedure and one that is designated as UET?

PA-SO-01053

- **Requirement 1**
  - The designated PIC *is not allowed to perform hands-on work* for procedures (DOPs/IWDs) that include:
  - Processing ≥ 500g of special nuclear material (unless performing duties to instruct)
  - Processing HSPu material in PF-4 (unless performing duties to instruct)
- **Requirement 2**
  - Use-Every-Time (UET) procedures (DOPs/IWDs) ***are required to be performed using the Reader-Worker technique*** for the following:
    - Processing ≥ 500g of special nuclear material
    - Processing HSPu material in PF-4

Nuclear Criticality Safety Program at TA55

We use two primary documents to communicate how the Nuclear Criticality Safety Program operates at TA-55. We also use Standing Orders to address temporary situations or issues needing immediate response.

- TA55-AP-522, Nuclear Criticality Safety at TA55
- PA-RD-01009, TA55 Criticality Safety Requirements

Nuclear Criticality Safety at TA-55
TA55-AP-522

Nuclear Criticality Safety at TA-55
TA55-AP-522

- Describes nuclear criticality safety program at the TA-55 facility.
- Applies to all TA-55 personnel involved in fissionable material operations:
  - Fissionable Material Handlers,
  - Facility Operations Director
  - Facility Operations Manager
  - Group Leaders
  - First Line Managers
  - Criticality Safety Officers
  - All personnel working in proximity to fissionable material
    e.g. housekeeping, maintenance, etc.

Key Definitions

- Key definitions of terms commonly used in the criticality safety program at TA-55 are listed in Section 3.0 of TA55-AP-522.
  - Look up the definition of:
    - Criticality Safety Requirements
    - Criticality Safety Evaluation
    - Criticality Safety Posting
    - Fissionable Material Form
    - Fissionable Material Form Pu in Metal
- What does a Criticality Safety Posting include?
- Can a Pu hemishell be treated under the Pu in Metal Material Form?

Key Definitions

- Criticality Safety Posting (CSP) is a posting that is a conveniently available reminder of those criticality safety requirements for which the operator has implementation responsibilities. Postings are neither generic nor interchangeable; they are process and location specific.

PA-CSP-XX-XXX TA-55 CSP TEMPLATE

Criticality Safety Posting

Activity/Task Title

TA	GB #	NMCA Location	References
			NCS-CSED-XX-XXXX
Building	Room	FMO ID	TA55-ESS-14-002 (if applicable)

CRITICALITY SAFETY REQUIREMENTS
NMCA LOCATION XXX

Administrative Controls

Material Limits

The material limits should be placed here. For example:
Pu in Pit/Hemishells/Waistbands/Metal/Oxide/Compounds/Dry Residue ≤ *4500g*

Additional Restrictions

Any additional operational restrictions should be listed in this section. For example
Pu in Metal: Greater than 3kg Pu metal must be transported in a container providing at least 1.0 cm of engineered spacing.

NOTE: Pits, hemishells and waistbands are excluded from this restriction.

Engineered Controls

Engineered features are listed to maintain operator awareness. Features are verified during CSP implementation and Operational Reviews of the criticality safety requirements in accordance with TA55-AP-522.
The engineered controls listed in the CSED, Release Review, etc. should be placed in this section.
Enter as bulleted text
Enter as bulleted text

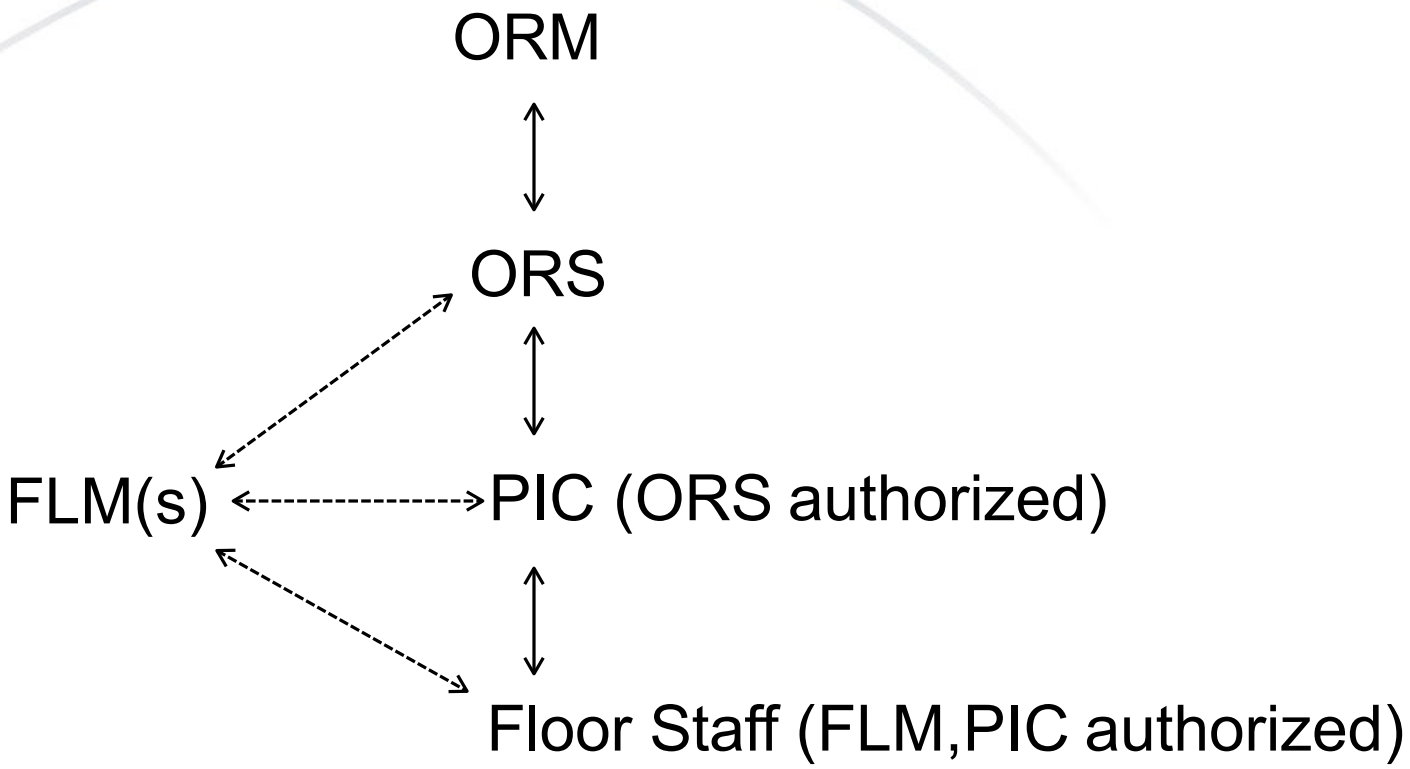
Process Description:
The process description should be entered in this section as a bulleted set or briefly described. The bulleted set shall be consistent with the process description provided in the criticality safety evaluation but should only be a summary thereof.
- Enter as bulleted text
- Enter as bulleted text

Workstation Diagram (if applicable):

Roles and Responsibilities

- The Roles and Responsibilities in the Criticality Safety Program at TA-55 are defined in Section 4.0 of TA55-AP-522.
  - Look up the role of the:
    - Facility Operations Director (FOD)
    - Facility Operations Manager (FOM)
    - Operations Responsible Manager (ORM)
    - Operations Responsible Supervisor (ORS)
- Who is responsible for the safety of process operations??
- Who is responsible for infraction recovery??

PF-4 Operations Management Chain



Establishing Criticality Safety Requirements

A criticality safety evaluation is required for all new or changed fissionable material operations. The establishment of criticality safety requirements is a two part process:

- Performance of a criticality safety evaluation (**CSE**)
  - The evaluation team shall develop the criticality safety controls. The order of preference for the controls is:
  - **Passive engineered controls** such as fixed spacing racks, limited diameter tanks, limited volume vessels
  - **Active engineered controls** such as α-activity or concentration monitors that automatically stop flow
  - **Administrative requirements** such as mass, form, and container limits
- Approval and Implementation of the criticality safety requirements.

Implementing Criticality Safety Requirements

The following process is used for implementing a CSP for all FMOs except Facility Wide FMOs such as PF4-HAND-00, PF4-CARTS-04, and PF4-CARTS-06.

- The new CSP has been **uploaded to the document control system**, and has been made **available to personnel in PF-4**. It is recognized that for a period of time that there will be more than one approved posting in Documentum. **The posting on the location is the implemented and governing posting.** The implemented posting should not be marked as "Superseded" in Documentum until the proposed posting has been completely implemented in accordance with this section.
- The LANMAS/LAMCAS account has been established by SAFE-NMCA for new locations. In the case of existing locations, **verify** that the material **inventory listed** in LANMAS/LAMCAS is **consistent** with the actual **material inventory within the FMO**.

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Implementing Criticality Safety Requirements

- A comparison of the criticality safety requirements to the actual material inventory within the FMO has been completed.
- A *Record of Fissionable Material Operational Review* form (Form 3026) has been completed in accordance with NCS-AP-009. This review will be performed against the proposed but not yet posted CSP. The TA55 FOM should be notified via email of planned implementation reviews such that a knowledgeable, independent reviewer may be assigned if so desired. Engineered controls listed in the CSED that are elevated to the Safety Basis have been verified in accordance with P116, *Implementation Verification Review Process for Safety Basis Changes*.

Implementing Criticality Safety Requirements (cont.)

- Implementation of CSPs that were developed to allow an FMO to exit from an ESS or Safety Basis level control are not posted at the FMO location until formal DOE approval of the basis change. The FMOR team will perform the FMOR to both the current basis and the proposed to be implemented basis. An IVR will also be performed as a part of the exit process. The actual posting of the FMO will be held in abeyance until DOE approval of the revised basis has been achieved. NNSA has relaxed this requirement for those controls implemented as a result of ESS-14-002 regarding the potential for criticality in a glovebox due to firewater.

Implementing Criticality Safety Requirements (cont.)

- Submit a completed FMO Posting Form shown as Attachment A with the implemented posting attached to ncsb@lanl.gov and ncsreview@lanl.gov.
- Post the approved CSP/CSPs and remove any and all obsolete CSPs.

In the cases where multiple copies of the CSP are posted in the work area, it is incumbent upon the ORS to ensure that all obsolete CSPs are removed and replaced with a copy of the approved CSP.

  - The posting of a CSP is the final action in implementing an approved posting. **Therefore, the posting at the location is assumed to be fully implemented and governs operations within that location.** The status of a CSP or CSLA can be verified by contacting the Document Control System at ta55documents@lanl.gov and requesting a certified copy of the posted CSP.

Implementing Criticality Safety Requirements Facility Wide FMOs

The following process is used for implementing CSPs for Facility Wide FMOs, e.g. FMOs PF4-HAND-00, PF4-CARTS-04, and PF4-CARTS-06:

- Engineered controls listed in the CSED that are elevated to the Safety Basis have been verified in accordance with P116, *Implementation Verification Review Process for Safety Basis Changes*.
- Submit a completed FMO Posting Form shown as Attachment A with the implemented posting attached to ncsb@lanl.gov and ncsreview@lanl.gov.
- The new CSP has been **uploaded to the document control system**, and has been made **available to personnel in PF-4 as a required reading**. There will be a 20 working day implementation period for the new posting. During this time the new CSP will have a watermark indicating that it is "Proposed".

Implementing Criticality Safety Requirements Facility Wide FMOs

- The obsolete posting shall be marked as “Superseded” in Documentum once all of the actions listed above have been completed and the watermark on the new CSP has been removed.
- The final action in implementing an approved posting for FMOs PF4-HAND-00, PF4-CARTS-04, and PF4-CARTS-06 will be marking the obsolete CSP as “Superseded” in Documentum. **Therefore, the postings as shown in Documentum are the implemented and governing postings for these FMOs and must be used for all evolutions of these FMOs**.

Operating Procedures

- Section 5.10 of TA55-AP-522 addresses Operating Procedures. A short summary follows:
  - The handling, processing, and movement of fissionable material must be performed by **FMH certified workers** and controlled by written work authorizing documents. Procedures and other work authorizing documents involving fissionable material, performed within an FMO, or with the potential to affect fissionable material will normally require **FMH certified workers to be present and in direct control of the work being performed.** However if the actual tasks do not involve the direct handling of fissionable material, the NCSB with the concurrence of NCSD may grant an exception to this requirement.
- Please open your copy to Section 5.10 and review this section.
- What does * in front of a performance step indicate?
- What does a $ in front of a step indicate?
- Does NCS need to review a procedure to repair chilled water line?

Operator Authorization

- FLMs must authorize operators to perform specific processes under the direction of an assigned PIC. FLMs are responsible for authorizing personnel under their line management authority to participate in a particular process, and for ensuring that the process is appropriately authorized and released.

Requirement Compliance

Compliance with the criticality safety requirements must be verified prior to beginning work with fissionable material in an FMO. The verification must include a visual inspection of the workstation to identify unexpected changes in the work environment. The FMH must confirm NCS Administrative Controls are met by:

- Verifying that the LANMAS/LAMCAS derived inventory report is compliant with the criticality safety posting (CSP) for the specified workstation.
- Verifying the actual SNM holdings against the LANMAS/LAMCAS derived inventory report for the specified workstation.

(Continued on next slide)

Requirement Compliance

- Verification must include one or more of the following:
  - **Visual Inventory verification** is acceptable if compliance with mass and material type is apparent or is known through process knowledge.
  - **A Count Inventory verification** is acceptable if compliance with material type is apparent or is known through process knowledge and the mass of individual items is understood. The only uncertainty in the inventory being the number of items.
  - **A Touch Inventory verification** is required if compliance with material type and mass cannot be determined with either a Visual Inventory or a Count Inventory.

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Requirement Compliance (cont.)

- The elemental weight of all isotopes of Plutonium (e.g.Pu238 + Pu239 +Pu240 +Pu241+Pu242+etc.), as listed in the LANMAS system for a particular item will be used for Plutonium material forms. Whereas the isotopic weight of a particular item will be used for verifying compliance with Uranium material limits.
- In determining compliance with criticality safety requirements listed in the CSP, the word **"or"** is understood to mean either of the two identified conditions is acceptable as stated. Furthermore, **"or"** does not imply a combination of the items is acceptable.
- The symbol "/" is utilized to signify the condition when any combination of the two conditions is acceptable.

Material Labeling

- TA55-RD-585, *Nuclear Material Control and Accountability Requirements*, requires accountable items to be labeled with the MATL **NAME (i.e. Lot ID) and MT (Material Type).**
- The Criticality Safety Program at TA-55 utilizes LANMAS/LAMCAS system as its labeling system and relies upon this system to ensure that criticality safety requirements are being enforced. In order to address all of the criticality safety requirements, the operator is required to enter additional data into the comment field.
  - The Lot ID provides the operator with a unique identifier and data field for recording more comprehensive information in the LANMAS/LAMCAS database.
- If the material is containerized, the container volume and type must be recorded in the **"remarks field"** to ensure compliance with nuclear criticality safety limits.

Suspected Process Deviation

- **Potential Process Deviation** - Apotential process deviation is an abnormal process condition that may impact the criticality safety margin.
  - Required procedural steps are skipped
  - Procedure steps are performed out of a required order
  - A criticality safety control cannot be met or has been exceeded
  - An engineered feature does not meet the requirements or fails (tank leaking or rupture) during use

Suspected Process Deviation

If at any time it is suspected or known that a process deviation has occurred, e.g., a criticality safety control has been compromised, the worker identifying the potential process deviation must complete the following steps in the **order indicated.** In all cases these actions must be completed in order and as quickly as possible.

1. Pause work in a safe manner.

Warning Do NOT attempt to recover from the situation

2. Back away from the situation at least 15 feet.
3. Promptly establish an exclusion zone such that personnel within the room are at least 15 feet away from the area of concern and control access to the affected area(s). Delay the self-monitoring required by TA55-RD-555 until you have exited from the exclusion zone. If necessary, the room may be evacuated and the Red Light may be used to help control access.
4. Warn others in the area to avoid the exclusion zone.
5. Notify supervision and the TA55 Operations Center.
6. Await further instructions in a safe location.

Configuration Management

- CSPs are ADPSM documents and are controlled in accordance with in PA-AP-01000, *Document Control Process*.
- Engineered Controls are selected by the Criticality Safety Evaluation Team during the preparation of the CSE. These features are credited in the analysis and must be maintained in the stated condition for the analysis to be valid.
- In order to ensure that the analysis remains valid, they are placed under configuration control in accordance with P341 *Facility Engineering Processes Manual*. The engineered controls will be included in the Master Equipment List (MEL) unless a specific variance is granted in accordance with Section 5.22 for an alternative configuration management system.
- Validation will be performed annually in conjunction with annual Operational Review to certify that the Engineered Feature is as described in the CSED and accomplishes all of the listed requirements per the CSED.

Criticality Alarm System and Emergency Response

- Due to the nature of the work with fissionable materials at TA-55, the risk of a criticality accident is **non-trivial**. As a result and an assessment of the risk versus benefit, a Criticality Alarm System (CAS) has been installed and is operating within PF-4.
- The criticality alarm sounds after the initial burst of energy from a criticality accident. It can not protect you from this initial burst of energy. However, you should immediately evacuate the facility and proceed to the appropriate assembly area.

TA55 Criticality Safety Requirements PA-RD-01009

TA55 Criticality Safety Requirements PA-RD-01009

- TA-55 General Criticality Safety Requirements are listed in Section 5.0 of PA-RD-01009. The operation specific CSED always trumps this RD!
- Please open your copy to Section 5.0 and look up the following topics:
  - **Maintenance Supplies**
    - How much cleaning solution is allowed in an FMO?
  - **Material in spool pieces or airlocks.**
    - Can material be staged within spool pieces?

TA55 Criticality Safety Requirements PA-RD-01009

- **Handling Open Containers and Wagons within Rooms.**
  - What should you do if you see a mop bucket and other open containers left unattended within room 401?
- **Liquid Spills**
  - Do you have to report a three liter liquid spill inside the glovebox?
  - What should you do if you observe a leaking 6-inch pencil tank?
- **Water Resistant Containers**
  - Is a SAVY-4000 an approved water resistant container?
  - Is a sliptop container an approved water resistant container?
- **Transporting Pu as Metal**
  - Do you need to use an approved container to move 2 Kg of Pu as metal?

TA55 Criticality Safety Requirements PA-RD-01009

- The lid on containers being used to store or stage SNM shall be secured in place using the appropriate hardware, i.e. nuts, bolts, etc.
- The boundaries of FMOs shall be physical barriers which preclude the **inadvertent** movement of an item from one FMO to another.
- The use of new or changes to existing temporary or permanent shielding must have concurrence from the Nuclear Criticality Safety Division (NCSD) prior to implementation.

TA55 Criticality Safety Requirements PA-RD-01009

Infractions of these requirements must be reported as Potential Process Deviations!!

Los Alamos
NATIONAL LABORATORY
EST. 1943

TA-55 Material Handling and Movement

What is DOP-016?

- Purpose
  - Instructions for performing material handling and movement in and between TA-55 Fissionable Material Operation (FMO) locations

- Scope
  - It is a facility-wide general use procedure that is utilized in a significant number of locations throughout the facility

What is a FMO Location?

- For the purpose of this procedure
  - A Fissionable Material Operation (FMO) location in TA-55 is defined by the criticality safety evaluation document (CSED)

What is an FMO Location?

- Specific examples include
  - ✓ Vault storage room 19 – “per 12x12 location”
  - ✓ Non-destructive Assay(NDA) KARDEX storage – “per storage location”
  - ✓ Pu238 Operations – “Glovebox in Room XXX” “Room XXX”, “Description of Locations”

When does DOP-016 not apply?

- Entering an FMO Work Location that is established to be the entire room or is established to occupy a large geographic space within a room to conduct

  - ✓ Administrative Work
  - ✓ Maintenance
  - ✓ Construction
  - ✓ Custodial services

How is DOP-016 Organized

- Organized into 5 Operational Sections
  - Verifying NCS requirements
  - Handling Material
  - Splitting, combining, or repackaging
  - Moving non-nuclear material
  - Moving nuclear material

Handling Examples

- Moving and Handling
  - ✓Non-nuclear items
  - ✓NCS insignificant materials (NCS-IM)
  - ✓SNM containers

What are non-nuclear items?

- ✓ Tools
- ✓ Parts
- ✓ Empty containers
- ✓ Consumables

What are NCS-IM items?

- ✓ Waste
- ✓ Unaccountable sources
- ✓ Contaminated equipment

Can you Identify activities that require handling of SNM containers?

- ✓ Read a label
- ✓ Apply a TID
- ✓ Weigh an item
- ✓ Open a safe or TA-55 vault drawer to inspect its contents
- ✓ Unpacking a container from another
- ✓ Loading a container
- ✓ Removing pits or hemi-shells from protective containment

Identify examples of Splitting, Combining, or Repackaging

- Removing or processing SNM from a container for the purpose of altering weight, or configuration (splitting, combining repacking)
- Weighing items
- Process handling does not include removing processing SNM items from a container for the purpose of altering material form.

What are Technical Safety Requirements?

- **Technical Safety Requirements**
  - Steps specifically implementing a TSR control shall be denoted by a ($)

Criticality Safety Requirement

- **Criticality Safety**
  - performance steps critical to criticality and have criticality implications are denoted by a (*).

What is Pause/Stop Work?

- All workers are responsible for pausing or stopping work when they have a reasonable belief that quality, work risks, or hazards are not effectively controlled and workers have the right to do so without fear of reprisal.

Pause/Stop Work

- If this procedure cannot be completed as written or abnormal conditions are encountered, PAUSE WORK, place the work in a safe configuration if possible, and notify the Operations Center (OC) and Operations Responsible Supervisor (ORS).

Planning and Coordination

- Schedule the work (IPOD, WPOD)
- Pre-job must been conducted
  - PIC/Worker is responsible for ensuring the work shall be performed to the most current procedure and performance documents
  - Tools, equipment and materials are available

Training Requirements

- Attachment A – performer and verifier (peer check)
  - Must be performed by at least two certified FMH Individuals

- All remaining sections/steps
  - Must be performed by at least one certified FMH Individual

Field Preparation

- Preparatory Activities
  - Identify the Work Locations associated with the move
  - Gather documents and information
  - Perform field walk-downs
  - Coordinate resources

Consider the complexity of the move

Performance Activity One

- Time to apply what we have learned
  - Using Attachment A Nuclear Criticality Safety Verification Guide
  - ✓ Determine if the FMO meets the NCS requirements.

Performance Activity Two

- Time to apply what we have learned
  - Perform handling activities: Picking and inspecting the container

Performance Activity Three

- Time to apply what we have learned
  - Perform process handling activities: Weighing the material on the balance

Performance Activity Four

- Time to apply what we have learned
  - Perform process handling activities: Non-nuclear NCS-IM between work locations

Performance Activity Five

- Time to apply what we have learned
  - Perform a Nuclear Material between work locations

Operating Electronic Balances

Measurement Control Program

- **Terms**
  - Net weight = the weight of a product without the packaging
  - Tare weight = the weight of the packaging
  - Gross weight = the net weight + tare weight
  - Element weight = the weight of Nuclear Material (NM)

Measurement Control Program

- **NM/SNM Measurement Control Program requirements**
- Requires that all NM measurement techniques that are used for MC&A purposes follow a prescribed measurement control program
  - ✓ Balances
  - ✓ TNC & SAI
  - ✓ NDA Laboratory (SGS, Neutron, Shuffler, Cal/Iso, etc)

Measurement Control Program

- **Balances**
- FMH Operators and FMH Supervisors use NMCA qualified accountable balances
  - ✓ to take mass measurements which may be input into the LANMAS/LAMCAS System, verifying the accuracy of the accountability data and records.

Measurement Control Program

- **Balances**
- FMH Operators and FMH Supervisors use certified accountable balances
  - ✓ to comply with the DOE NMCA requirements.

Measurement Control Program

- **Balances**
- FMH Operators and FMH Supervisors use certified accountable balances
  - ✓ Where PF-4 Operations or activities call for a balance measurement as referenced on the PMFD.
    - Mixing, Splitting

Measurement Control Program

- **Operating Balances**
- FMH Operators and FMH Supervisors
  - ✓ Must follow the CSP and confirm compliance with criticality safety in accordance with AP-522 before using a balance.

Measurement Control Program

- **Operating Balances**
- Confirming Compliance with the CSP *$
  - ✓ Verify the actual SNM holdings against the LANMAS derived inventory
  - ✓ Verify the Administrative Requirements
  - ✓ Review Engineering Features to maintain operator awareness

Measurement Control Program

- **Operating Balances**
  - Suspect balances or improperly performing equipment requires immediate attention
    - Measurement System Operations (MSO) Team should be contacted

Measurement Control Program

- **Operating Balances**
- MSO Team
  - ✓ Provides testing of new balances
  - ✓ Verifies functionality and coordinates the balance on the Nuclear Material Accountability System (LANMAS/LAMCAS)
  - ✓ Balance is good until 11:59pm

Measurement Control Program

- **Operating Balances**
- Performance 5.1
  - ✓ Electronic balances are registered on the Nuclear Material Accountability System as Qualified

Measurement Control Program

- **Operating Balances**
- Performance 5.1
  - ✓ The operator must verify the condition of the balance
    - Daily measurement control check
    - Balance is in service and available for use

Measurement Control Program

- **Operating Balances**
- Performance 5.1
  - ✓ Tare the balance
  - ✓ Place the item on the balance platform
  - ✓ Obtain the mass measurement
  - ✓ Repeat as necessary

Measurement Control Program

- **Operating Balances**
- Performance 5.1
  - ✓ Enter results into the Nuclear Material Accountability System

Measurement Control Program

- **Balances**
- In general, balance measurements are among the most precise and accurate measurements.
  - ✓ Metals
  - ✓ Oxides

Measurement Control Program

Neutron Barrel Counter

G05 Segmented Gamma Scanner

Measurement Control Program

- **Time to demonstrate what we have learned**