NRC REVIEW OF THE TOKAI-MURA CRITICALITY ACCIDENT, LESSONS LEARNED AND IMPLICATIONS FOR THE NRC PROGRAM

May 8, 2000

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BRIEFING OUTLINE

- Purpose
- Background
  - JCO Process Flow Diagram
  - Root Causes
  - Consequences
- NRC Staff Actions
- Implications for NRC Licensed Facilities
- Emergency Response
- Conclusions

PURPOSE OF REVIEW

Ensure that a similar accident would be unlikely at U.S. commercial fuel cycle facilities

- Safety operations at NRC licensed and certified fuel cycle facilities
- Implications for NRC's oversight program
- Report addressing lessons learned and implications

BACKGROUND

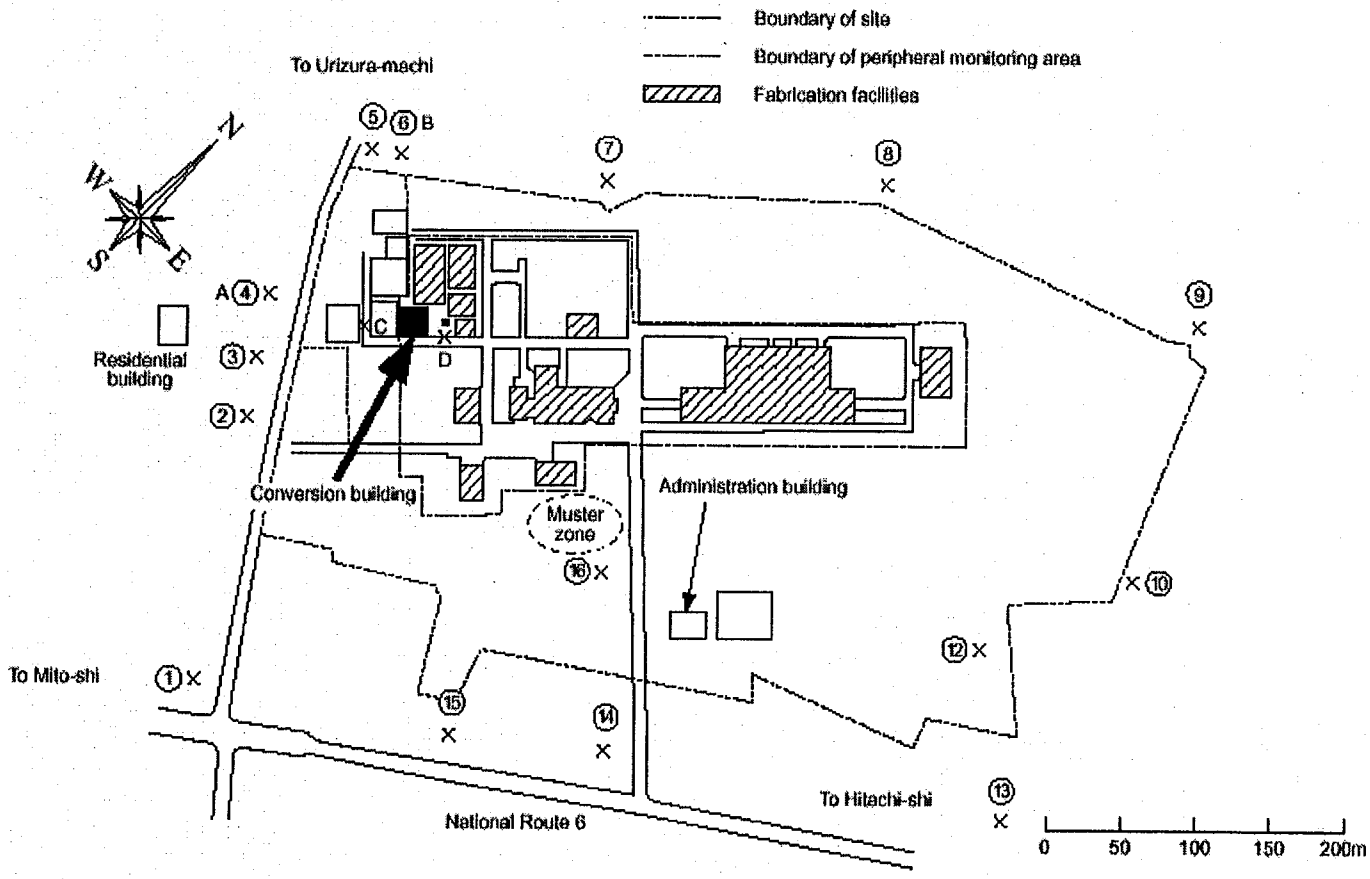


Fig. 4. Plan of the JCO site with location of monitoring points (circled numbers).

JCO PROCESS FLOW DIAGRAM

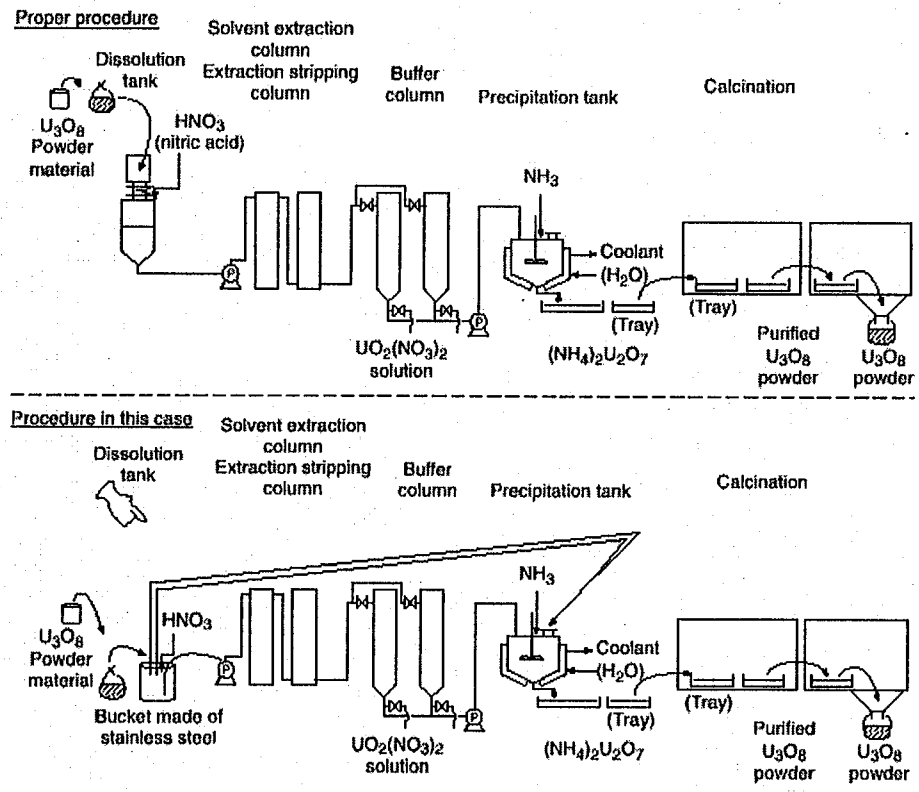


Fig. 7. Schematic diagram of the proper procedure and the actual procedure used in this case for dissolution and precipitation.

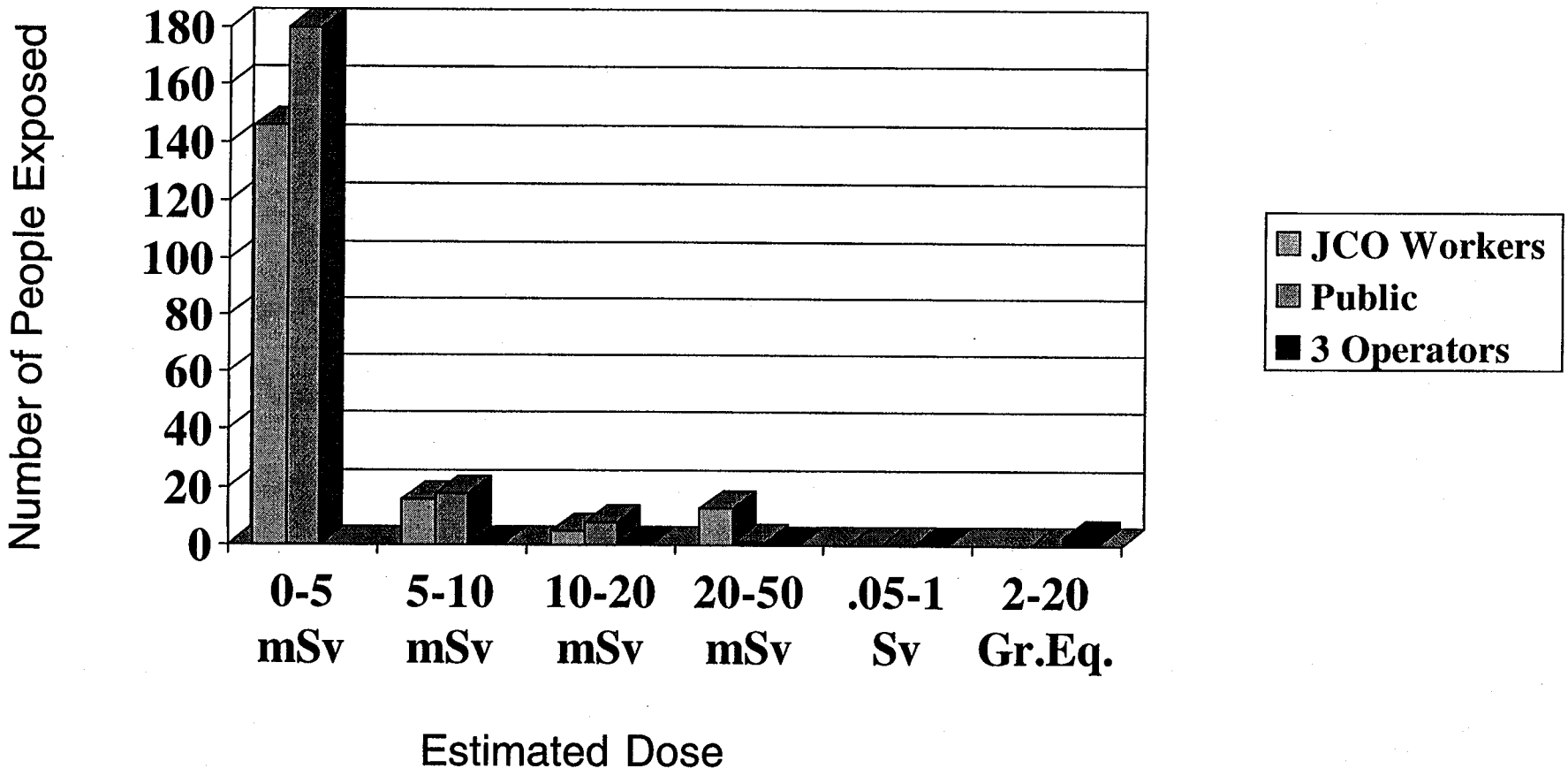
ROOT CAUSES

The direct cause was conduct of operations. The facility was not operated in accordance with the legal requirements.

Based upon Staff's review of the Japanese regulatory authority's (Nuclear Safety Commission) report, the overarching root causes were:

- Inadequate Regulatory Oversight
- Lack of an Appropriate Safety Culture
- Inadequate Worker Training and Qualification

Consequences



NRC STAFF ACTIONS FOLLOWING ACCIDENT AT TOKAI-MURA

- Heightened NRC resident inspector focus on implementation of criticality safety programs at the high enriched uranium facilities and gaseous diffusion plants (October 12, 1999)

- Issued Information Notice 99-31 to alert licensees to the circumstances surrounding the accident (November 17, 1999)

- Evaluated lessons learned as they became available from various sources to consider in review

IMPLICATIONS FOR NRC LICENSED FACILITIES

Program Component	**JCO Conversion Facility**	**U.S. Licensed Fuel Fabrication and Enrichment Facilities**
Criticality Evaluation (Licensing)	Assumed Criticality Not Possible	Assumes Criticality Possible
Criticality Accident Alarm System	None	Required
Emergency Plan	None	Required
Operator Training on Criticality	Not Required –Minimal to None	Operator Training Required

IMPLICATIONS FOR NRC LICENSED FACILITIES

Program Component	**JCO Conversion Facility**	**U.S. Licensed Fuel Fabrication and Enrichment Facilities**
Operations	Not inspected since 1992	Inspected routinely
Procedures	Required by license	Required by license; use verified by inspection
Startup Authorization (Mangt. Control)	Not reviewed	Required by license; confirmed by Inspection
Site Safety Culture	Not reviewed	Reviewed as part of Licensee Performance Reviews

EMERGENCY RESPONSE

Tokai Issues

- Lack of criticality accident alarm system complicated the initial emergency response
- The local population did not receive timely notification to evacuate the immediate area
- Interface problems occurred between the national, local and municipal governments
- JCO's communications and emergency response systems were inadequate

EMERGENCY RESPONSE (cont.)

NRC Emergency Response Requirements

- Criticality accident alarm system
- Emergency plan required for larger fuel cycle facilities
- Regulatory Guide 3.67, "Standard Format and Content Guide for Emergency Plans for Fuel Cycle Facilities," provides general guidance
- Emergency plans must address prompt notification of offsite response organizations and coordination emergency actions
- Licensees must develop site-specific implementing procedures, conduct periodic drills with local emergency organizations and invite the state and local governments to participate, and hold drill critiques
- NRC core inspection program reviews emergency planning

CONCLUSIONS

- The Japanese Government has conducted a thorough investigation of the criticality accident at Tokai-mura
- Accident root causes are similar to causes of previous criticality accidents that have occurred in the world
- The current safety program carried out at commercial U.S. fuel facilities makes a similar accident unlikely
- Emergency response plans provide defense-in-depth at U.S. facilities

Criticality Safety and Emergency Preparedness

Review of U.S. Commercial Fuel Cycle Facilities
(1999-2000)

Briefing to U.S. Nuclear Regulatory Commission
May 8, 2000

Review Team
John C. Brons, NEI
Robert M. Bernero, Consultant
James R. Clark, JAI Corporation

Factors Contributing to the Tokaimura Event

1. *A culture that permitted deviations from licensed procedures to respond to external pressures such as cost and schedule*
2. *Tacit approval of procedural deviation by explicit involvement in unlicensed procedures and by routine willingness to deviate from "official" procedures*
3. *An insufficient criticality safety program, lacking appropriate use of the double contingency principle and maximum reliance on engineered controls*
4. *Insufficient administrative controls, including change control, procedures for starting/restarting infrequent operations and configuration management*
5. *Insufficient training to workers on the potential for criticality, the severe consequences of such an event and on adherence to procedures*
6. *Insufficient oversight, supervision or critical self-assessment particularly with regard to inexperienced workers and unusual operations*
7. *Insufficient instrumentation to monitor the potential for criticality or personnel radiation safety*
8. *Inadequate emergency planning measures particularly with regard to termination of an extended event, timely notification and care of exposed personnel*
9. *Inadequate regulatory oversight*

Results - General

- Beneficiaries of the Regulatory and Standards Process in the United States
- Regulations and Standards are observed and provide fundamental safety
- Did not observe any conditions of safety urgency
- Facilities are operating safely

Results - Contributing Factors

- 1,2 Safety Culture for Operations
  - Safety of operations is dominant focus
  - Authority to stop for safety or process uncertainty is clear
  - Procedures consistent with licensed conditions
  - Striving for procedural adherence

Contributing Factors (Continued)

- 3 Nuclear Criticality Safety Program
  - Uniform adoption of double contingency principle
  - Engineered controls preferred
  - Some use of "triple contingency"
  - NCS Postings

Results - Contributing Factors (Continued)

- 4,5,6 Management, Training and Oversight
  - Use of Tokaimura event experience
  - Understanding of criticality/criticality controls
  - Qualification process
  - Supervisory involvement
  - Operating procedure control
  - Configuration, start/restart control
  - Audits, surveillance's
  - Corrective action programs diffuse, deferential to NRC

Results - Contributing Factors (Continued)

- 7 Instrumentation and Dosimetry
  - All aspects reviewed fully acceptable
- 8 Emergency Preparedness
  - Plans/Facilities
  - Scope of exercises, drills
  - Consideration of extended criticality, highly irradiated personnel
- 9 Regulatory Oversight
  - Regulatory oversight is sufficient or more than sufficient

Results - Integrated

- Unique opportunity
- Competition and Consolidation
- Risk and the Regulatory Process
  - These are not reactors
  - Risk is on-site
  - Offsite risk is low
  - One size does not fit all

Conclusions

- Team affirms safety
- Opportunities for safety improvement
- Industry assumption that “criticality can happen here” is a sound basis for safety planning

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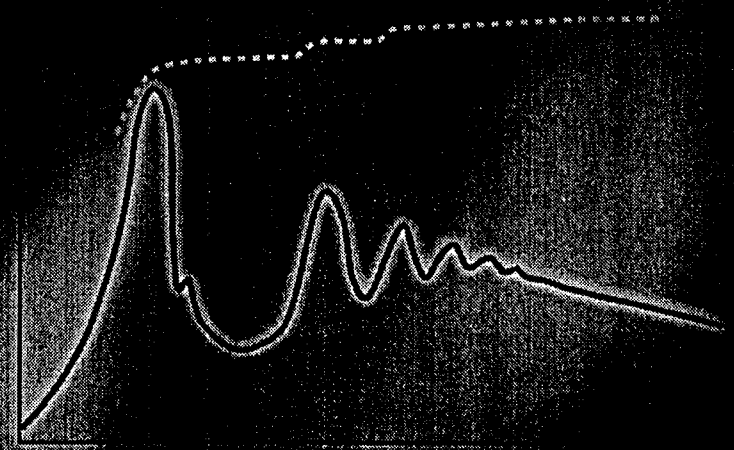
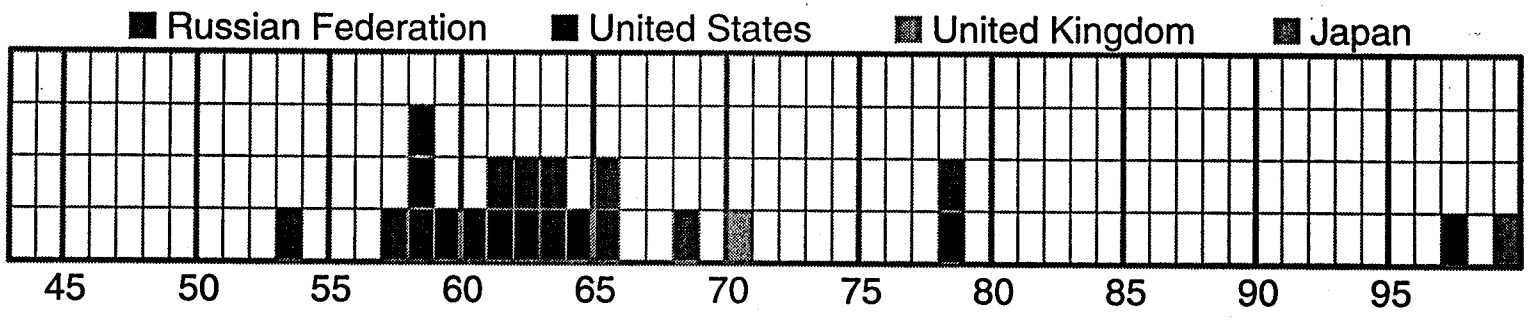
A Review of Criticality Accidents

2000 Revision



Los Alamos
NATIONAL LABORATORY
Los Alamos, New Mexico 87545

Los Alamos National Laboratory is operated by the University of California for the United States Department of Energy under contract W-7405-ENG-36.


Russian Federation
United States
United Kingdom
Japan
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PROCESS CRITICALITY ACCIDENTS

- **Total Reported = 22** — **21 in Solutions; 1 in Metal**
- **Worker Fatalities = 9**
- **Public Exposures:** — **Not health threatening; Measured levels in only one accident**
- **Environmental Contamination:** — **Negligible**
- **Equipment Damage:** — **Negligible**

MAJOR ACCIDENT CAUSES
And
LESSONS LEARNED

General Issues

- No single failure accidents
- No accidents primarily attributable to hardware failure.
- The human element(communications, understanding, following procedures, etc.) dominated all accident causes

MAJOR ACCIDENT CAUSES
And
LESSONS LEARNED

Operator Related Issues

- Do you, the operator, understand your procedure and any associated criticality controls and postings?

- Do you work only according to your written procedures? Important instructions should always be in writing.

- Do you know the consequences of a criticality accident in your operations?

- Do you understand and follow the stop work policy?

MAJOR ACCIDENT CAUSES
And
LESSONS LEARNED

Supervisory/Management/Regulatory Issues

- Avoid unfavorable geometry equipment in areas where concentrated, enriched fissile material is processed.

- Make it easy to perform the job properly - according to procedures. (Is equipment arranged for ease of operation?)

- When was the last time you observed the job being performed according to procedures?

- Do operators know the consequences of not following procedures?