

Investigation of Machining Injury and Resulting Internal Radioactive Contamination

October 2008

Briefing to the EFCOG Contractor Assurance Working Group

Roland Knapp, Investigation Team Lead

Scope & Team

DIR-08-193...”the team will conduct a causal analysis of this incident and will provide a report on the causes of the incident for my approval no later than September 25, 2008. The scope of the team’s investigation will include, but not be limited to collecting all relevant facts leading up to the incident; determining the causes of the glovebox glove puncture including adequacy of activity hazard analysis and control identification for glovebox operations, work controls and procedures relevant to the associated activity, and training and qualification of the involved workers on the above work controls and procedures.” August 15, 2008

Roland Knapp – Team Leader

John Balog – Machinist, Technical Expert

Terry Helm – Organizational Systems

Beverly Ramsey - ISMS

Mark Schmitz – Deputy AD NHHO

Garry Schramm – Radiation Protection

Susan J. Voss – Causal Analysis

Methodology for Investigation

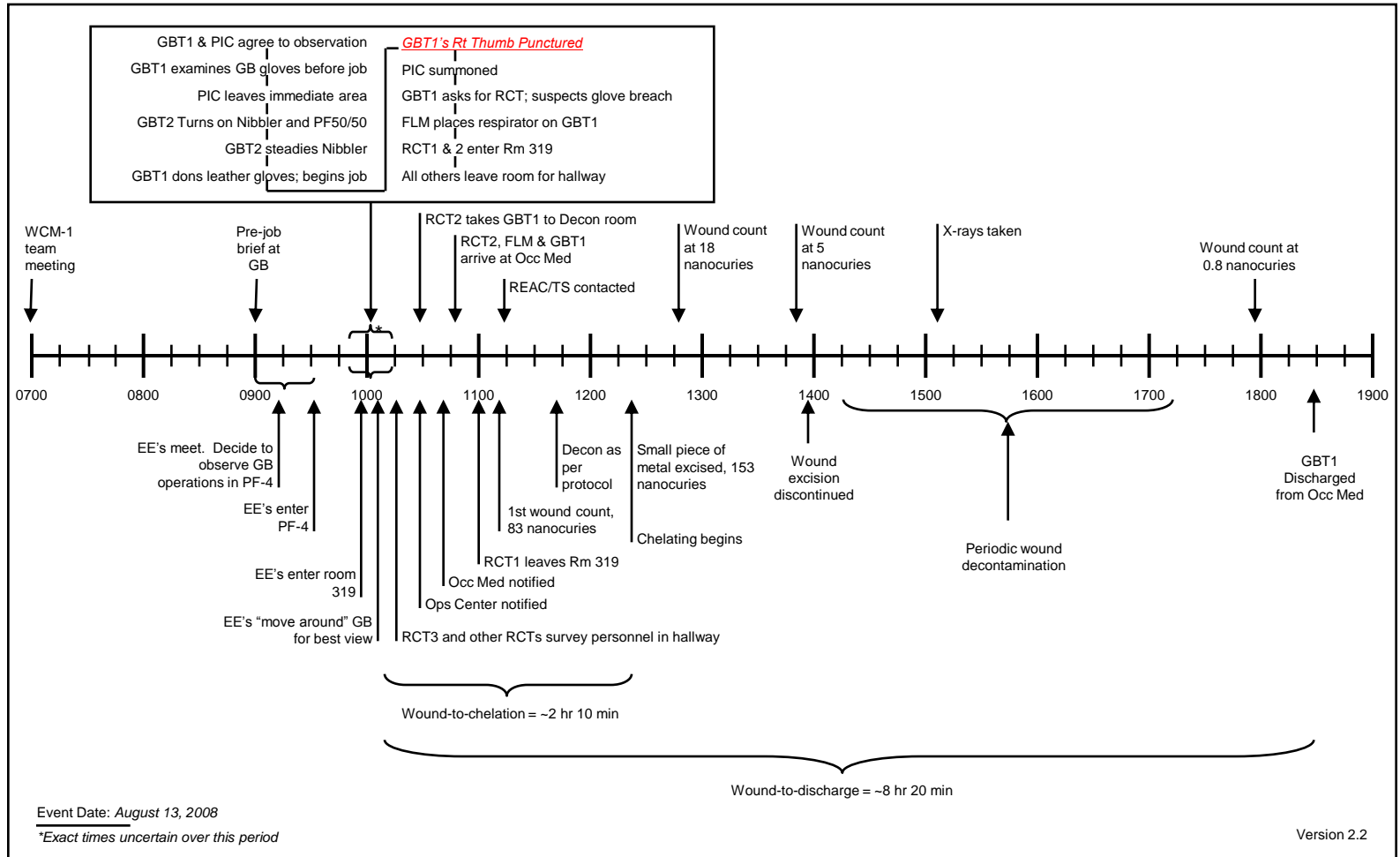
- **In compliance with ISD 322-3.1 *Manual for Communicating, Investigating, and Reporting Abnormal Events* and PS7-PRO-T101, *Conduct a Team Investigation***
- **Use Human Performance Improvement processes as trained in “HPI Accident Investigation Theory” (ESD # 45090)**
- **Interviews (affected worker, work team, others in the work area, management – line, program and FOD)**
- **Inspection and photographing scene and work tools, machined parts**
- **Reviews of work control documents**
- **Forensics of PPE and machined parts**
- **Reconstruction of the event and response time line.**

The Event



On August 13, 2008, a WCM-1 Machinist suffered a plutonium-239 contaminated wound while performing a size-reducing operation on a stainless steel part. The machinist's PPE (4 layers of gloves) was punctured by an undetected metal spur left on the part during the machining operation.

Timeline of Room 319 Glovebox Event:

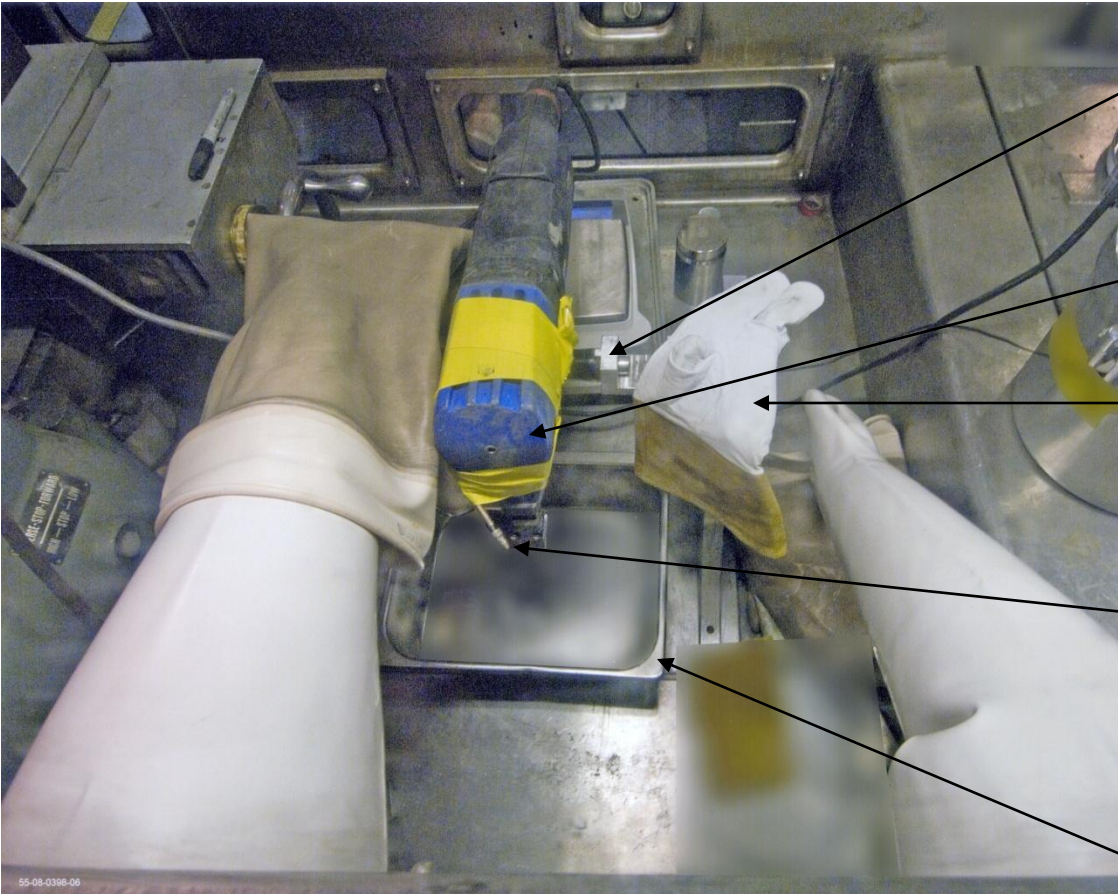


Reconstructed Event in Photographs: 1: The work environment - Glovebox in Room 319



Reconstructed Event in Photographs:

2: Machinist's View of The Equipment



Nibbler Fixed
"Stand"

Nibbler

Leather Over
Glove

PF50/50 Coolant
Nozzle

Catch Pan

Reconstructed Event in Photographs: 3: The Reconstructed Task-- Machining

Nibbler Fixed "Stand"



Work Piece (Simulated)

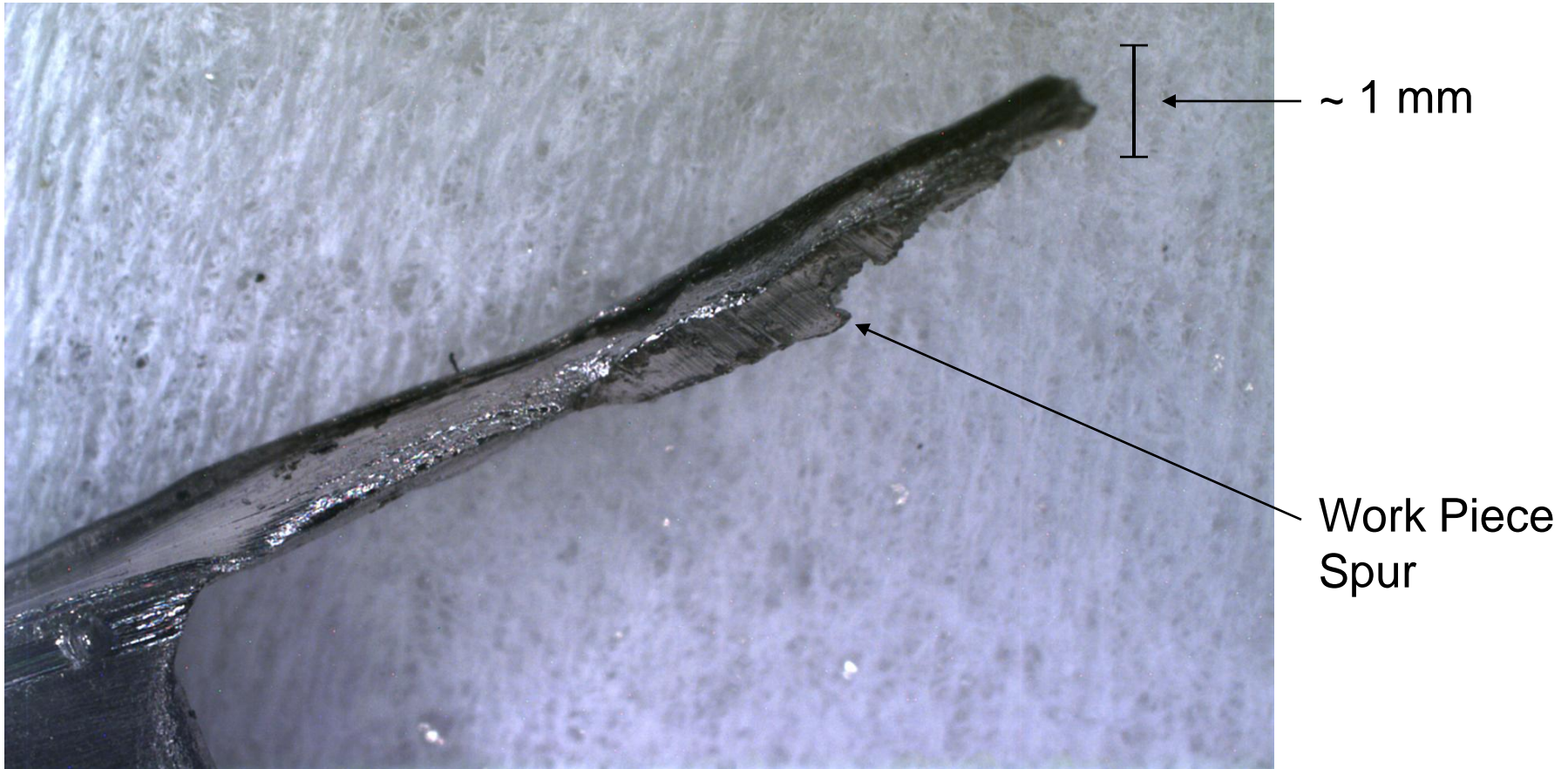


Nibbler
Punch

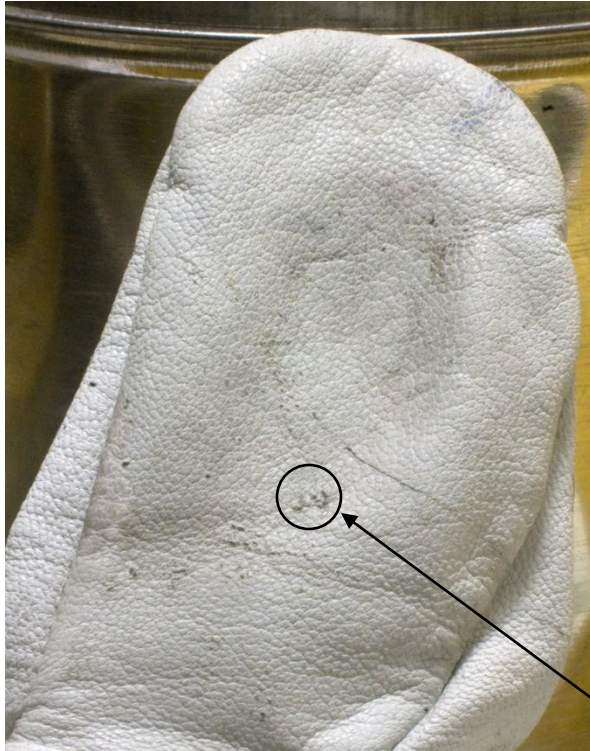


Work Piece
(Simulated)

Reconstructed Event in Photographs: 4: The Problem --- Sharp Spur on edge of SS Sample

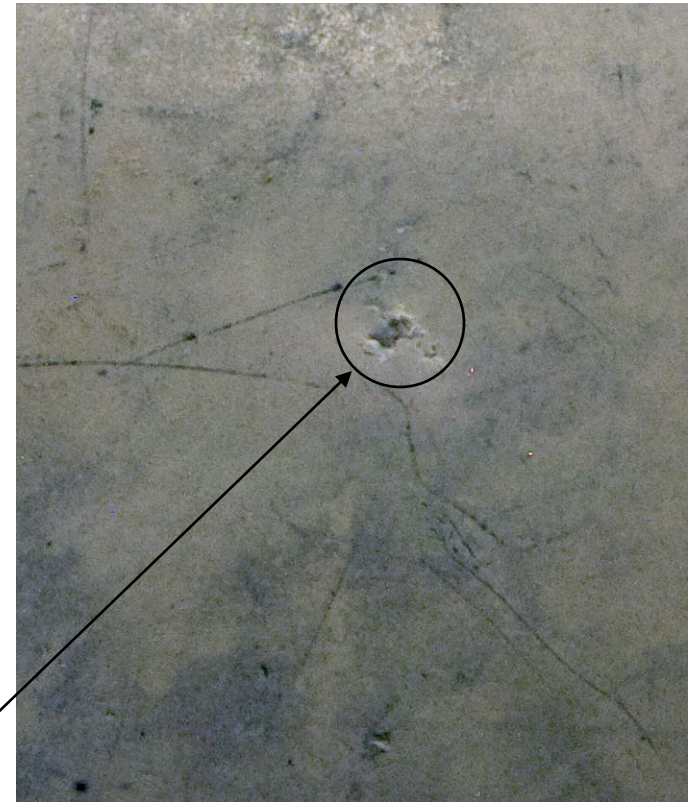


Reconstructed Event in Photographs: 5: The Resultant Wound Through 4 Layers of Gloves



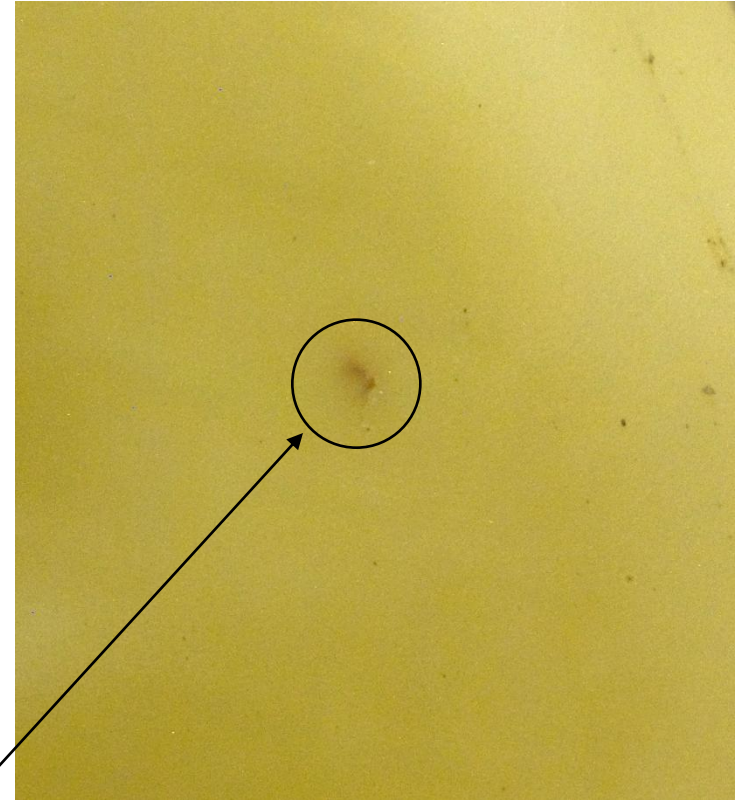
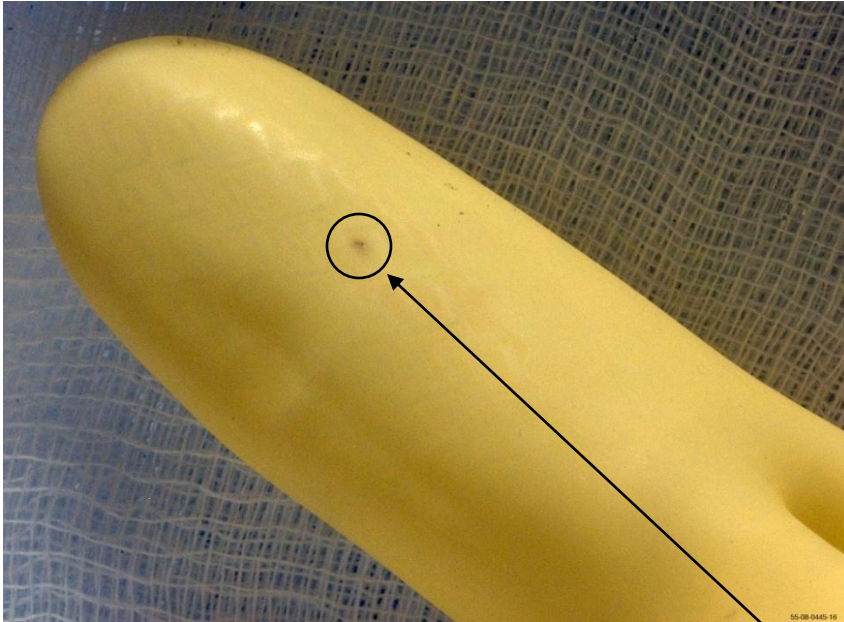
1. **Leather** Over Glove Puncture Site

Reconstructed Event in Photographs: 5: The Resultant Wound Through 4 Layers of Gloves



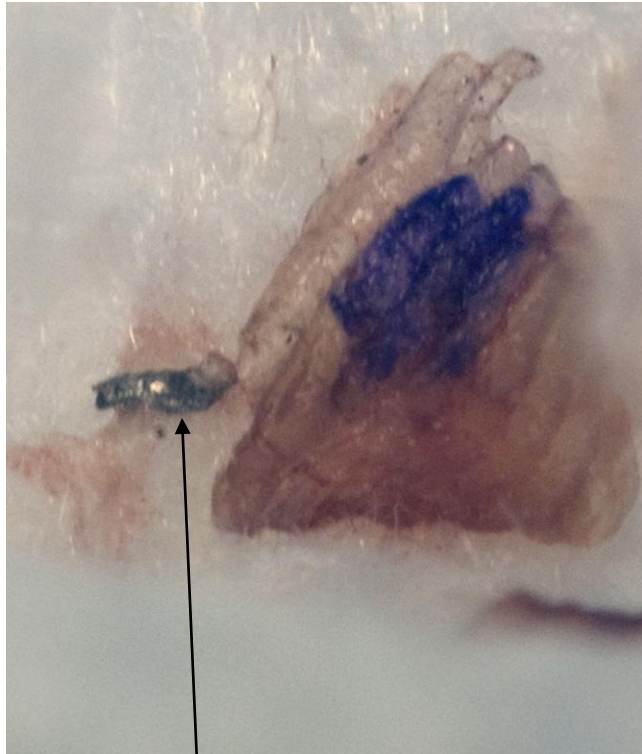
2. Glovebox Glove Puncture Site

Reconstructed Event in Photographs: 5: The Resultant Wound Through 4 Layers of Gloves

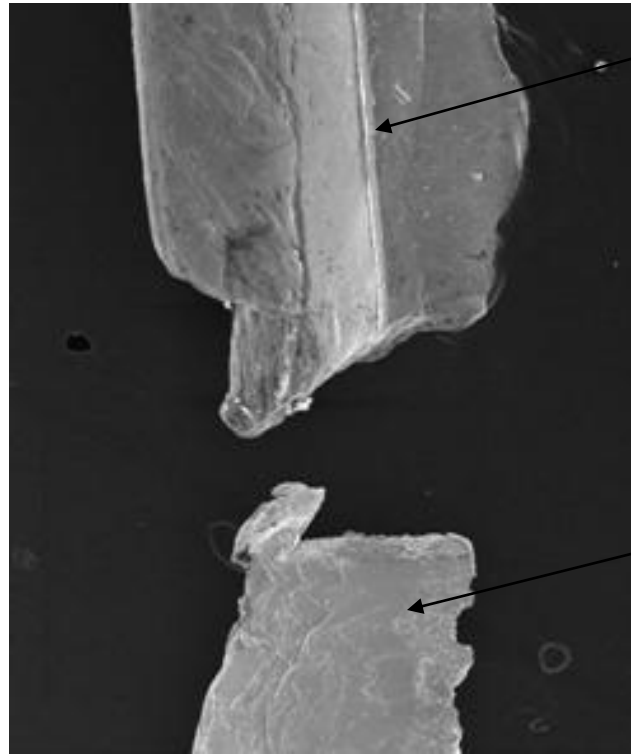


3. Surgeon's Glove Puncture Site

Reconstructed Event in Photographs: 6: The Determination of Material Embedded in Thumb



Sliver Removed
from Thumb



Work Piece
Spur

Sliver Removed
from Thumb

***Spur and Sliver Are the Same
Material and the Same Size***

The Analysis



The Direct Cause or Active Error

On August 13, 2008, a WCM-1 Machinist suffered a plutonium-239 contaminated wound while performing a size-reducing operation on a stainless steel part. The Direct Cause was that the machinist's PPE (4 layers of gloves) was punctured by an undetected metal spur left on the part during the machining operation.

Results of Human Performance Analysis

- ❖ **The purpose of analyzing the human behavioral component of any event is to understand WHY those involved (both directly and indirectly) did the things that they did within the CONTEXT of their work environment.**
- ❖ **With the entire context of this event taken into account, from an HPI perspective this accident is determined to be a blameless error. This error categorization indicates that there were latent organizational weaknesses that combined with work environment conditions and worker capabilities to enable an error.**

Results of Human Performance Analysis

➤ **Error Precursors Identified in this Event (not ordered):**

- *Stress and Distractions:* Unplanned observers, Schedule pressures, Change-out of worker, and OJT.
- *Assumptions/Knowledge:* Sample size and Sample fragility.
- *Loss of Tactility/Poor Visibility:* Layers of gloves and Equipment location.
- *Infrequent Job Execution:* Relatively long time between operations with specific materials.
- *Past Successes:* If it worked in the past, it will work in the future.

➤ **Latent Organizational Weaknesses in this Event (not ordered):**

- *Long Lead Times and Program Uncertainties:* Use of less-than-modern equipment.
- *Values and Priorities:* Different programs independently establish priorities based on local values and resources (equipment and people). It is difficult to see impacts on other organizations as a result, i.e., using WCM-1 nibbler as backup to PMT-4 CNC machine.

Event & Causal Factor Analysis

DOE Cause Codes Assigned by the Investigation Team (not ordered):

A1B5C01 Ergonomics Less than Adequate

A3B3C06 Worker underestimated the problem using past successful experience

A4B1C01 Management policy/guidance/expectations were not well-defined

A4B1C09 Corrective action from previous problem did not prevent event

A4B3C11 Inadequate work package prepared

ISMS Analysis of This Event

- **The Five Core Functions of ISMS were used in planning and executing the task.**
- **There were weaknesses in application of 2 ISMS principles which contributed to the event:**
 - ***Balanced Priorities and Schedule*** – LANL purchased appropriate equipment to remove the hazard from the worker, however, the equipment has not been installed and appropriately authorized for use.
 - ***Tailoring Hazard Controls*** – The sequence of cutting, use of handling tools, and the routine practice of de-burring/roughing edges were not defined as tailored controls for use in machining stainless steel.

Judgments of Need



The Team identified 3 JONs

- *There were several positive actions/attributes identified and reported.*
- *There were several additional observations on process, work control, and work planning & authorization included in the report for management consideration.*

JON 1

LANL should require specific procedures for handling, cutting, and machining of hard materials (such as stainless steel parts) in gloveboxes that identify the additional hazards and provide additional controls.

***Supporting Discussion:* Specific hazards of generation of burrs and spurs and tailored controls already in use in TA-55, PF-4, 100-Area for processing stainless steel were not covered in the WCM-1 work planning and work control documents.**

JON 2

LANL should require the inspection of metal parts and mitigation of sharps hazards after each cutting or machining operation.

Supporting Discussion: The mitigation of the generated spurs/burrs hazards was not shared among work teams and was not formalized into work planning for machining stainless steel, a relatively rare tasking in Room 319.

JON 3

LANL should, to the greatest extent possible, develop remote and automatic metal handling, cutting, and machining techniques to reduce worker exposure to potential puncture/cut wounds.

Supporting Discussion: The glovebox gloves are the most vulnerable part of the glovebox protective system. Any breach in the gloves puts the worker at risk of exposure to radioactivity. A “hands-off” philosophy for higher risk tasks needs to be evaluated and implemented as an engineered control rather than continuing to adjust/add PPE as administrative controls.

Positive Actions & Attributes

- **Lessons learned and corrective actions from previous events were generally in place and well implemented.**
- **Event response by Facility, Radiological Protection, and Occupational Medicine personnel was strong and prevented spread of contamination and significantly reduced the potential dose to the affected worker.**

Additional Concerns

- **There are some inconsistencies and weaknesses in work control documents pointed out in this report.**
- **The leather gloves were transported from one glovebox to another in the same container with the sample pieces which had not been de-burred. This was initially considered a possible source of the splinter that injured the machinist.**
- **The action of immediately placing a respirator on an affected worker prior to a facial survey should be evaluated.**
- **Review respiratory requirements for entering a room when there is a suspected glovebox glove breach.**
- **Consider additional job hazards analysis and oversight for infrequently performed tasks.**

Additional Information



The following are included as additional information to management regarding the HPI Analysis.

Additional HPI Information

HPI Methods (in **red** used in this investigation)

1. Personnel surveys (awareness of risks),
2. HPI-based interviews (to assure work planning or for investigations),
3. **Identifying error precursors,**
4. Identifying defenses (including performance tools),
5. **Identifying latent errors/conditions,**
6. **Identifying latent organizational weaknesses, and**
7. **Providing feedback to improve risk management.**

Applicable HPI Definitions

	Active Error	Latent Error or Condition
Consequences	<i>Immediate</i>	<i>Delayed, or not occurring</i>
Persons	<i>“Hands On”</i>	<i>Everyone: workers, management, SMEs</i>
Visibility (identification)	<i>Very Visible</i>	<i>Not usually detected</i>
Example	<i>Gripping sharp with PPE</i>	<i>Mandating PPE that is not Applicable</i>

Additional HPI Information

Error Precursors are task-related conditions or actions routinely taken in the work environment that invoke human error and increase the chance of a technical error or an adverse consequence.

Latent organizational weaknesses are unmitigated (or partially mitigated) weaknesses in companies, business units, agencies, etc. that provoke errors, degrade the integrity of defenses, or both. Most often not identified.