Sandia National Laboratories

HERMES Access Control - Shield Door Not Closed

Location of Incident:	TA-4, Building 970, Test Cell
Date of Incident:	6/28/2016
Version Number:	1
Version Date:	July 7, 2016

CAUSE MAPPING®

Problem Solving • Incident Investigation • Root Cause Analysis • Risk Mitigation

Investigation File

The purpose of this file is to organize all relevant information.

The following worksheets are contained in this workbook:

	Area	Worksheet (links)	Description
	Investigation Information	Outline	This worksheet
		Version Control	Evolution of this workbook and contributors
		Contacts	People / Contact info of those involved with the analysis
		CM Steps	Cause Mapping Method, Steps and Tools (layout)
Start here →	Step 1. Define the Problem	1. Problem	Problem Outline
	Step 2. Conduct the Analysis	2. Cause Map	5-Why basic Cause Map to get started
	Step 3. Select the Solutions	3. Solutions	Action Items table listing solutions, owner, due dates
	Additional Information & Tools	Timeline	Sequence of events with date, time, description
		Photos	Photographs and pictures
		Extent of Conditions	Review of impact on other operations.
		Cause Analysis Tree	DOE Cause Codes
		Document Repository	Storage location for rosters, emails, documents, etc.
		Human Performance Indicators	Indicators that affect human performance
		Flawed Defences	Flawed Defenses and Barrier Analysis
		Latent Org Weaknesses	Review of organizational weaknesses.
		Excel Instructions	Tips for using the template in Microsoft® Excel®
		Box Templates	Cause map text templates
		CM Examples	Example Cause Maps
		END	

Version	Date	Description	Time	Update By	Contributors
1	July 7, 2016	Initial Causal Meeting	11:00 AM	Seth	Team
2	July 12, 2016	Added 3rd branch to cause map: existing cause box "Ops personnel walked different route from standard process for sweeping. (Deviation from procedure process)". New branch cause box, "Operations personnel implemented workaround to lock-up sweeping paths".	2:50 PM	Seth	
		Transfred the "potential solutions" to the Solutions tab.		Seth	
		Added cause codes to cause map.		Seth	

Causal Team

Organization	Name	Role	Email	Contact Number	Notes
1300	Seth Nelson	Causal Facilitator	jsnels@sandia.gov	284-2570	
1340	Bryan Oliver	Senior Manager	bvolive@sandia.gov	284-7868	
1342	Debra Kirschner	Department Manager	dskirsc@sandia.gov	844-9152	
1342	Gary Tilley	HERMES Operator	gdtille@sandia.gov	845-7226	
1342	John Lott	HERMES Team Lead	jalott2@sandia.gov	844-7538	
4821	Todd Culp	Health Physicist	taculp@sandia.gov	845-7886	
4132	Holly Chamberlin	Safety Basis	hchambe@sandia.gov	844-5019	

CAUSE MAPPING®

Problem Solving • Incident Investigation • Root Cause Analysis • Risk Mitigation

Step 1

Problem

Capture specifics about the problem as well as the impact to each of the organization's overall Goals.

- Answer each question in the Outline.

1

Define the Problem in the Problem Outline

Step 2

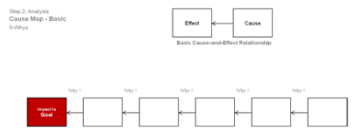
Analysis

Lay out the cause-and-effect relationships for the incident.

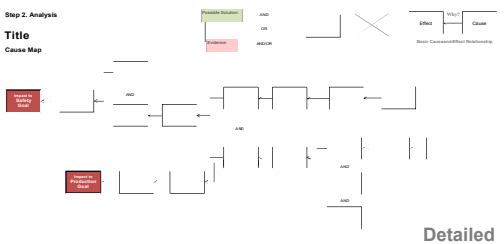
- Write down one of the Goals that was affected.
- Write the impact to that Goal in the next box.
- Answer the question "Why did that happen?" Ask Why again.
- In the more detailed analysis, ask as many Why questions as necessary to thoroughly explain the issue.

2

Start with 3 to 5 Why questions (Causes)...



...add as much detail as necessary to thoroughly explain the issue



Step 3

Solutions

Identify the specific actions that will be taken to reduce the risk of a similar issue occurring.

- Place a possible solution above the cause that it controls.
- Evaluate the different possible solutions.
- Create a plan for actions or a combination of actions that will be implemented.

3

Propose Possible Solutions

Based on causes identified in the analysis step

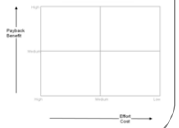
Use: Convention, Industry Standards and Creative Ideas

Possible Solution:

Evaluate Solution Options

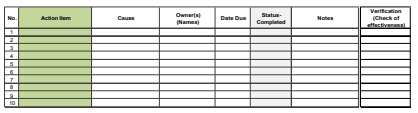
Consider the Effort IN to the Solution versus the Result OUT

The impact and risk to each Goal should be reduced to an acceptable level



Create Action Plan

Each action item is a project.
Follow-up should evaluate effectiveness.



Step 1. Define the Problem

What	Problem(s)	Test cell shield door left open during pre-shot sweep (lock-up).
When	Date	June 28, 2016
	Time	~ 1200 Hours
	Different, unusual, unique	High voltage and limited approach boundary's in the courtyard.
Where		
	Facility, site	TA-4, Building 970
	Unit, area, equipment	Test cell shield door (Door - A)
	Task being performed	HERMES pre-shot sweep.

Impact to the Goals

Safety	Potential for personnel to receive radiation dose.
Environmental	
Cust. Service	
Regulatory	
Production-Schedule	
Property, Equip, Mtls	
Labor, Time	

Description of Incident

Description Of Event

On June, 28, 2016, the HERMES III accelerator (TA-IV, Building 970) operations team began preparing for the third test shot of the day. Prior to the shot, operations personnel conducted the required pre-shot clearance and lock-up process. Following the shot, an operator and RCT re-entered the controlled area to perform post-shot clearance activities and found the shield door in the open position. All other control measures (interlocks and other access controls) were in place during this event and there was no personnel exposure. The test cell shield door is a six-inch thick steel door; it's principal function is to privide shielding, however, it also serves as a pedestrian entrance into the test cell. The shield door is located on the north side of the test cell and, aside from distance, is a primary control to mitigate personnel exposure to ionizing radiation.

Compensatory Actions

A JSA was created to supplement the HERMES accelerator procedure (HIII-51 RADOPS) with specific job steps to ensure positive verification of controls. The new JSA requires two operations personnel (rather than one) and identifies the sequence of job steps for personnel sweeping the area to ensure access controls are in place. Following this sweep and closure of all access doors, an independent person, will verify via visual inspection, that the shield doors are in place. This second verification step can be conducted without breaking the access control doors. In all cases, during the sweep and during the independent inspection, the keys to the Operators Control Console Power Key are retained by the persons conducting the sweep or the verification step. Upon completion of the sweep the key will be handed to the person conducting the verification. Following verification, the verification will be logged in the Operators log book and the keys returned to the HERMES Control Operator.

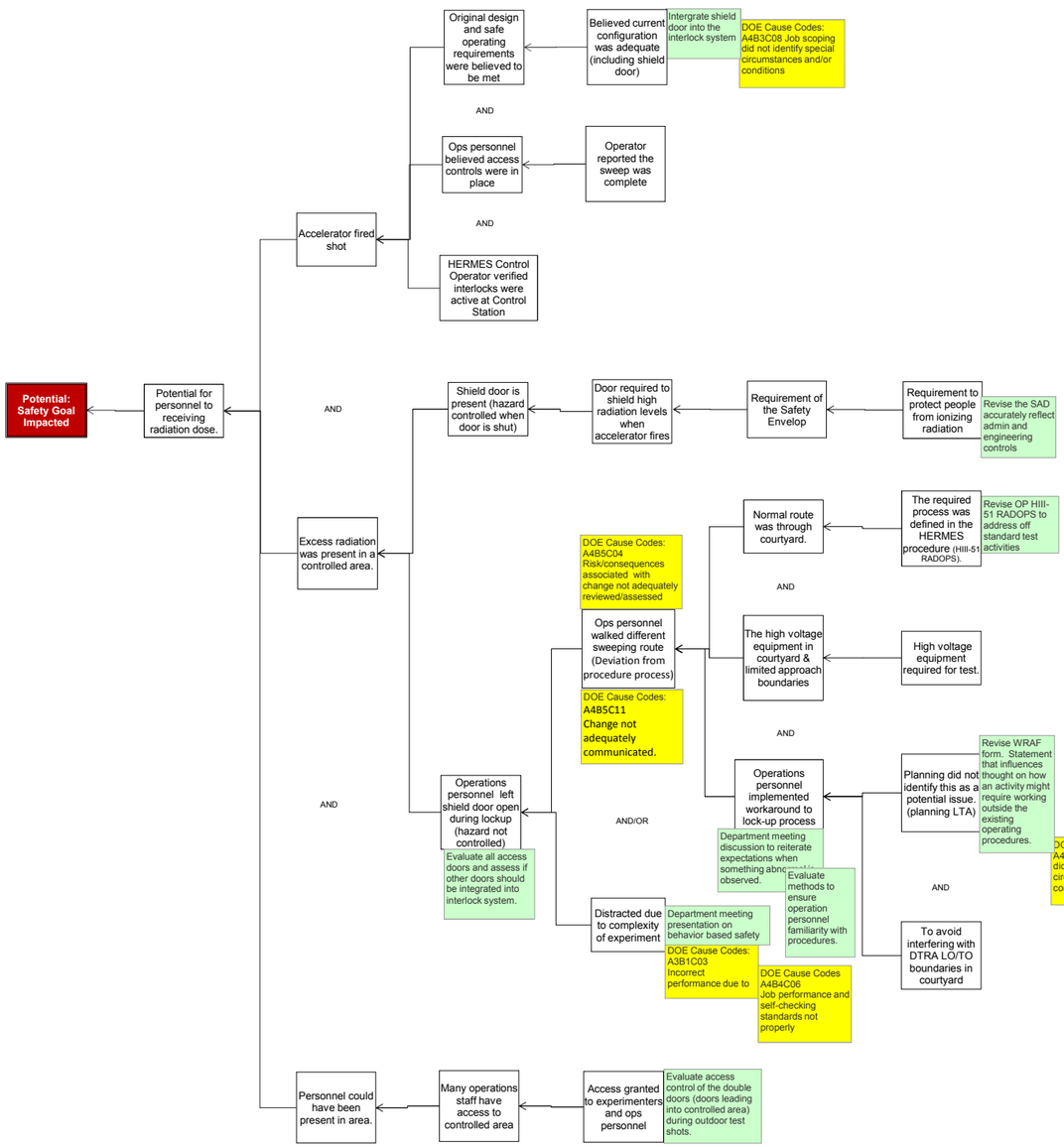
Applicable WP&C Documents Reviewed Prior To Causal

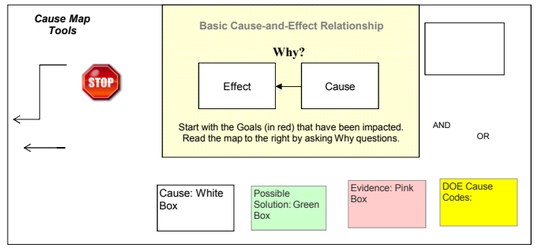
Title	Document Number
Radiological Operations for the HERMES III Accelerator Procedure	HIII-51 RADOPS, Issue B

HERMES Access Control - Shield Door Not Closed

Step 2. Analysis

Cause Map





3. Solutions

Corrective Actions to be taken from this Incident that are Causally Related

No.	Cause	Action Item	Owner	Due Date	Status	Completed
1	Original design and safe operating requirements did not include the shield door to interlock system.	Shield door will be added to interlock system.	Kirschner	8/31/2016		
2	Operations personnel left shield door open during preshot lockup sweep.	Evaluate all access doors and assess if other doors should be integrated into interlock system.	Kirschner	8/31/2016		
3	The test series was an off normal activity and caused a deviation from standard process.	Revise OP HIII-51 RADOPS to address off standard test activities.	Kirschner	8/31/2016		
4	Engineered control inaccurately described in the SAD.	Revise the SAD to accurately reflect admin and engineering controls.	Kirschner	2/28/2017		
5	Planning meetings did not identify the deviation from procedure (lock-up process & walking paths). Planning LTA.	Revise the WRAF form. Add statement that provokes discussion on test activities that would require ops personnel to deviate from standard procedure processes.	Kirschner	8/31/2016		
6	Operations personnel implemented workaround to lockup process & sweep so they didn't' have to breach limited approach boundaries in the courtyard.	Department meeting presentation to reiterate stop work expectations when something abnormal is observed i.e. stop work, evaluate, mitigate.	Kirschner	8/31/2016		
7	Operations personnel implemented workaround to lockup process so they didn't' have to breach limited approach boundaries in the courtyard.	Evaluate methods to ensure/improve operation personnel familiarity with procedures.	Kirschner	9/30/2016		
8	Many operations staff have access to controlled area	Evaluate access control of the double doors (doors leading into controlled area) during outdoor test shots. (potential camera system or installation of box over cypher to prevent access)	Kirschner	9/30/2016		
9	Operator assigned to perform lockup was distracted due to complexity of experiment	Department meeting presentation on behavior based safety.	Kirschner	8/31/2016		
10						

TimeLine

Date	Time
Tuesday	
June 28, 2016	
June 28, 2016	
June 28, 2016	
June 28, 2016	
June 28, 2016	~ 12:30 PM
June 28, 2016	12:30 - 2:30 PM
June 28, 2016	~ 2:30 PM
June 28, 2016	~ 2:53 PM
Wednesday	
June 29, 2016	~ 8:30 AM
June 29, 2016	8:35 AM
June 29, 2016	9:00 AM
June 29, 2016	11:30 AM
June 29, 2016	2:30 PM

Other Facts Collected By Department M
Department Manager originally understo test cell, not the shielded personnel door
The shield door (Door A) is supposed to b
Hermes Evacuator believes that Door A w
Due to the customer's High Voltage hazar the outdoor test cell after clearing the ind clear the user screen room area and indo outdoor test area to evacuate and clear it the shots in this series leading up to the c
The intent of the procedure was followed

After the discovery, the operations staff s for the next two shots of the day.
The shield door (Door A) is a 6” thick shee
The shield door (Door A) is not part of the directly between to other gates that are i
There is a locking mechanism attached to possibly associated to legacy security equ
Radiation protection placed TLDs on the i that location during this experiment. Sho
There was a previous outdoor mode shot setup for surveying and measured about the indoor test cell.
Does has never been measured on the ins now.
RP doesn’t believe that there was a posti
RP will try to calculate what the dose on t
A JSA was developed 6/29/16 to add an i process prescribed in HIII-51 RADOPS. Th LOTO box and go through the outdoor tes verifier to obtain the master power key fr

Description
Preparing for third accelerator test shot of the day.
DTRA equipment was prepared and set-up in courtyard.
Clearing Exclusion Area Activity: HERMES Operator performed sweep and lock-up prior to shot. - Shield door accidently left open
HERMES Control Operator performs preshot checklist and fires accelerator
Clearing Test Cell Post Shot Activity: HERMES Operator and RCT re-enter the radiation area to perform post shot sweep and discovered that the shield door was open.
HERMES Operator notified Joe Stewart.
Joe Stewart notified Department Manager.
Department Manager notified Senior Management and other appropriate Sandia personnel.
Department Manager submitted an occurrence report and formally contacted Dave Barber (SFO FR).
Department Manager notified the EOC to report OOPS.
Compensatory Actions Review Initiated: Department Manager directed for a JSA to be created to add independent verification of the gates and doors.
Department Manager and Operations Personnel reviewed and walked down the JSA. JSA approved.
Conducted fact finding activity.

anager
od the issue to be with the personnel door (unshielded) that leads to the outside that leads to the Indoor Test Cell.
e closed during the HERMES Evacuation (lock-up) prior to an operation.
as closed, but can't guarantee.
rd that was set up in the outside test cell, the Evacuators were not exiting into door test cell like the HIII-51 RADOPS procedure specifies. Instead, they would or test area then go around the front of the machine to the other side of the t, so they wouldn't be exposed to the high voltage. This was the protocol for all of discovery shot.
l, but not the steps.

started doing secondary verifications of the gates and doors directly after lock-up
et of solid steel.
e interlock system. John Lott recalls that was due to the fact that the door is interlocked.
the door but Gary Tilley says that it has never been used before and could uipment.
inside of the shield door (facing indoor test cell) to capture what the dose is at ts for the 6/29/16 would indicate the dose.
with a similar configuration performed last October where RP has a lot of TLDs 50 mrem on the outside of the shield door (Door A), which is the opposite side of
side of that door during this configuration, so that is why TLDs were attached
ng violation even with the extra dose.
the inside of the door would be if the outside saw 50 mrem. They will also try to
ndependent verification of Doors A and B in addition to the normal evacuation e JSA also prescribes that the evacuators apply their LOTO to the customer's st cell as is the normal process. It also directs the evacuators and independent rom the console to prevent firing the machine during lock-up sweeps.

Photos

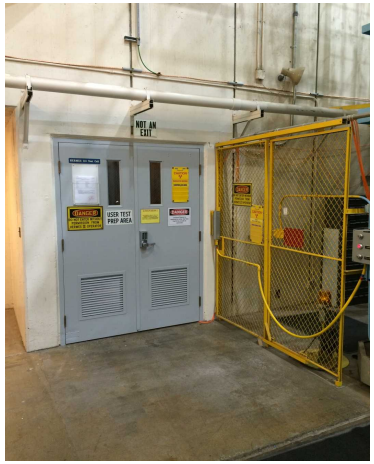


Photo 1: Entrance door into Controlled Area

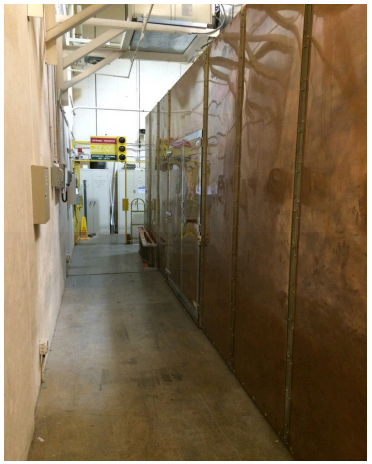


Photo 2: Standing inside double doors. Walking route that is leading to Test Cell & Shield Room

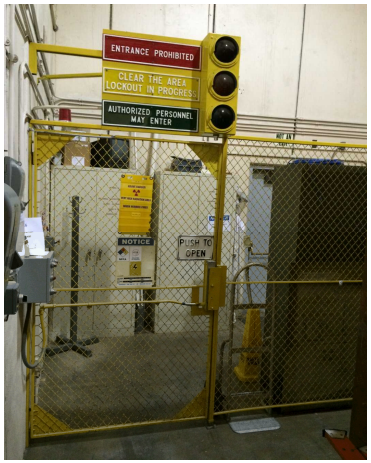


Photo 3: Gate 4, Interlocked Gate

Photo 4: Standing just inside the Interlocked gate. View of closed shield Door (Door A). Also the ntrance door into the Test Cell

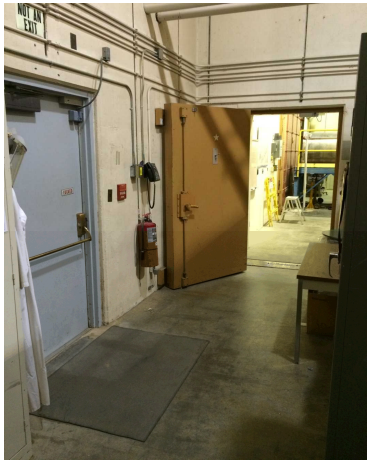


Photo 5: Shield Door (Door A) in open position.

Photo 6: HERMES Courtyard. View of personnel entrance door (Door - B) and the test cell rolling door (Door - C).

Document Repository

1. Causal Roster
2. HERMES - Map of Area and Calculated Dose
3. Procedure Excerpt: Radiological Operations for the HERMES III Accelerator Operating Procedure (*HIII-51 RADOP*

Sandia National Laboratories

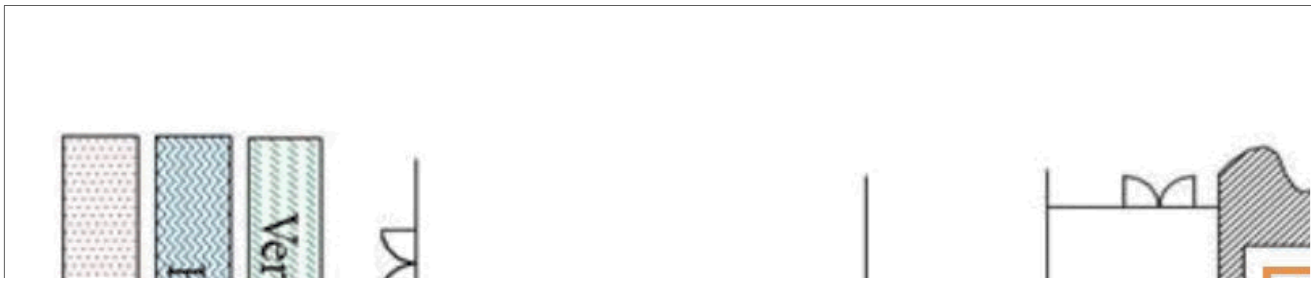
HERMES Test Cell Access Control

Causal Analysis Roster

Date: 7/7/16 Time: 11:00 AM Location: 962/1402

Participants

Name(s)	Org
Sue Nelson	1300
Bryan Oliver	1340
Debra Kirschner	1300
Gary Tilley	1342
Todd Culp	4821
H. Chamberlin	4135
John Lott	1342



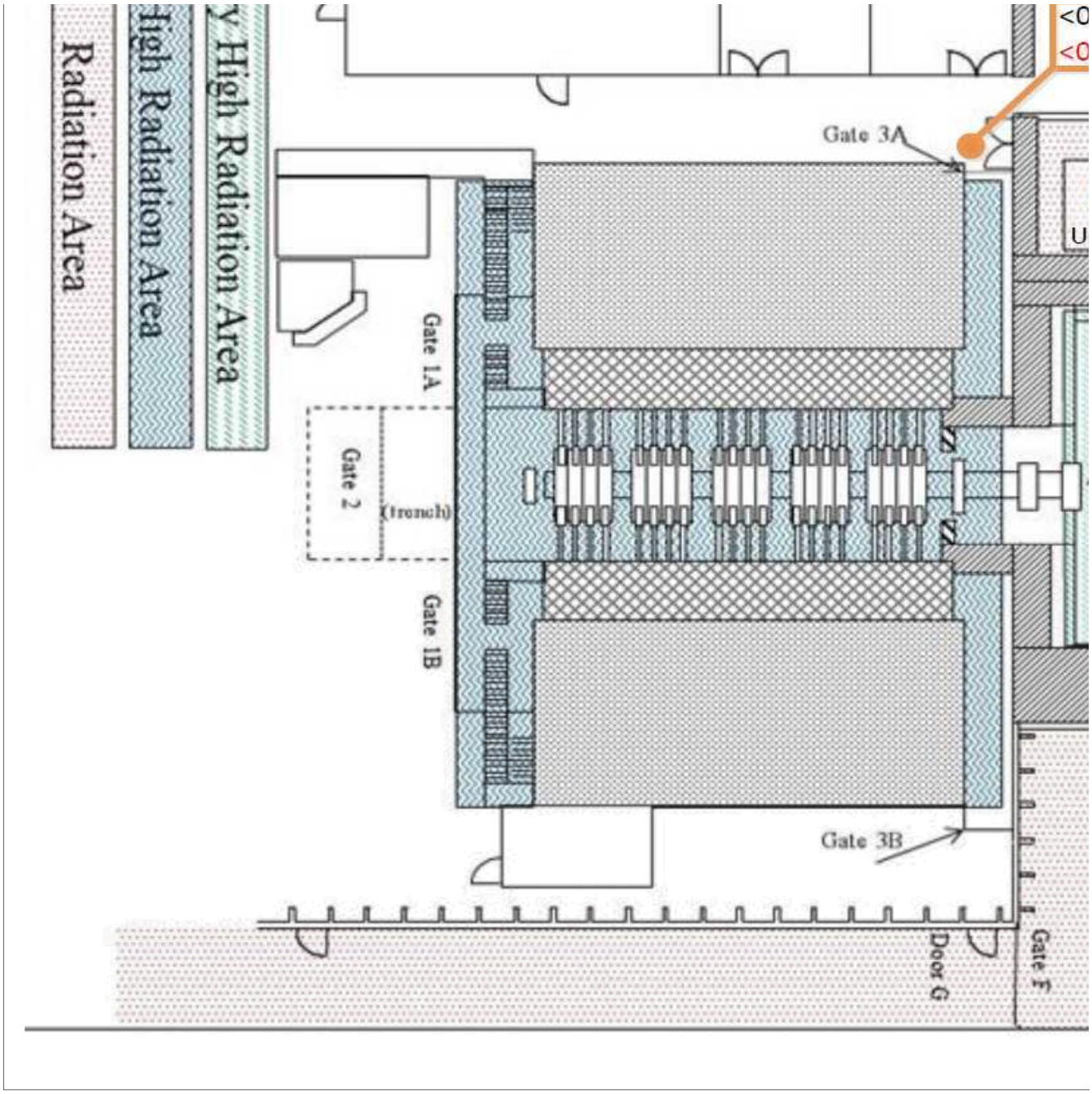


***Diagram**: HERMES - Map of Area and Calculated Dose. Calculations performed on July 1, 2016, by Russell Durrer (Rad Engineer).*

Note: *The Indoor Test Cell can be evacuated by either the West Evacuato*
evacuator.

WARNING: *The Indoor Test Cell does not need to be evacuated for high*

tests but shall be evacuated before a down line shot.

4.1.11 [West Evacuator] Proceed to the Local User Screen Room and ver
video monitor, that the Indoor Test Cell trench is clear of personne

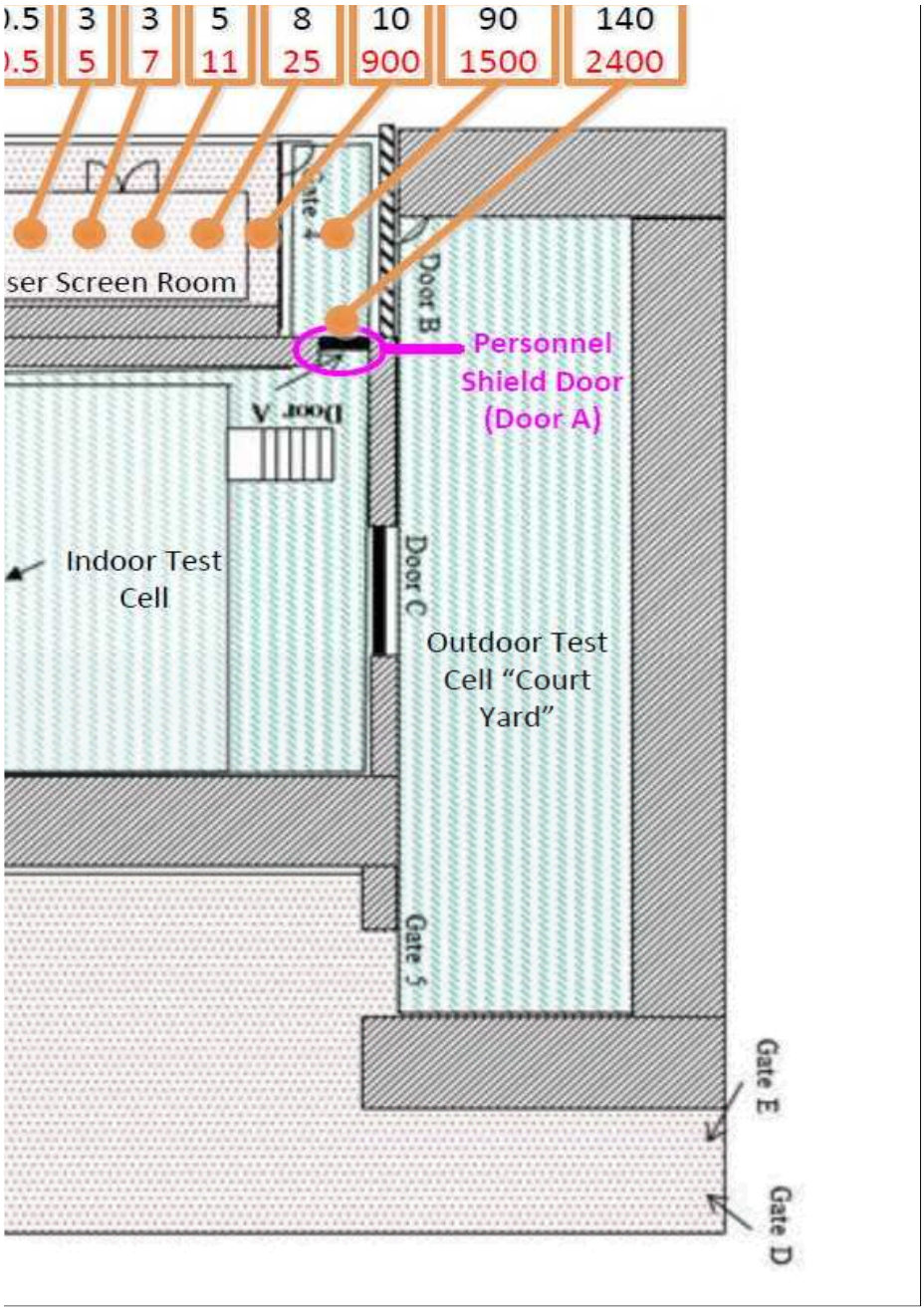
4.1.12 [West Evacuator] Proceed through Gate 4 and Door A, entering th
4.1.13 [West Evacuator] Clear the Indoor Test Cell of all personnel and er
opening is locked and Door C is closed.
4.1.14 [West Evacuator] Exit the Indoor Test Cell through Door A, closing
behind.
4.1.15 [West Evacuator] Proceed to the Outdoor Test Cell through Door E
clear of personnel and that Gate 5 is closed and locked. Verificatio
engagement can be accomplished via communication with the ope
4.1.16 [West Evacuator] Reenter the building through Door B and ensure
Gate 4 is clear of personnel.
4.1.17 [West Evacuator] Exit through Gate 4, closing and locking it behinc
4.1.18 [All Evacuators] After all areas are confirmed evacuated, report tc
Operator and initial the Shot Logbook verifying that the Indoor an
are clear of personnel.
4.1.19 [Operator] Ensure that the person clearing the test cells has initial

Procedure Excerpt: **Radiological Operations for the HERMES III Accelerator Operating Procedure (*HIII-51 RADOPS).*** Section 4: Clearing Exclusion Areas

Note: This section discuss clearing routes for areas during outdoor test shots. Operations personnel made

shots. Operations personnel made deviations from this section so could avoid the high voltage (limited approach boundaries) areas.

ɔs). Section 4: Clearing Exclusion Areas *(during outdoor test shots)*



r or a third

voltage trigger

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ısure that the trench

and locking it

3 and ensure that it is
ın of Gate 5's
erator at the console.
the area behind

d.
› the HERMES III
d Outdoor Test Cells

ed the Shot Logbook.

Extent

Who does this issue impact?
What are the impacts beyond the immediate area?
Has a similar issue occurred in this or another area in the past?
If so, how was it addressed, what were the impacts, and was the issue successfully resolved?
Does the potential exist for a similar issue to occur in this or another area?
What are some possible impacts to the immediate and other areas if a similar issue were to occur?
Can this issue be successfully resolved by implementing solutions within the immediate area's scope of influence?
Does successful resolution of this issue require action or involvement outside the immediate area's scope of influence?
If so, what actions should be taken and who needs to be involved to attain successful resolution of the issue?

of Condition

Causal Analysis

A1 Design / Engineering Problem

B1 DESIGN INPUT LTA
- C01 Design input cannot be met
- C02 Design input obsolete
- C03 Design input not correct
- C04 Necessary design input not available

B2 DESIGN OUTPUT LTA
- C01 Design output scope LTA
- C02 Design output not clear
- C03 Design output not correct
- C04 Inconsistent design output
- C05 Design input not addressed in design output
- C06 Drawing, specification, or data error
- C07 Error in equipment or material selection
- C08 Errors not detectable
- C09 Errors not recoverable

B3 DESIGN / DOCUMENTATION LTA
- C01 Design / documentation not complete
- C02 Design / documentation not up-to-date
- C03 Design / documentation not controlled

B4 DESIGN / INSTALLATION VERIFICATION LTA
- C01 Independent review of design / documentation LTA
- C02 Testing of design / installation LTA
- C03 Independent inspection of design / installation LTA
- C04 Acceptance of design / installation LTA

B5 OPERABILITY OF DESIGN /

A2 Equipment / Material Problem

B1 CALIBRATION FOR INSTRUMENTS LTA
- C01 Calibration LTA
- C02 Equipment found outside acceptance criteria

B2 PERIODIC / CORRECTIVE MAINTENANCE LTA
- C01 Preventive maintenance for equipment LTA
- C02 Predictive maintenance LTA
- C03 Corrective maintenance LTA
- C04 Equipment history LTA

B3 INSPECTION / TESTING LTA
- C01 Start-up testing LTA
- C02 Inspection / testing LTA
- C03 Post-maintenance / Post-modification testing LTA

B4 MATERIAL CONTROL LTA
- C01 Material handling LTA
- C02 Material storage LTA
- C03 Material packaging LTA
- C04 Material shipping LTA
- C05 Shelf life exceeded
- C06 Unauthorized material substitution
- C07 Marking / labeling LTA

B5 PROCUREMENT CONTROL LTA
- C01 Control of changes to procurement specifications / purchase order LTA
- C02 Fabricated item did not meet requirements
- C03 Incorrect item received
- C04 Product acceptance requirements LTA

B6 DEFECTIVE, FAILED OR CONTAMINATED
- C01 Defective or failed part
- C02 Defective or failed

A3 Human PerformanceLTA

B1 SKILL BASED ERROR
- C01 Check of work was LTA
- C02 Step was omitted due to distraction
- C03 Incorrect performance due to mental lapse
- C04 Infrequently performed steps were performed incorrectly
- C05 Delay in time cause d LTA actions
- C06 Wrong action selected based on similarity with other actions
- C07 Omission / repeating of steps due to assumptions for completion

B2 RULE BASED ERROR
- C01 Strong rule incorrectly chosen over other rules
- C02 Signs to stop were ignored and step performed incorrectly
- C03 Too much activity was occurring and error made in problem solving
- C04 Previous success in use of rule reinforced continued use of rule
- C05 Situation incorrectly identified or represented result ing in wrong rule used

B3 KNOWLEDGE BASED ERROR
- C01 Attention was given to wrong issues
- C02 LTA Conclusion based on sequencing of facts
- C03 Individual justifie d action by focusing on biased evidence
- C04 LTA review based on assumption that process will not change
- C05 Incorrect assumption that a correlation existed between two or more facts
- C06 Individual underestimated the problem by using past events as basis

B4 WORK PRACTICES LTA
- C01 Individual's capability to

A4 Manag

B1 MANAGEMENT MI LTA
- C01 Management policy g expectations not well-defi understood or enforced
- C02 Job performance stan adequately defined
- C03 Management directio insufficient awareness of i actions on safety / reliabili
- C04 Management follow-u monitoring of activities di identify problems
- C05 Management assessm determine cause s of previ known problem
- C06 Previous industry or i experience was not effecti to prevent recurrence
- C07 Responsibility of pers well-defined or personnel accountable
- C08 Corrective action resp known or repetitive proble untimely
- C09 Corrective action for identified problem or ever adequate to prevent recurr

B2 RESOURCE MANA LTA
- C01 Too many administra assigned to immediate sup
- C02 Insufficient supervisio to provide necessary super
- C03 Insufficient manpowe identified goal / objective
- C04 Resources not provid adequate training was pro maintained
- C05 Needed resource char approved / funded
- C06 Means not provided t procedures / documents / r of adequate quality and up
- C07 Means not provided f adequate availability of ap materials / tools
- C08 Means not provided f adequate equipment quali reliability, or operability
- C09 Personnel selection d

ENVIRONMENT LTA C01 Ergonomics LTA C02 Physical environment LTA C03 Natural environment LTA	material C03 Defective weld, braze or soldering joint C04 End of life failure C05 Electrical or instrument noise C06 Contaminant	perform work LTA [Examples include: Sensory / perceptual capabilities LTA, Motor / physical capabilities LTA, and Attitude / psychological profile LTA.] C02 Deliberate violation	match of worker motivatic descriptions C10 Means / method not p assuring adequate quality services

Tree Rev. 0

ɡement Problem

ETHODS

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B3 WORK ORGANIZATION & PLANNING LTA
- C01 Insufficient time for worker to prepare task
- C02 Insufficient time allotted for task
- C03 Duties not well-distributed among personnel
- C04 Too few workers assigned to task
- C05 Insufficient number of trained or experienced workers assigned to task
- C06 Planning not coordinated with inputs from Walk downs/ task analysis
- C07 Job scoping did not identify potential task interruptions and / or environmental stress
- C08 Job scoping did not identify special circumstances and / or conditions
- C09 Work planning not coordinated with all departments involved in task
- C10 Problem performing repetitive tasks and / or subtasks
- C11 Inadequate work package preparation

B4 SUPERVISORY METHODS LTA
- C01 Tasks and individual accountability not made clear to worker
- C02 Progress / status of task not adequately tracked
- C03 Appropriate level of in-task supervision not determined prior to task
- C04 Direct supervisory involvement in task interfered with overview role
- C05 Emphasis on schedule exceeded emphasis on methods / doing a good job
- C06 Job performance and self-checking standards not properly communicated
- C07 Too many concurrent tasks assigned to worker
- C08 Frequent job or task "shuffling"
- C09 Assignment did not consider worker's need to use higher-order skills
- C10 Assignment did not consider worker's previous task
- C11 Assignment did not consider worker's ingrained work patterns
- C12 Contact with personnel too infrequent to detect work habit/attitude changes
- C13 Provided feedback on negative performance but not on positive performance

B5 CHANGE MANAGEMENT LTA
- C01 Problem identification did not identify need for change
- C02 Change not implemented in timely manner
- C03 Inadequate vendor support of change
- C04 Risks / consequences associated with change not adequately reviewed / assessed
- C05 System interactions not considered
- C06 Personnel / department interactions not considered
- C07 Effects of change on schedules not adequately addressed
- C08 Change-related training / retraining not performed or not

A5 Communications LTA

B1 WRITTEN COMMUNICATIONS METHOD OF PRESENTATION LTA
- C01 Format deficiencies
- C02 Improper referencing or branching
- C03 Checklist LTA
- C04 Deficiencies in user aids (charts, etc.)
- C05 Recent changes not made apparent to user
- C06 Instruction step / information in wrong sequence
- C07 Unclear / complex wording or grammar

B2 WRITTEN COMMUNICATION CONTENT LTA
- C01 Limit inaccuracies
- C02 Difficult to implement
- C03 Data / computations wrong / incomplete
- C04 Equipment identification LTA
- C05 Ambiguous instructions / requirements
- C06 Typographical error
- C07 Facts wrong / requirements not correct
- C08 Incomplete / situation not covered
- C09 Wrong revision used

B3 WRITTEN COMMUNICATION NOT USED
- C01 Lack of written communication
- C02 Not available or inconvenient for use

B4 VERBAL COMMUNICATION LTA
- C01 Communication between work groups LTA
- C02 Shift communications LTA
- C03 Correct terminology not used

A6 Training Deficiency

B1 NO TRAINING PROVIDED
- C01 Decision not to train
- C02 Training requirements not identified
- C03 Work incorrectly considered "skill of the craft"

B2 TRAINING METHODS LTA
- C01 Practice or hands -on experience LTA
- C02 Testing LTA
- C03 Refresher training LTA
- C04 Inadequate presentation

B3 TRAINING MATERIAL LTA
- C01 Training objectives LTA
- C02 Inadequate content
- C03 Training on new work methods LTA
- C04 Performance standards LTA

A7 Other Problem

B1 EXTERNAL PHENOMENA
- C01 Weather or ambient conditi
- C02 Power failure or transient
- C03 External fire or explosion
- C04 Other natural phenomena I

B2 RADIOLOGICAL / HAZARI MATERIAL PROBLEM
- C01 Legacy contamination
- C02 Source unknown

USED ONLY FOR ORPS C

Level A nodes are underlined.
Level B nodes are in ALLCAPS.
Level C nodes are in "sentence case."
LTA = Less than ade

ıd not assure ons / job provided for of contract	C08 Change-related training / retraining not performed or not adequate C09 Change-related documents not developed or revised C10 Change-related equipment not provided or not revised C11 Changes not adequately communicated C12 Change not identifiable during task C13 Accuracy / effectiveness of change not verified or not validated	C04 Verification / repeat back not used C05 Information sent but not understood C06 Suspected problems not communicated to supervision C07 No communication method available


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Human Performance Indicators			
P1	**Task Demands**	**P3**	**Individual Capabilities**
A	Time pressure (in a hurry)	A	Unfamiliarity with task/1st time evolution
B	High workload (memory requirements)	B	Lack of knowledge (mental model)
C	Simultaneous, multiple tasks	C	New technique not used before
D	Repetitive actions/Monotony	D	Imprecise communications
E	Irrecoverable acts	E	Lack of proficiency/inexperience
F	Interpretation requirements	F	Indistinct problem-solving skills
G	Unclear goals, roles, & responsibilities	G	"Un-safe" attitude for critical tasks
H	Lack of, or unclear standards	H	Illness/fatigue (general health)
I	Confusing Procedure/ Vague Guidance	I	Unawareness of Critical Parameters
J	Excessive Communication Requirements	J	Inappropriate Values
K	Delays; Idle Time	K	Major Life Event (medical, financial, emotional)
L	Complexity ' High Information Flow	L	Poor Manual Dexterity
M	Excessive Time on Task	M	Low self esteem; moody
N	Long-term Monitoring	N	Questionable Ethics (bends the rules)
		O	Sense of Control/Learned Helplessness
P2	**Work Environment**	**P4**	**Human Nature**
A	Distractions/Interruptions	A	Stress (limits attention)
B	Changes/departures from routine	B	Habit patterns
C	Confusing displays or controls	C	Assumptions (inaccurate mental picture)
D	Workarounds/out of service instruments	D	Complacency/overconfidence
E	Hidden system response	E	Mind-set
F	Unexpected equipment conditions	F	Inaccurate risk perception
G	Lack of alternative indication	G	Mental shortcuts (biases)
H	Personality conflicts	H	Limited short-term memory
I	Backshift or recent shift change	I	Pollyanna Effect "noting bad can happen"
J	Excessive Group Cohesiveness/ Peer Pressure	J	Limited perspective (bounded rationality)
K	Production Overemphasis	K	Avoidance of Mental Strain
L	Adverse Physical Climate (habitability)	L	First Day Back from Vacation / Days Off
M	No accounting of performance	M	Sugar Cycle (after a meal)
N	Poor Equipment Layout; Poor Access	N	Fatigue (sleep deprivations, circadian rhythms)
O	Fear of Consequences of Error	O	Tunnel Vision (lack of big picture)
P	Mistrust among workgroups	P	"Something is not right" (gut feeling)
Q	Meaningless Rules	Q	Pattern Matching bias
R	Unavailable parts or Tools	R	Social Deference (excessive courtesy)
S	Acceptance of "Cook Booking" Practices	S	Easily Bored
T	"rule Book" Culture	T	Close-in-time Cause/Effect correlation
U	Equipment Sensitivity (inadvertent actions)	U	Difficulty Seeing Own Errors
V	Lack of Clear Strategic Vision or Goals	V	Frequency and Similarity Bias
W	Identical or adjacent Displays/Controls	W	Availability Bias
X	Out-of-service Warning Systems	X	Imprecise Physical Actions
Y	Nuisance Alarms	Y	Limited Attention Span
Z	Lack of Place Keeping	Z	Spatial Disorientation
		AA	Physical Reflex
		BB	Anxiety (involving uncertainty)

Flawed Defenses / Barrier Analysis by Type of Control			
D1	**Engineering**	**Y/N**	**Description**
I	**Individual**		
IA	PPE		
IB	Human Factors/Ergonomics		
W	**Worksite**		
WA	Alarms and Interlocks		
WB	Barriers/ Containment		
WC	Equipment Labeling		
WD	Equipment Condition		
WE			
O	**Organization**		
OA	Design Process		
OB	Maintenance Backlog or Rework		
OC	Spare Parts Availability		
OD	Safety Bias		
D2	**Administrative**		
I	**Individual**		
IA	Knowledge/skills/abilities		
IB	Fitness for Duty		
IC	Training		
ID	Worker Input		
IE	Jow walk-down		
W	**Worksite**		
WA	Accuracy of Drawings		
WB	Work Package / procedure		
WC	Foreign Maqterial Exclusion		
WD	Rad Work permit		
WE	Task Preview / Pre-job briefing		
WF	Flagging		
WG	Concurrent / Independent Verification		
WH	Quality Control Hold Points		
WI	Work Around		
O	**Organization**		
OA	Conduct of Operations Program		
OB	Trainint Program		
OC	Procedure Program		
OD	Roles and Respnsibilities		
OE	Work Control		
OF	Configuration Control		
OG	Surveillance and Preventative Maintenance		
OH	Scheduling		
OI	Staffing		
D3	**Cultural**		
I	**Individual**		
IA	Questioning Attitude		
IB	Stops When Unsure		
IC	Place Keepng		
ID	Prolem Solving		
IE	Teamwork Contribution		
IF	Courage and Integrity		
W	**Worksite**		
WA	Turnover		
WB	Housekeepng		

WC	Jobsite Review		
O	**Organization**		
OA	Expectations		
OB	Goals and Prioirities		
OC	Role Models		
OD	Accountabiloity		
OE	Recognition and Rewards		
OF	Values and Beliefs		
OG	Proper Reactions		
OH	Communications		
OI	Prolblem Solving		
OJ	Chane Management		
OK	Intolerance for Error Traps		
OL	Labor Relations		
OM	Health Relationships		
D4	**Oversight**		
I	**Individual**		
IA	Identifying Error Traps		
IB	Self Checking		
IC	Situational Awareness		
ID	Problem Reporting		
W	**Worksite**		
WA	Supervision		
WB	Just-in-Time		
WC	Post-Job Review		
WD	Training Critiques		
O	**Organization**		
OA	Review and Approval		
OB	Operating Experience		
OC	Self-Assessments		
OD	Corrective Action Program		
OE	Trend Analysis		
OF	Benchmarking		
OG	Coaching and Observation		

Latent Organizational Weaknesses			
O1	**Training**		
A	Lack of Effective training		
B	No task qualification requirement when the task is skill-based		
C	Focus on lower level of cognitive knowledge		
D	Failure to have management involved in training		
E	Training is not consistent with the equipment, procedures or processes		
O2	**Communications**		
A	Failure to reinforce use of 3-way communications		
B	Failure to use specific ID numbers in procedures		
C	Failure to reinforce use of phonetic alphabet		
D	Unclear priorities or expectations		
E	Unclear roles and responsibilities		
O3	**Planning Scheduling**		
A	Not anticipating failures and providing contingencies		
B	Not considering multiple components out of service		
C	Not providing required materials or procedures		
D	Over-scheduling resources		
E	Failure to consider mis-operation or damage to adjacent equipment		
F	Specific type of Work is not performed		
G	Specific type of issue not addressed		
H	Inadequate resources assigned		
O4	**Resource Management**		
A	Selection		
B	Staffing / manning		
C	Excessive cost cutting		
D	Lack of funding		
E	Equipment facility resources		
F	Purchasing unsuitable equipment		
G	Inadequate parts or tools		
O5	**Design / Process Change**		
A	Poor design		
B	Inadequate involvement of users in design change		
C	Inadequate training		
D	Inadequate contingencies		
O6	**Values / Priorities / Policies**		
A	Management policies discourage Line input		
B	Willingness to accept degraded conditions or performance		
C	Too high priority placed on schedules		
D	Management failure to recognize the need for or importance of related program		
O7	**Procedure Development and Use**		
A	Human Factors not considered in procedure development / implementation		
B	Failure to perform procedure verification or validation		
C	Failure to reference procedure during task performance		
D	Assumptions made in lieu of procedure guidance		

E	Omission of necessary functions in procedures		
O8	**Organizational Interfaces**		
A	Lack of clear lines of communications between organizations		
B	Conflicting goals or requirements between programs		
C	unclear interfaces for defining work processes		
D	Lack of self-assessment monitoring		
E	Lack of interface between program		
F	Lack of measurement tools for monitoring program performance		
O9	**Organizational Processes**		
A	Operating tempo		
B	Time pressure, stress (demands and resources		
C	Workload (demands and resources		
D	Faulty Work Control Process		
E	Weak Safety Programs		
F	Flawed Risk Management		
O10	**Organizational Climate**		
A	Meaningless rules		
B	Lack of accountability for actions		
C	Weak organizational culture (misaligned values, beliefs)		
D	Unjust climate		
E	Lack of clear strategic mission or goals		
F	Hiring and firing and promotion anomalies		
O11	**Supervisory Involvement**		
A	Failure to perform management observations and coaching		
B	Not correcting poor performance or reinforcing good performance		
C	Unassigned or fragmented responsibility and accountability		
D	Inadequate program oversight		
O12	**Work Practices**		
A	Failure to reinforce use of established error prevention tools and techniques (Human Performance Tools)		

ThinkReliability 16 Tips for the Drawing Tools in Excel 2007

Notes to help you get started. These are the 16 Best Tips for building Cause Maps and Process Maps using the drawing tool Excel 2007. They are intended for ThinkReliability clients who have attended a workshop or participated in a faciliation. This tip sheet is for ThinkReliability clients and Cause Mapping users who have used the drawing tool in Excel 2003 and have moved or are about to move to Excel 2007

Click here for more information www.thinkreliability.com

Excel 2003 Drawing Tool – Tips and Shortcuts

Menu Bar and Ribbon

The Menu Bar in Excel 2007 is different from 2003. It will take some practice, but all the functionality is still there - it is just in a different place. The menu bar is now Home, Insert, Page Layout, Formulas, Data, Review, View and in some cases Developer. The ribbon is a new Excel 2007 user interface. The ribbon consists of different commands that are organized by group. Each item on the menu bar has its own ribbon of commands.

Quick Access Toolbar

There is a Quick Access Toolbar that can be used to create a customized toolbar with different Excel commands and regularly used drawing tools. See the Strongly Suggested note under Tip 3 (Arrow Cursor - Select Objects).

1. Removing Grid Lines

Click View on the menu bar at the top of the screen. Inside of the second group, which is called Show/Hide, is the Gridlines function. Uncheck the box next to Gridlines to turn off the gridlines for that worksheet.

2. Making a Text Box

Click Insert from the menu bar. Inside the second group, which is called Illustrations, is a Shapes icon with a drop down. Click here for the expanded drop down for dozens of different shapes divided by section. The fourth section is Basic Shapes. The first shape in this section is the Text box. Click on the text box and release the mouse. Move the cursor, which now looks like a vertical line with a bar toward the bottom, to the spreadsheet. Click and hold the left mouse button to drag a box to the desired size. See Tip 6 for sizing text boxes.

3. Arrow Cursor - Select Objects

The arrow cursor for selecting objects is located by clicking on Home from the menu bar. The last group on the ribbon is called Editing. Inside of Editing is a Find & Select icon with a drop down. Click on Select Objects - the arrow - to select it. Strongly Suggested - Right click on Select Objects - the arrow - and then click Add to Quick Access Toolbar. The Quick Access Toolbar is the only toolbar that you are allowed to customize in Excel 2007. Placing the most frequently used drawing tools on the Quick Access Toolbar makes Excel 2007 much easier to use for drawing.

4. Drawing Tools

In Excel 2007 there is a ribbon to access the shapes for the drawing tools. To access the ribbon you first select (click on) an object, such as a text box, on the worksheet. Notice when you select an object a new item, Format, is immediately added to the end of the menu bar. Just above Format is a Drawing Tools tab. When you click on either Format or Drawing Tools the ribbon in Excel 2007 changes to a drawing tools ribbon. Remember you must have an object selected on the worksheet to access either Format or the Drawing Tools tab.

5. Box Border - Blue/Clear Dots

Clicking anywhere on a text box highlights that box with dots in each corner and a square on each of the four sides. Clicking directly on the thin border between the dots will turn the dots blue. Blue dots are for selecting the entire box. Clear dots show that the inside of the box has a cursor so that text can be added or edited. Click in the middle of the box or directly on the thin border to move between blue and clear dots.

6. Sizing Boxes

The dots in the corners and on the sides of the boxes can be dragged with the mouse to make the box smaller or larger. The boxes can also be sized from the Drawing Toolbar (Tip #4). The fifth group is Size. Vertical and horizontal dimensions can be set to exact dimensions. Several boxes can be sized at the same time by selecting multiple boxes. If the text box resizes itself to fit the text, right click on the text box, and choose Format Shape from the dropdown menu. Then select Text Box from the categories on the left, and uncheck the box labeled “Resize shape to fit text.” With 10 point font a box size of 0.7 by 1.0 works well. For 12 point font a larger box of 0.8 by 1.2 may be required.

7. Moving Boxes

To move a box click on directly on the thin border, hold down the left mouse button and drag the box to the desired location. The box can also be moved by clicking directly on the border, so that it has blue dots and using the arrows on the keyboard to move the box up, down, left or right.

8. Selecting Multiple Boxes

Hold down the shift key and left click on the each box you wish to add to the selection. Multiple boxes can be selected. This multiple selection using the shift key works for selecting any object including lines.

9. Copying Boxes

Copying a box requires the box to be selected with blue dots. See Tip #5 above. Here are four basic ways to copy a box:

9-1. Select box, make blue dots. Click on Home, the first group is Clipboard, and inside of that are the Copy and Paste functions.

9-2. Select box, make blue dots. Click Ctrl C, then Ctrl V to copy and past.

9-3. Right click directly on the box border and select Copy from the drop down menu.

This last one is the best tip (Great Tip)

9-4. Left click directly on the border, hold the mouse down and drag the box to the desired location. Before releasing the left mouse button hold down the Ctrl button on the keyboard. This is known as the Ctrl-Drag copy method. It is typically the fastest way to copy many boxes onto a worksheet.

10. Aligning Text inside a Box

The third group inside of Home on the menu bar is Alignment. There are top, middle, bottom and left, center, right alignment buttons inside that group.

11. Changing, Adding, or Removing Borders

Select an object using blue or clear dots (Tip 5). Click on Format or Drawing Tools (Tip 4). The second group on the Drawing Tools ribbon is Shape Styles. Inside of Shape Styles select the Shape Outline drop down to change, add or remove (No Outline) the border.

12. Adding Color to the Boxes

12. Adding Color to the Boxes

From the Drawing Tools ribbon select the Shape Fills drop down. This is in the same location as Removing Borders (Tip 11).

13. Using Connectors (Great Tip)

The connectors in Excel 2007 connect by clicking and holding the left mouse button at the beginning connection point and then moving the cursor to the ending connection point then releasing the mouse. The connector end is red when it is connected to a box and blue when it is not connected. The blue end can be dragged to an object. Note that in Excel 2007 the connectors will connect to different locations on, in and around a box so be careful to drop the connector directly on the red connecting square on the side of a box. Here are two different ways to access the connector arrow:

13-1. The connectors are located in Drawing Tools (Tip 4) in the first group, Insert Shapes. Click on the Elbow Arrow Connector (3rd column, 2nd row) to select one connector. This Elbow Arrow Connector from this menu is the only one that can be locked down for adding multiple connectors. Right click on that Elbow Arrow Connector and select Lock Drawing Mode. You must remember to left click on the connector again to unlock it.

13-2. The connectors can also be found by clicking Insert on the menu bar. In the Illustrations group select the Shapes drop down. In the Lines section the Elbow Arrow Connector is the 5th choice. Strongly Suggested – The Elbow Arrow Connector can be added to the Quick Access Toolbar by right clicking anywhere on the Quick Access Toolbar. Click on Customize Quick Access Toolbar to open a new window. From the vertical menu on the left side of the window click on Customize. Click the drop down at the top of the window labeled Choose Commands From and select All Commands. Use the scroll bar to move down the alphabetical list to the Elbow Arrow Connector. Click on that connector then click the Add button in between the two columns. Click OK to exit the window. The entire objects gallery can also be added to the Quick Access Toolbar. Click Insert from the menu bar. Inside the second group, which is called Illustrations, is a Shapes icon with a drop down. Click here for the expanded drop down with dozens of different shapes divided by section. Right click on anyone of those objects and select the Add Gallery to Quick Access Toolbar. This will add a small Shapes icon to the Quick Access Toolbar.

14. Aligning Boxes

Boxes can be aligned by moving them using the mouse or the arrows on the keyboard as explained in Tip 7. Boxes can also be aligned by selecting two or more boxes using the shift key (Tip 8) and clicking on the Drawing Toolbar (Tip 4) to access the fourth group named Arrange. The Align button is a drop down for aligning left, center, right, top, middle, bottom, etc. Align uses the extreme edge of the selected boxes for the chosen alignment. Note in Excel 2007 only use the shift key (Tip 8) to select and align the boxes. Using the arrow cursor (Tip 3) to select boxes and connectors will move the connectors from the boxes.

15. Moving Boxes in a Straight Line (Great Tip)

When moving a box hold down the shift key to move the box only at 90-degree angles: left, right, up or down. The shift button also works when copying something in only a straight line such as with the Ctrl-Drag copy method in Tip 9-4. This is the Shift-Ctrl-Drag method.

16. Zoom-in, Zoom-out

Zooming in and out can be done by selecting View on the menu bar and picking from the zoom options in the third group named Zoom. Zoom can also be done if you have a wheel on your mouse by holding the Ctrl key down as the wheel is moved forward or backward. This is an easy way to utilize the zoom. The wheel on the mouse can be swapped to be the zoom all the time by right clicking anywhere on the Quick Access Toolbar. Select Customize Quick Access Toolbar. Click Advanced from the vertical menu on the left side of the window that opens. The first section inside of Advanced is called Editing Options. The eighth choice down is Zoom on roll with IntelliMouse. Check this box and hit OK at the bottom of the window.

Cause Map & Process Map

Copy the Boxes from this Worksheet as needed

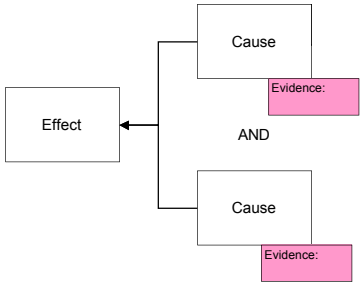
Possible Solutions:

Cause

Evidence:

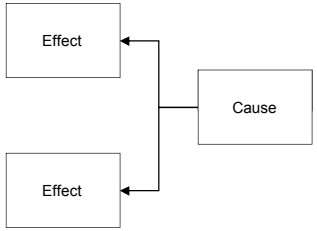
Causes Support with Evidence

EX: Both Causes are required to product the effect



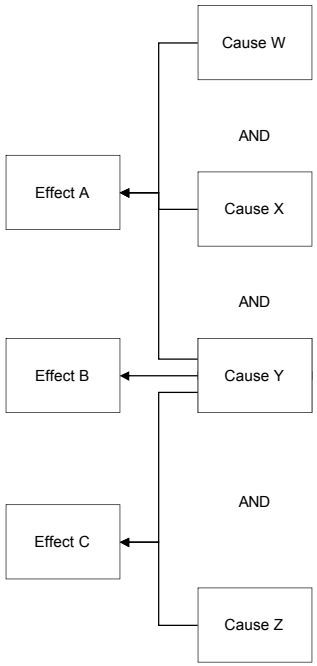
Cause Produces Two Effects

EX: One cause has two separate effects

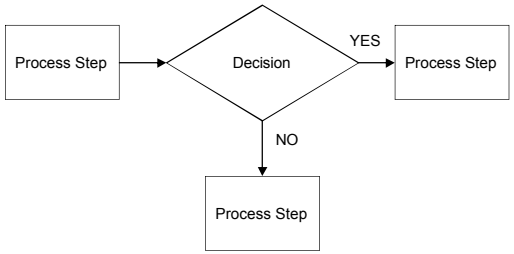


Cause with 3 Separate Connectors

EX: Y causes A, B, and C. W and X are also required to produce A. Z is also required for C to occur.

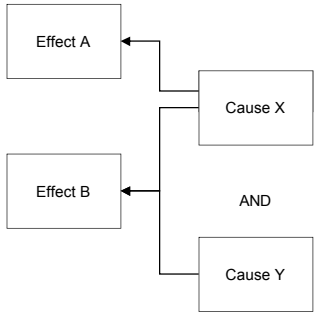


Process Maps Example



Cause with 2 Separate Connectors

EX: X and Y are both required to cause B, but only X is required for A



Cause Map Examples