TEMPORARY CHANGE REQUEST

TCR NO. TCR-QA-019,R1-001
(e.g., TCR-ENG-021,R1-001)

The Temporary Change Request (TCR) Form is to be used to process urgent or minor changes for PPPL Policies, Organization/Mission Statements and Procedures. The TCR should be used when changes are:
1) urgent, and can not wait the 2-4 week period for Department Head review/comment, or
2) minor, and do not warrant Department Head review.

Person Requesting Change: Judith Malsbury

Department Name: ES&H/Infrastructure Support **Phone Ext:** 2415

Document Number: QA-019 **Revision No.:** 1

Document Title: Root Cause Analysis

Reason for change: Updated Attachment 4, Suggested Categories for Direct, Contributory, and Root Causes to reflect causes in associated DOE Standard.

Removed reference to obsolete DOE document

Change description: (Summarize and attach changed pages, with changes clearly indicated)

TCR-QA-019,R1-001 replaces QA-019 revision 1.
Extend effective date through July 2005.

1. Does this TCR significantly alter the intent or scope of the document? **YES:**___ **NO:**X

2. Does this TCR significantly impact **ES&H**? **YES:**___ **NO:**X

If 1 or 2 is **YES**, Explain why the changes should not be routed for Department Head review:

_____

_____

Judith Malsbury **7/19/02**
Department/Division Head Approval **Date**

J.W. Anderson **8/2/02**
Head, ES&H and Infrastructure Support/designee **Date**

Release/Effective date of this TCR: **8/2/02**

Incorporate this TCR into next revision of this document? **Yes** X__ **No**_____

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PPPL	PRINCETON PLASMA PHYSICS LABORATORY	PROCEDURE	No. QA-019 Rev 1 page 1 of 3
Subject: Root Cause Analysis		**Effective Date:** April 9, 1999	**Initiated by:** QA Division Head
		Supersedes: QA-019, Revision 0 dated 5/6/92 and TCR-QA-019-001	**Approved:** Director

Introduction

This procedure establishes the process and provides instructions by which the Laboratory conducts root cause analyses.

Root cause analysis refers to the process of identifying those specific or systematic factors that caused or fostered adverse consequences. The process may be a less structured or a more formal approach dependent upon the significance of the initial problem. Care must be taken to clearly distinguish symptoms that indicate the existence or occurrence of a problem from the root causes. In addition, care must be taken to distinguish between apparent causes and the true root causes. Properly performed root cause analysis reduces the amount of subjectivity. Three of the most common root cause analysis techniques are briefly described in Attachment 1.

The advantages of root cause analysis include:

- Provides enhanced utilization of limited resources.
- Focuses on preventing recurrence as well as providing immediate corrective action.
- Provides objectivity in problem solving.
- Aids in identification, assembly, and integration of contributory circumstances.
- Predicts other problems.
- Provides comprehensive set of potential solutions.
- Suggests solutions that may be applied to other areas and problems.
- Identifies opportunities for improvement.

This procedure was modeled on information contained in the referenced documents.

Reference Documents

DOE Guideline DOE-NE-STD-1004-92, *Root Cause Analysis Guidance*

Definitions

Root Cause - The most basic reason for an problem/event, which if corrected, will minimize the chance of recurrence of that and other similar problems or events.

Direct Cause - The cause that directly resulted in the problem/event. For example, in the case of a leak, the direct cause could be the problem in the component that leaked.

Contributing Cause(s) -Cause(s) that, if corrected, would not by themselves have prevented the problem/event but are important enough to be recognized as needing corrective action to improve the quality of the process or product. For example, in the case of a

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leak, a contributing cause could be lack of operator training in leak detection and response, resulting in a more severe event than otherwise would have occurred.

Root Cause Analysis (RCA) -Root Cause Analysis performed following the requirements and guidance of this procedure. It is desirable (but not mandatory) that one of the persons assigned to performing the analysis be trained in the methods of root cause analysis.

Root Cause Analysis Report -A comprehensive report of a problem/event addressing all aspects of the event, conditions leading up to the reported event, conclusions, recommendations, and, optionally, planned corrective action. Guidance on the content of the report is contained in Attachment 2, Root Cause Analysis Report Format and Instructions.

Procedure

Responsibility	Action
Appropriate Manager	1. Assigns the Investigator(s) to perform the root cause analysis, including a team leader if appropriate, and communicates the expectations for report preparation target dates. Determines if the formal report should be issued after the investigation and recommended corrective action is specified or when the planned corrective action is specified. One member of the team should be a trained in the methods of root cause analysis. Training may be obtained via DOE sponsored courses or courses sponsored by outside professional organizations Team members should include the appropriate technical experts.
Investigator(s)	2. Begins the data collection phase immediately to ensure that data are not lost. Attachment 3 provides guidance for data collection.
	3. Performs assessment using attachment 1 as guidance for selecting and performing a specific method(s).
	4. Identifies the direct, contributory, and root causes. Attachment 4 lists possible categories for these causes.
	5. Identifies recommended corrective action for each cause, focusing on the root cause.
	6. Documents the results of the root cause analysis, the causes, and the recommended corrective action. Attachment 2 contains the suggested content.
Appropriate Manager	7. Determines the actual corrective action to be taken for the identified causes and assigns individual to implement this corrective action with a defined completion date. Documents this determination and either distributes to the Investigation Leader for incorporation in the final report or distributes separately. Assures that a copy is provided to Quality Assurance (QA) for tracking.

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Investigation Leader	8. Issues the report either at the time of completion of the investigation or when the planned corrective action is specified, at the direction of the Appropriate Manager. Assures that QA receives a copy of the report for tracking.
Assigned individual	9. Notifies QA when the corrective action has been completed.
Quality Assurance	10. Verifies that appropriate corrective action has been completed and notifies Appropriate Manager.

Attachments

1. Root Cause Analysis Techniques
2. Recommended Root Cause Analysis Report Format
3. Guidance for Data Collection
4. Categories for Direct, Contributory, and Root Causes

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ROOT CAUSE ANALYSIS TECHNIQUES

Further information may be found in
DOE-NE-STD-1004-92, *DOE Guideline Root Cause Analysis Guidance Document*, February 1992.

Events and Causal Factors Analysis – For analysis of events, typically accidents or incidents

Events and Causal Factor Analysis, also known as Cause and Effects Task Analysis, is a technique that analyzes events, conditions, how conditions influence events, and the chronology or sequence of events and conditions. It is based on the fact that accidents are the result of a set of successive events and associated conditions that result in the accident or incident.

The objectives of this technique include determining how a task was really performed (the steps actually followed) and identifying problems in human-factors, design, discrepancies in procedural steps, training, etc. so that they can be resolved.

This technique typically may involve a step-by-step reenactment of the actions leading to the event. This reenactment should include people who actually do the task. An alternative approach is to determine the steps that lead to the event by reviewing documents and interviewing the people who perform the task, line managers, and witnesses, as appropriately

Usually, a cause and effect chart is generated. A sample is given below. The chart is a time line of events culminated in the last event that is the accident or incident. Each event should describe an occurrence or happening. Events are symbolized by rectangles, usually with solid lines indicating factual accuracy; presumed events have dashed lines. Each event should be precisely described, describe a single occurrence, be quantified to the extent possible, and, if available, include time and date.

Associated with the events are conditions that describe circumstances or states that were in existence at the time of the events. These are typically denoted as ovals with solid borders representing factual accuracy and dashed borders representing presumed conditions. The conditions should be precisely described, quantified when possible, posted with date and time if possible, and related directly to the event.

All events and conditions should then be examined to determine less than adequate (LTA) conditions and sequences of events that in themselves may not cause an adverse conditions, but together could cause an unwanted accident or incident.

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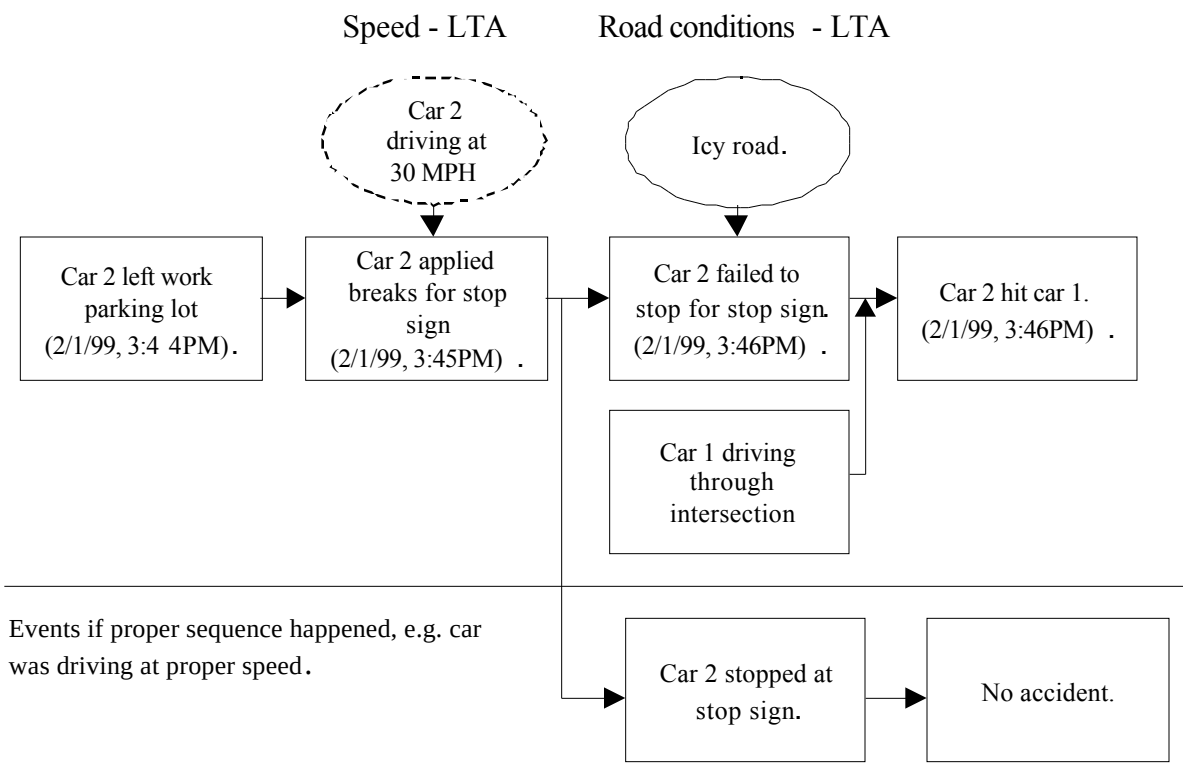
Note that in actual practice it is a good idea to write all events and conditions on Post-it™ sheets that may then be rearranged until the true sequence is identified.

Some individuals also include another time line of events below the failed one indicating the events that would have happened if the proper actions occurred and proper conditions existed.

Figure 1 – Sample Event and Causal Factors Chart



Root cause: Car 2 was driving too fast for the road conditions .

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Change Analysis – to identify the changes that resulted in an accident or incident or to identify the potential impact of a change.

Change analysis is an analytical technique that can be applied reactively or proactively. Change analysis may be performed in a reactive mode, typically for problems, by comparing previous trouble-free activity with the occurrence to identify differences. It may also be used in a proactive mode to ascertain the potential effects of changes before they are actually implemented.

For reactive change analysis, the steps are:

1. Describe the event situation including who was involved, what was involved, where the event took place, when the event took place, and how or what enabled the event to take place.
2. Describe an event-free situation also addressing the who, what, where, when, and how questions.
3. Compare the two processes to detect any differences.
4. Write down all the detected differences whether they appear to be relevant or not.
5. Analyze the differences to identify underlying changes and how they affect the event.
6. Integrate the information and specify the root cause.

An appropriate form to document this is given below:

	Event	Nonevent	Differences	Effect
What				
How				
When				
Who				
Where				

Why

For proactive change analysis, the steps are:

1. Describe the present situation in terms of who will be affected by the change, what will change, where the change will take place, when the change will take place, and how the change will be implemented.
2. Describe the planned changes in the same terms of who, what, where, when, and how. Note that terms of people, locations, materials, processes, and barriers and controls could be used for steps 1 and 2 instead of who, what, where, when, and how..

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3. List all known or potential effects of the proposed changes.
4. Analyze the potential effects and summarize the results.

A simple example of change analysis is given below. The example is to analyze failures in tensile strengths in a new lot of bolts.

Figure 2 – example of change analysis

	Event	Nonevent	Differences	Effect
What	Lot 109 fails tensile strength tests	Lot 108 and earlier lots passed tensile strength tests	Different lots- used different input material	Reduced tensile strength
How	Input material was not verified upon receipt	Input material was not verified upon receipt.	None	Dependent upon integrity of supplier's processes
When	Dated Jan. 1999	Dated Dec. 1998	No change in process but change in material	Reduced tensile strength
Who	Same company	Same company	--	--
Where	Same manufacturing line using same process	Same manufacturing line using same process	--	--

Why? The root cause of the failures was faulty material. A contributing cause was lack of material verification before use.

Barrier Analysis – to identify physical or administrative barriers or controls that should have prevented an event/failure and determine why they failed and what is needed to prevent recurrence.

Barriers exist to eliminate harm to the people, places, things, and the environment. Examples of barriers include:

- Personal protective equipment (physical barrier).
- Safety training (administrative barrier)
- Hand rails (physical barrier)
- Flow and pressure regulators (physical barrier)
- Procedural steps or requirements (administrative barrier)

For barrier analysis, the steps are:

1. Identify the sequence of events leading to the failure/event
2. Identify established barriers that should assure that no problems occurred.
3. Analyze the adequacy of these barriers, identifying those that were less than adequate.

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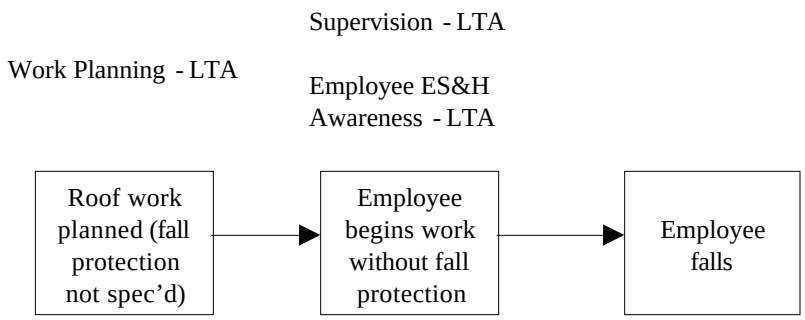
A simple example of barrier analysis is given below. The scenario is a fall taken by an employee from a roof.

Figure 3 – Barrier analysis for a fall



In the above example, three instances of failing barriers were identified:

- The hazards associated with the work were not properly identified during the work planning stage.
- Supervision for the work did not identify the hazard at the time that the work was being performed.
- The employee was not aware of the ES&H hazard or chose to ignore the hazard.

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RECOMMENDED ROOT CAUSE ANALYSIS REPORT CONTENT

The report should contain the following information:

1. The details associated with the incident/event that resulted in this root cause analysis.
2. The names of the individuals performing the root cause analysis.
3. A management summary of the report.
4. The approach taken by the investigators.
5. A detailed narrative of the event/incident.
6. Tables or illustrations resulting from the selected analysis technique.
7. The root cause(s)
8. The contributing and direct causes
9. Additional issues
10. Recommended or planned corrective actions for the direct causes, contributing causes, and root causes.

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DATA COLLECTION

This attachment provides guidance on what hardware, documentation, and information should be accumulated and preserved. It is important that hardware evidence be preserved in its "as found" condition; consider photographing the evidence. If any evidence indicates that a deliberate act may have caused the event, PPPL Site Protection should be immediately notified.

ENVIRONMENT

- Work place design
- Location and placement of equipment, tools, and other materials
- Noise
- Heat
- Light
- Time of day
- Ice or water

HARDWARE

- Equipment
- Tools

DOCUMENTATION

- Procedures
- Work instructions
- Sketches and Drawings
- Photographs
- Logs (Operator and Equipment)
- Process Strip Charts
- Work Orders
- Permits
- Equipment Maintenance & other History Records
- Quality Records
- Work schedules
- Computer printouts
- Inspection records
- Supplier manuals
- Design basis information

PEOPLE

- Involved people and their statements
- Witnesses and their statements
- Work history

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SUGGESTED CATEGORIES FOR DIRECT, CONTRIBUTORY, AND ROOT CAUSES

The use of standardized categories is encouraged since it aids in identifying trends and generic problems.

CAUSE CATEGORIES

1. EQUIPMENT/MATERIAL PROBLEM - an event or condition resulting from the failure, malfunction, or deterioration of equipment, parts, instruments, or material.

- Defective or Failed Part - a part/instrument that lacks something essential to perform its intended function.
- Defective or Failed Material- a defective failure of a material.
- Defective weld, braze, or soldered joint - a specific weld/joint defect or failure.
- Error by Manufacturer in Packaging, Shipping or Marking - an error by the manufacturer in the shipping or marking of equipment.
- Electrical or Instrument Noise - an unwanted signal or disturbance that interferes with the operation of equipment.
- Contamination - contamination due to radiation damage or foreign material such as dirt, crud, or impurities.
- End of Life Failure – a failure where the equipment or material is run to failure and has reached its end of design life

2. PROCEDURE PROBLEM - an event or condition that can be traced to the lack of a procedure, an error in a procedure, or a deficiency or inadequacy of a procedure.

- Defective or Inadequate Procedure - a procedure that either contains an error or lacks something essential to the successful performance of the activity.
- Lack of Procedure - no written procedure was in place to perform the activity.

3. PERSONNEL ERROR - an event or condition due to an error, mistake or oversight.

- Inattention to Detail - inadequate attention to the specific details of the task.
- Procedure not used or used incorrectly – the failure to use or the inappropriate use of written instructions, procedures or other documentation.
- Communication Problem - inadequate presentation or exchange of information.
- Other Human Error - human error other than those described above.

4. DESIGN PROBLEM - an event or condition that can be traced to a defect in design or other factors related to configuration, engineering, layout, tolerance, calculations, etc.

- Inadequate work environmentl - inadequate design of equipment used to communicate information from the facility to a person (displays, labels, etc) as well as inadequate work environment, such as inadequate lighting, working space, or other human factor considerations.
- Inadequate or Defective Design - a design in which something essential was lacking (defective), or when a detail was included but was not adequate for the requirement (inadequate).
- Error in Equipment or Material Selection - a mistake in the equipment or material selection only, not to include a procurement error (See (see Personnel Error – Other Human Error) or a specification error (See Design problem – Drawing, Specification, or Data Errors)
- Drawing, Specification, or Data Errors - an error in the calculation, information or specification of a design.

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5. TRAINING DEFICIENCY - an event or condition that can be traced to lack of training or insufficient training to enable a person to adequately perform a desired task.

- No Training Provided - a lack of appropriate training.
- Insufficient Practice or Hands-on Experience - an inadequate amount of preparation before performing the activity.
- Inadequate Content - the knowledge and skills required to perform the task or job were not identified.
- Insufficient Refresher Training - the frequency of refresher training was not sufficient to maintain the required knowledge and skills.
- Inadequate Presentation of Materials - the training presentation of materials were insufficient to provide adequate instruction.

6. MANAGEMENT PROBLEM - an event or condition that can be traced to managerial actions or methods.

- Inadequate Administrative Control - a deficiency in the controls in place to administer and direct activities.
- Work Organization/Planning Deficiency - a deficiency in the planning, scoping, assignment, or scheduling of work.
- Inadequate Supervision - inadequate techniques used to direct workers in the accomplishment of tasks.
- Improper Resource Allocation - improper personnel or material allocation resulting in the inability to successfully perform assigned tasks.
- Policy Not Adequately Defined, Diseminated, or Enforced - inadequate description, distribution or enforcement of policies and expectations.
- Other Management Problems - a management problem other than those defined above.

7. EXTERNAL PHENOMENA - an event or conditions caused by factors that are not under the control of the reporting organization or the suppliers of the failed equipment or service.

- Weather or Ambient Condition - unusual weather or ambient conditions, including hurricanes, tornadoes, flooding, earthquake, lightning, etc.
- Power Failure or Transient - special cases of power loss that are attributed to outside supplied power.
- External Fire or Explosion - an external fire, explosion, or implosion.
- Theft, Tampering, Sabotage, Vandalism - theft, tampering, or vandalism that could not be prevented by the reporting organization.

8. RADIOLOGICAL/HAZARDOUS MATERIAL PROBLEM - an event related to radiological or hazardous material contamination that cannot be attributed to any of the other causes.

- Legacy contamination – radiological or hazardous material contamination attributed to past practices
- Source unknown – radiological or hazardous material contamination where the source cannot be reasonably determined.

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