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PRACTICAL APPLICATIONS OF MORT CONCEPTS

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Practical Application of MORT Concepts

Useful concepts from the Management Oversight and Risk Tree (MORT) integrated and planned for inclusion into the safety program of a major research laboratory are discussed.

Programs involving infusion of the MORT concepts start with a Safety Orientation for new and experienced supervisors, a Safety Inspection Guide for first-line supervisors, and modification to other safety documents/programs as the Industrial Safety Manual.

Discussion of new programs in development and upgrading of existing programs will cover (but not be limited to) areas such as design, information systems, accident investigation and analysis, and hazard analysis and risk assessment.

Impact and influences of MORT on the administrative and management system are included in the discussion.

PRACTICAL APPLICATIONS OF MORT CONCEPTS

Public demands for a higher level of safety performance as well as compliance with a broad array of codes, standards and regulations have created an environment which requires application of the best methodologies and techniques available. Some disciplines which present the opportunity to borrow useful techniques are suggested in this slide.

Slide 1

What we need to do is evaluate our present policies, programs and implementation in light of the "best practices." Borrow what makes sense to us and tailor for our specific needs at whatever level. Implement any changes in an orderly, systematic way.

Mr. David V. MacCollum, in your February issue of Professional Safety refers to these as the fifth force (technological transfer of knowledge from other disciplines).

Slide 2

The Management Oversight and Risk Tree (MORT) is one methodology which offers over 1500 safety-program elements or factors established through thousands of application cycles. The MORT program has and continues to include the best practices from many disciplines.

(Ref: MORT Users Manual, SSDC-4.)

Slide 3

It provides programatic concepts and analytical methodology for considering all elements of an individual safety program and guidelines for judging the adequacy of these elements.

Slide 4 The MORT chart configuration consists of Specific Control Factors (S-branch) on the left side ard Management System Factors (M-branch) on the right hand side.

The MORT logic diagram is an idealized safety system model based upon the fault-tree method of system safety analysis. The idea of the MORT diagram is to avoid oversight and to look at the areas which might give us safety problems. It is not expected that everyone will utilize every MORT method or to the same extent.

These examples of MORT--what it is, what it does, and something about its makeup--provide the basis for our discussion here tody.

As an R&D laboratory, we have used and continue to use many methodologies which are compatible with MORT. In addition, our approach has been to analyze our safety programs, practices and documents using MORT concepts as a guide. Where we have found soft spots, we are revising and upgrading programs and documents. Some revisions are further along than others. We expect this to be a continuing process.

Safety Orientation Manual

One of our first program changes involved development of a Safety Orientation for New Supervisors as part of a broad orientation program. A changing supervisory environment brought about by new appointments to supervisory positions, by new safety environments and pressures caused us to reevaluate and change our approach to supervisory orientation and training.

Slide 5 We wanted our supervisors to have some exposure to the complex safety and legal environment of today. We wanted them to understand their roles and responsibilities, and we wanted to start the infusion of the

Slide 6 state of the art (tools) which could help them do a better job.

This program for new supervisors has now been extended to experienced supervisors on request. Over 100 experienced supervisors (first through third level) have attended a session.

Safety Inspection Guide

Our second program change involved the development of a Safety Inspection Guide. Use of this document is voluntary. MORT concepts were used but translated to optimize use by supervisors and those individuals assigned responsibility for safety.
(Ref: SAND 77-0837.)

From a Systems Safety standpoint, one task is to:

Slide 7

- Identify hazards
- List and rank hazards
- Resolve/closeout hazards
- Safety assurance

Slide 8 We start this identification and control process by requiring a preliminary safety analysis during the early design concept stage, followed by a final analysis before start of construction. Acceptance must be contingent on meeting specifications. For facilities or operations considered hazardous, Safe Operating Procedures (SOPs) must be prepared and approved before operations begin. Inspections of the work area by supervisors and employees are the regular checks to continue the identification and control of hazards as conditions change.

Slide 1

Written criteria exists and is specified as to what is required for an adequate safety analysis, for occupancy use readiness (acceptance), and a guide exists for development of Safe Operating Procedures. No adequate criteria existed for making inspections at the level envisioned by MORT. This was the need and as a result of that need, the Inspection Guide was devised.

Slide 9

The General Guide design concepts were to provide practical tools for conducting inspections, provide uniformity and criteria and to optimize resource allocation. These were accomplished through (1) the Guide configuration, (2) the questions, and (3) the forms and information in

Slide 10

the appendices.

Slide 1

The basic concept is that one starts evaluating hazard potentials from the physical work place and continues considering other elements as they are added to the physical work place. This approach provides a better understanding of the interfaces of each section to the entire group.

Each section is examined/explored through the use of appropriate questions. Some of the questions are directed to the operator level, while others are directed to the supervisor. The design intent is to create a frame of mind or questioning attitude on the part of the user.

Slide 11

MORT concepts included in the Guide come from both the Specific Control Factors and Management Branches. Some concepts are obvious, while others are perhaps hidden in the questions which are asked. One obscure example is Human Factors.

(Ref: MORT Users Manual, SSDC-4.)

Slide 12 The report form (Appendix A) has a simple scaling mechanism to assist the supervisor in determining a level of risk and the urgency for correction of the deficiency. It also categorizes the information. One of the key factors in MORT is not only to identify but to measure. Use of this form for reporting inspection results to Safety is optional. The supervisor can write a memo if he wishes. The important things are (1) to do an adequate inspection and (2) to take corrective action.

Slide 13 The Profile Chart (Appendix C) which is included has two purposes. When used as a:

1. positive tree -- deficiencies can be categorized/visualized and followed up for correction and used as a reference.
2. negative tree -- accidents can be analyzed to show
   a. what was involved (blue)
   b. what defects, oversights, omissions were involved (red)
   c. what changes are needed in the management system as well as specific fixes to prevent future accidents

Use of the profile chart enhances the collection of factual data. When used in the two suggested modes, the full range of the document is realized. These modes provide an information gathering system, a feedback loop, and a simple analytical or measuring tool.

How are people using the Guide?

Examples of applications:

1. One supervisor assigned applicable sections of the Guide to each of his employees for a scheduled inspection of their facility. The employee selected by the supervisor was one judged by the supervisor as knowing the least about that particular subject. He was using the Guide as an educational tool.

Slid
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2. Another supervisor, who was moving to new (modified) quarters took the Profile Chart and Guide questions and inspected the area he was supposed to move into. He found several deficiencies which needed to be taken care of before his organization moved in.

3. Several design engineers with years of design experience are using the Profile Chart and Manual as a guide in their design processes.

4. Other supervisors are using the Guide for special reference purposes; i.e.,
   a. section on explosives
   b. section on pressure systems

5. An independent audit team at another laboratory used the Guide in its evaluation of the readiness for occupancy (acceptance) of a brand new facility.

6. Human Factors personnel cite the Guide as one way to apply useful Human Factors concepts.

These are just a few of the many examples of how the Guide is being applied.

Slides 14, 15

An example of the use of the profile chart in analyzing an accident is shown in the next two slides. The first slide is a description of an accident. The second slide is the profile chart analysis. These two slides were used in our supervisor orientation program.

Sequence Charts

Slide 16 Let's use another methodology from MORT--the sequence chart. The concept schematic looks like this. The technique is applied during the accident investigation process. Information derived from witnesses, documents, and investigators is charted step by step across a sheet of paper. Basic events are entered in rectangles and are joined by heavy black lines. An arrow at one end of the line indicates direction.

Conditions applicable to a given event block are entered above or below and a dotted line and an arrow indicates direction.
(Refs: MORT, p 385; NTSB Report HAR-71-6.)

Slide 17 For our previous accident example (profile chart analysis), the events and causal factors schematic (sequence chart) looks like this--

Can line supervisors use these charts or are they just for Safety Professionals? One of our departments has a requirement to complete a Profile Chart and a Sequence Chart for each serious accident in that organization. This sequence example of a near-miss

Slide 18 accident was drawn by one of our shop supervisors.

Sequence charting is an excellent tool to visualize (1) a "pre-accident" chain of events and conditions (design changes, administrative actions, etc); (2) an accident event/condition/situation, and (3) post accident events and conditions. Witness testimony can be charted to identify gaps in information, to clarify confusion in observations, to identify a lying witness, to show chronology of events for the accident, and so on.

In addition, I have found this tool useful in analyzing documents as a policy statement, a job safety analysis, a program implementation proposal. Slide 21

Slide 19 Relationships/impacts and time elements are more readily apparent than when looking at the normal written page.

Writing the accident report and the recommendations for corrective action are enhanced when the thinking process has been clarified through use of the Events and Causal Factors Chart (sequence charting).

Discussions with supervisors and briefings of top management or others are greatly improved with the use of sequence charts.

Change-Based Analysis

Experience has shown that one of the more important factors in producing accidents is change. Another useful MORT tool is change-based analysis. Simply stated, change analysis is the systematic consideration and evaluation of changes which have taken place (with hardware, procedures, or personnel) over a given time span.

Management of change is one of the more important MORT control concepts. (Ref: The Rational Manager, Kepner-Tregoe.) Slide 22

Slide 20 One application of specific change analysis is when an accident situation is compared to a comparable accident-free situation, and all known differences are analyzed for effect on producing the accident. The information developed is then used in the accident investigation process and for later recommended corrective actions.

Slide 21 Another application of change-based analysis is this result combined with a sequence chart, which might look like this example. A change in a personnel policy which impacts safety in an unsuspected or unanticipated way. You can develop this concept further by substituting a piece of hardware or a procedure in place of the personnel policy and enter appropriate information in the other blocks. It may also be necessary to change the blocks and the connecting line relationships. Change analysis and sequence charting are by no means limited to just accident situations. They can be used for many other applications (accounting, security, etc).

Energy Considerations

MORT sets forth considerable criteria for examination and review of energies, energy-control techniques, and barriers to prevent unwanted energy flow.

From a preactive standpoint, energy considerations should be addressed in the design phase and analysis, the construction phase, the operational phase, and the subsequent inspections of the operational phase.

Slide 22 One concept application for an accident investigation is a meticulous trace of energy sources, along with consideration of the adequacy of barriers provided to focus upon factors contributing to the accident.

Sections D and E of the Guide focus on Energy Sources and Management Control Factors. Appendix D of the Guide is a listing of energy sources borrowed from MORT documents.

Use of experts from various disciplines, previous incidents review, testing and analysis, analysis of physical evidence, computer modeling and calculations are just some of the ways in which energies can be traced and evaluated.

The Profile Chart permits a third application, if the user so desires. If the user has sufficient data from inspections (most hazardous areas/ problems) or preferably data from accident occurrences, the results from this data can be plugged into the Profile Chart for evaluation and

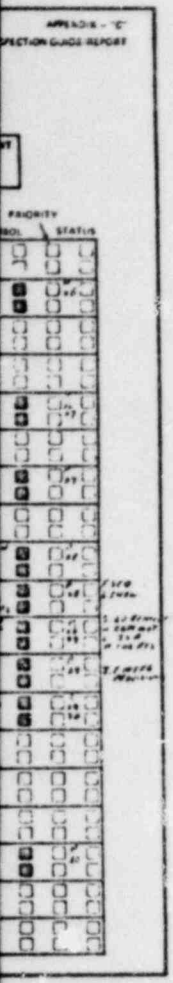
Slide 23 review. The user will probably find (as we have) that Categories A-D show up as being <u>involved</u> at one level, whereas those that are <u>responsible</u> (causative) for an accident will show up at a different level.

The "E" category (management factors) is 100% responsible and should have been involved 100% (if you believe that any accident which occurs is a management failure). Clues that we get from this type of analysis should help us to concentrate on our serious problems/soft spots and a more realistic allocation of resources.

The applications discussed here today are small steps with broad implications. Our approach will perhaps suggest some ideas for your consideration.

Thank you for your attention.

Are there any questions?



SYSTEMATIC APPLICATION

- ☐ BEST ENGINEERING PRACTICES/METHODS
- ☐ BEST SAFETY PRACTICES/METHODS
- ☐ BEST MANAGEMENT PRACTICES/METHODS
- ☐ BEST ANALYTICAL PRACTICES/METHODS
- ☐ BEST BEHAVIORAL PRACTICES/METHODS

MORT

A BRIEF ABSTRACT

MORT is a comprehensive analytical procedure that provides a disciplined method for determining causes and contributory factors of major accidents.

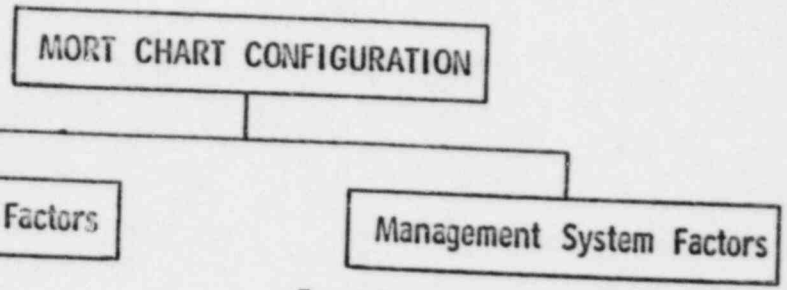
It presents over 1500 specific elements of an ideal "universal" management program for maximizing occupational safety.

MORT CONFIGURATION

Programmatic Concepts/Analytical Methodology

Examples:

- System Safety/Analysis
- Best Safety Practices
- Human Factors
- Organization Systems/Services
- Analytical Sciences
- Measurement Techniques
- Energy Control Techniques
- Barrier Considerations
- Error Reduction Techniques
- Change Analysis
- Risk Analysis/Projection
- Information Systems
- Work Processes/Schematics



Examples:

- Energy Control
- Barriers
- Tech Information System
- Functional Operability
- Occupancy Readiness
- Maintenance
- Inspection
- Supervision
- Amelioration

Examples:

- Policy
- Implementation
- Risk Assessment
  - Tech Information System
- Hazard Analysis
  - Concepts/Requirements
  - Design Development Plan
- Safety Program Elements
- Human Factors

ORIENTATION OUTLINE

I. Today's Safety Environment

   A. Safety/Legal Requirements

II. Safety Responsibilities

III. Investigating/Notifying/Reporting

IV. Expertise/Tools/Aids

EXPERTISE/TOOLS/AIDS AVAILABLE

Consultants

Safety Manual

Pressure Manual

Cross Index to DOE Standards

System Safety Documents

Data Banks

Safety Library

Sequence Chart

Change Analysis

Job Safety Analysis

Design Guide (SOP)

Safety Inspection Guide

SYSTEM SAFETY TASKS

- Identify Hazards
- List and Rank Hazards
- Resolve/Closeout Hazards
- Safety Assurance

are the regular checks to continue the identification and control of hazards as conditions change.

HAZARD IDENTIFICATION PROGRAM

Preliminary Safety Analysis Report

Final Safety Analysis Report

Acceptance

Safe Operating Procedures

Inspections

The employee selected by the supervisor was one judged by the supervisor as knowing the least about that particular subject. He was using the Guide as an educational tool.

GENERAL GUIDE CONCEPTS

Involve Supervisor and Employee

Provide Systematic Plan

Provide Mechanics

Use Best Techniques

GUIDE CONFIGURATION

A. Physical Work Place

B. Machines/Mechanical Equipment

C. Hazardous Materials/Processes/Environments

D. Energy Sources

E. Management Hazard Control Factors

a lying witness, to show chronology of events for the accident, and so on.

GUIDE MORT CONCEPTS

Information System

Codes and Standards

Design

Energy Sources

Energy Controls

Barriers

Human Factors

Safe Work Sequencing

Safety Training

Safe Operating Procedures

Inspections

Maintenance

Other

E.	Management Board Control Factors	Inadequacies/Oversights/Omissions Recommendations which Promotes Action	Priority	Disposition

E.

Management Hazard Control Factors	Inadequacies/Oversights/Omissions Noncompliance which Requires Action	Priority	Disposition

Definitions:

Physical Work Place - includes the plant and environment applicable to where employee(s) work.

Machines/Mech Equt - includes all types used/operated by employee(s) in performance of assigned tasks.

Hazardous Material, etc. - includes all used by, performed by, or existing where employee(s) performs assigned task(s).

Energy Sources - includes all energy, separate or in combination, used in performance of a task. (Concern here is unwanted energy flow.)

Management Hazard Control Factors - includes programs to control (minimize) hazards and associated risks through design, energy management, safety programs, etc.

Consider for inspecting and recording

a. Areas where you have direct responsibility and control.

b. Areas not under your direct control but where your employees may be exposed to hazards while performing their tasks (streets, roads, shared facilities, etc.).

c. Areas of interface with other organizations.

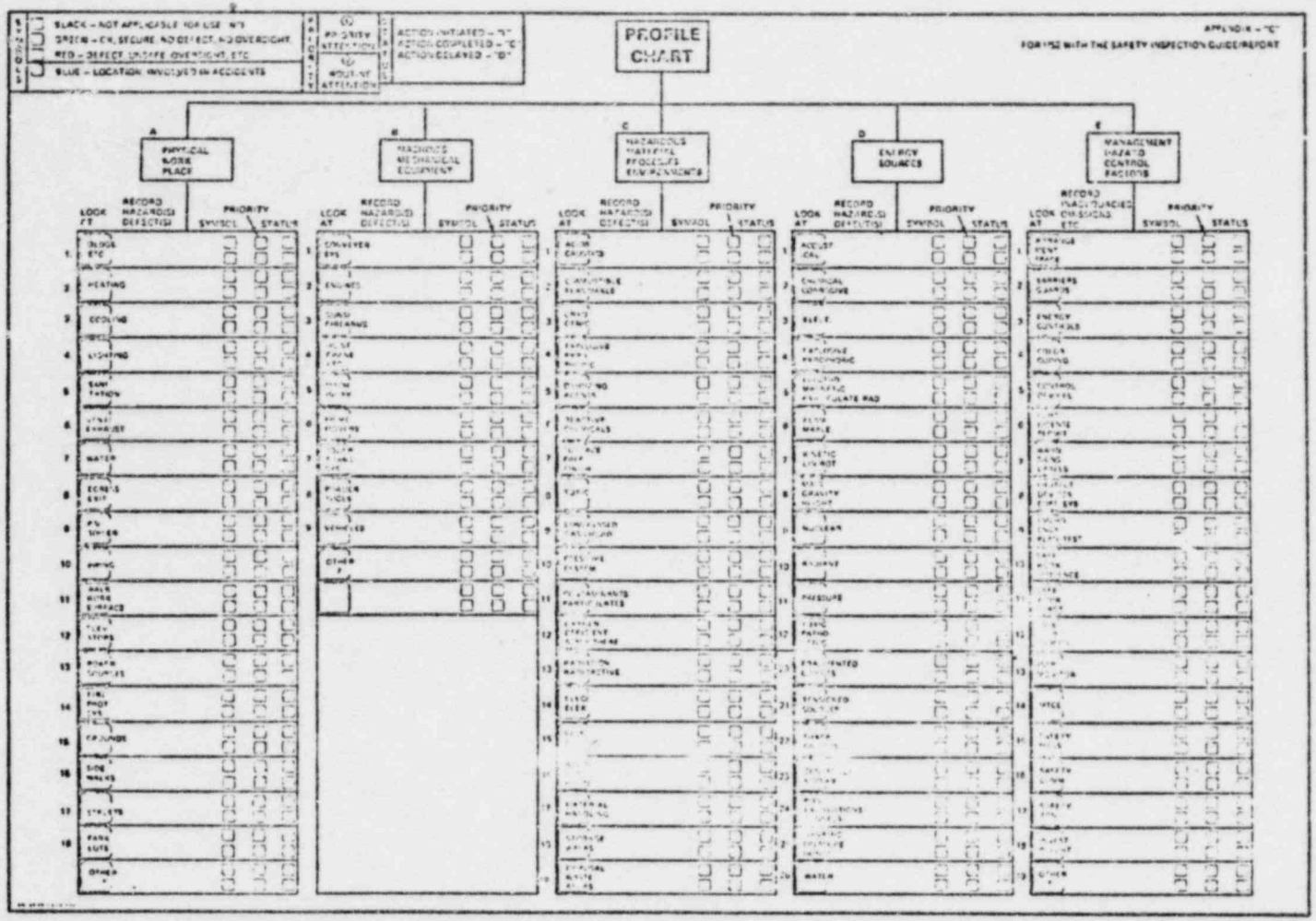
d. Employee safety concerns.

Corrective Action:

Priority 1 - Priority attention

Priority 2 - Routine attention

Assign corrective priority (best estimate) required by frequency of exposure to the hazard, by potential severity and potential impact (negative) on public.


PROFILE CHART
A
PHYSICAL WORK PLACE
B
MACHINES MECHANICAL EQUIPMENT
C
HAZARDOUS MATERIAL PROCESSES ENVIRONMENTS
D
ENERGY SOURCES
E
MANAGEMENT HAZARD CONTROL FACTORS
LOOK AT
RECORD HAZARD(S) DEFECT(S)
PRIORITY
SYMBOL
STATUS

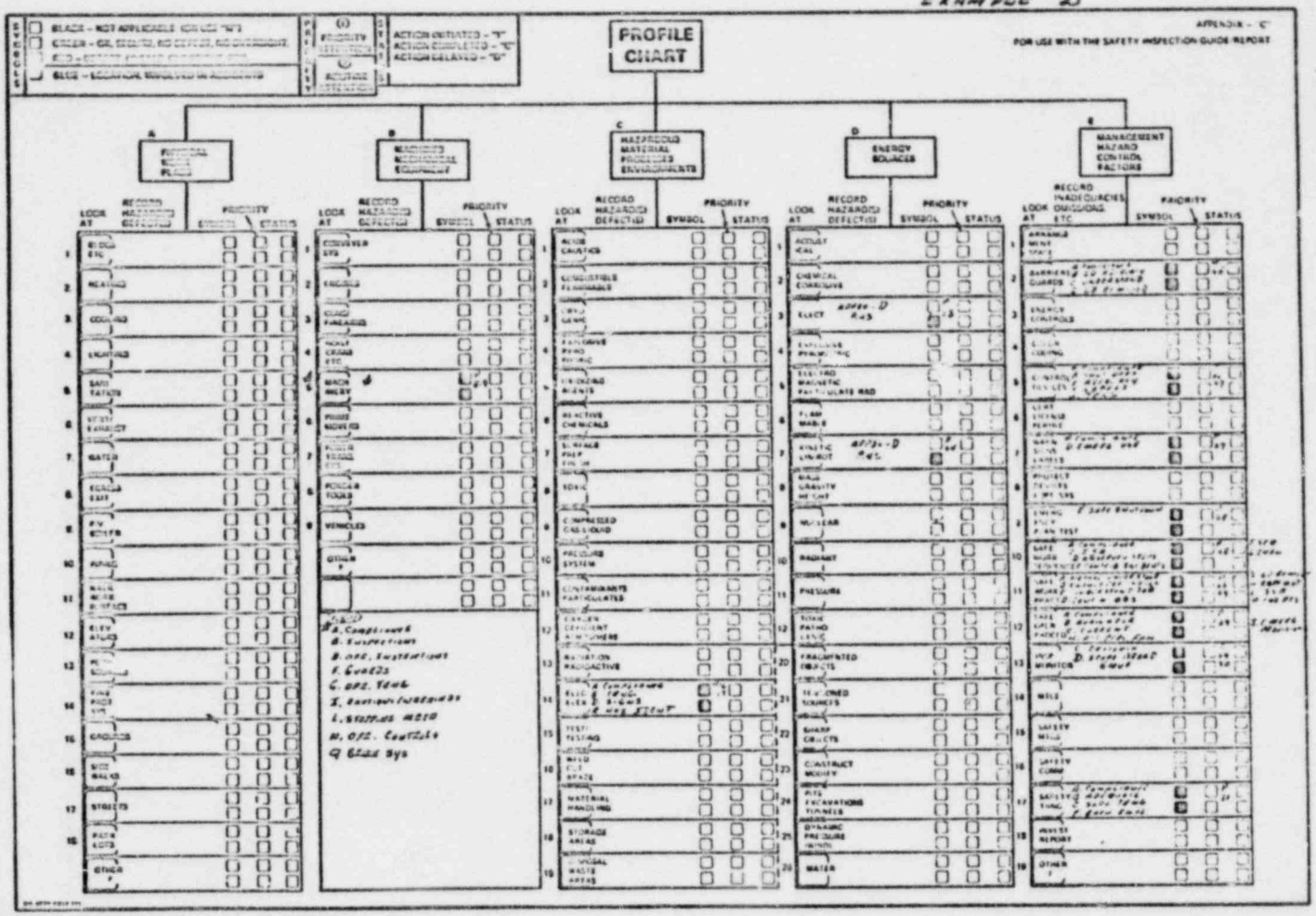
Employee was using a rag dampened with cleaning solvent to clean printing ink from the blanket cylinder of a Harris press.

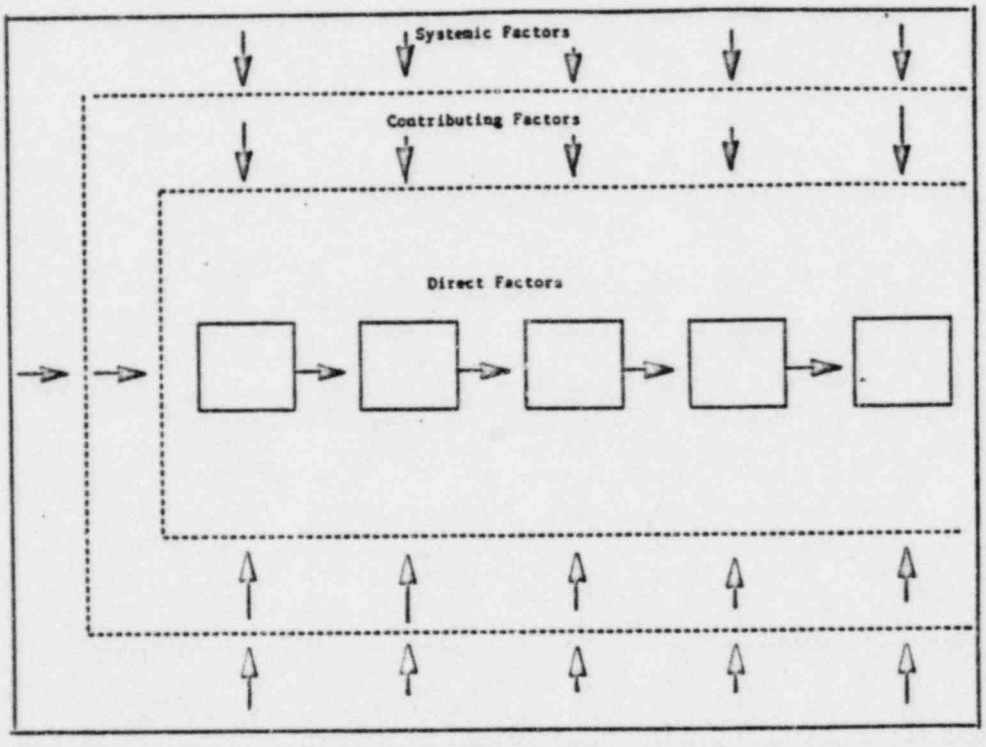
The employee was inching the press while he was cleaning the blanket when the rag he was using was pinched between the plate and the blanket cylinder. As the rag was pulled between the cylinders, the fingers of his right hand were pulled in behind the rag.

The safety guard was not in place, and the rag being used was not balled sufficiently so that no loose ends were exposed.

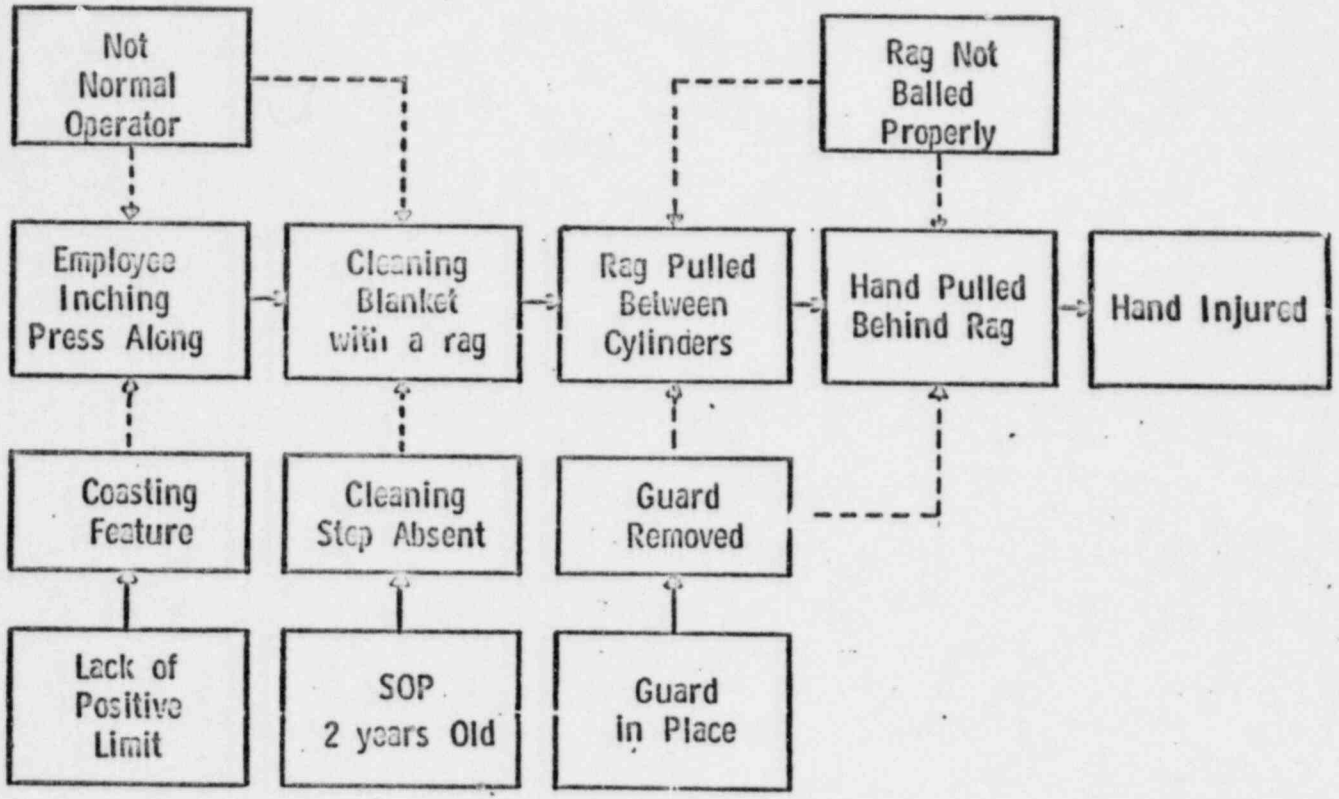
EXAMPLE #21

EXAMPLE #2


PROFILE CHART
FOR USE WITH THE SAFETY INSPECTION GUIDE REPORT
ACTION INITIATED - "I"
ACTION COMPLETED - "C"
ACTION DELAYED - "D"
A
B
C
D
E
MANAGEMENT HAZARD CONTROL FACTORS
ENERGY SOURCES
LOOK AT
RECORD HAZARDS DEFECTIVE
PRIORITY
SYMBOL
STATUS
RECORD INADEQUACIES OMISSIONS ETC



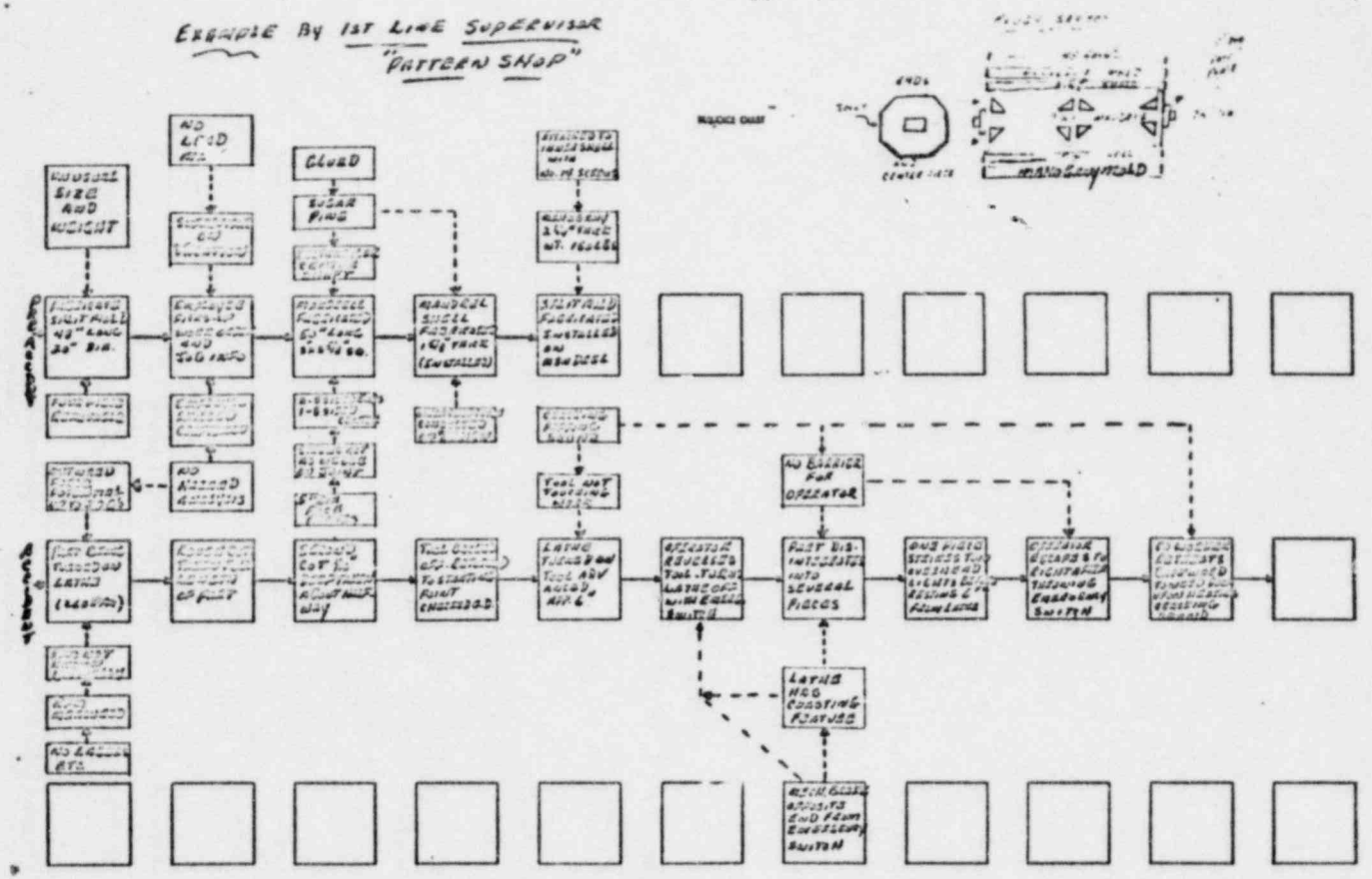
4-6 Figure 23. EVENTS AND CAUSAL FACTORS (General Schematic)


Not Normal Operator
Rag Not Balled Properly
Employee Inching Press Along
Cleaning Blanket with a rag
Rag Pulled Between Cylinders
Hand Pulled Behind Rag
Hand Injured
Coasting Feature
Cleaning Step Absent
Guard Removed
Lack of Positive Limit
SOP 2 years Old
Guard in Place

SEQUENCE 2

EXAMPLE BY 1ST LINE SUPERVISOR

"PATTERN SHOP"



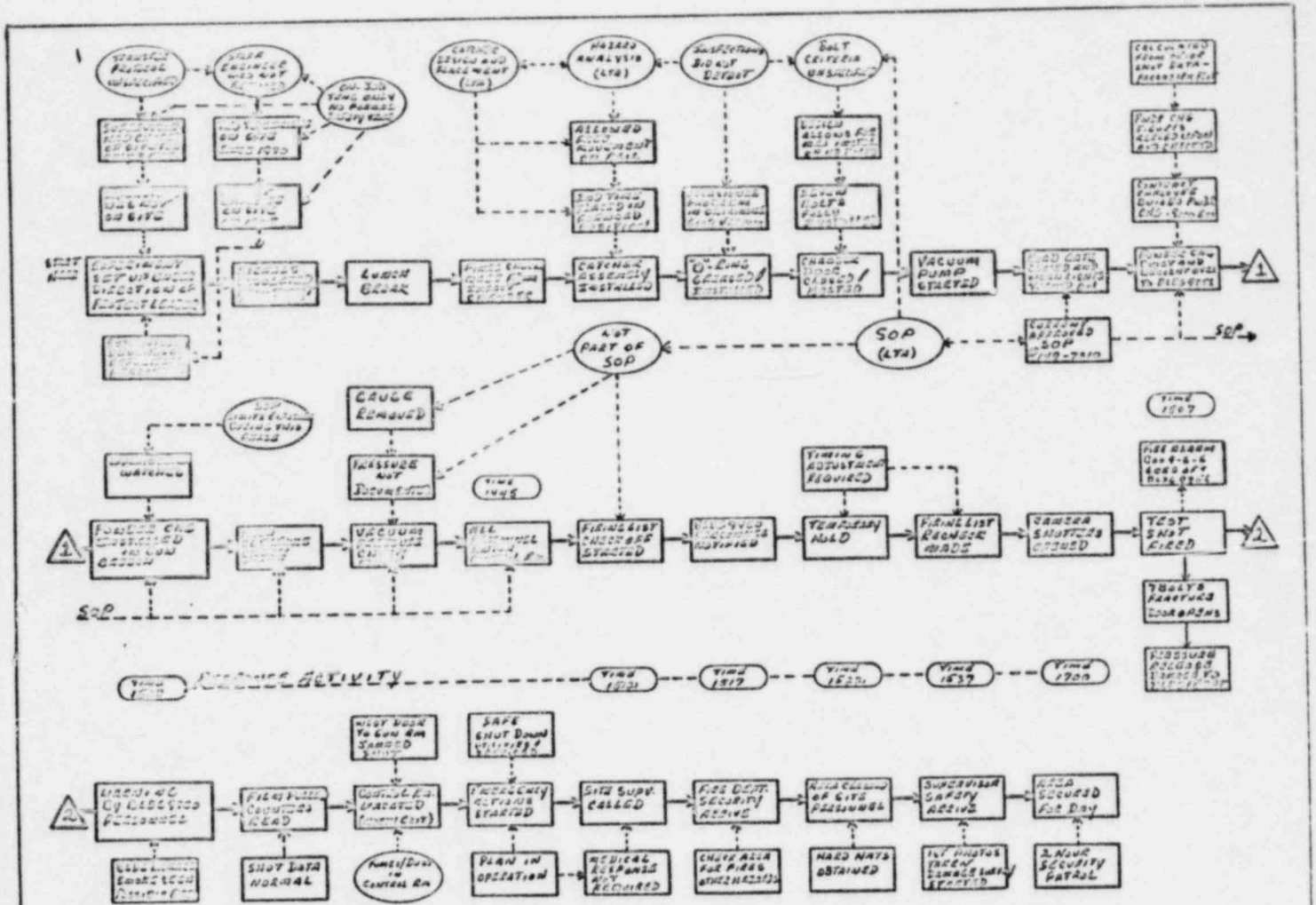
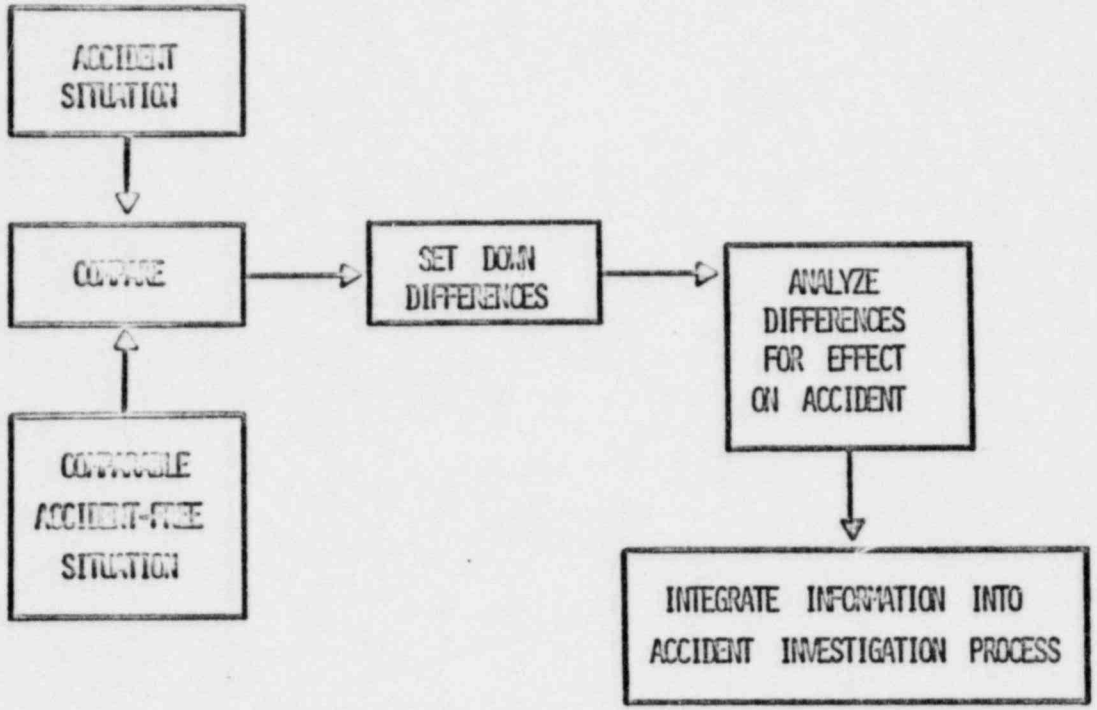
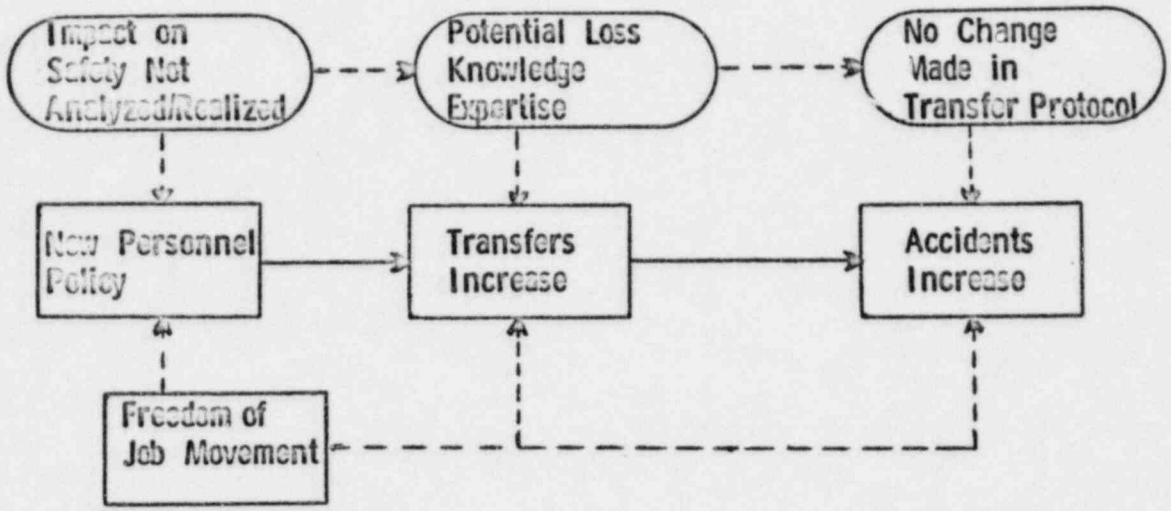


FIG. EVENTS AND CAUSAL FACTORS

CHANGE-BASED ANALYSIS



CHANGE ANALYSIS (RESULTS)
(CHARTED)



ACCIDENT ENERGY ANALYSIS

Energies Involved

- Expected
- Unexpected
- Unwanted Transfers

Control / Barriers

- Hardware / Equipment
- Software

INVOLVED-vs-RESPONSIBLE

Category		Involved	Responsible
A.	Physical Work Place	27%	5%
B.	Machines/Mechanical	26%	7%
C-D.	Hazardous Materials/Processes and Energies	47%	88%
E.	Management Control Factors	100%	100%

Reference Material

*1. System Safety Development Center Documents (DOE):

- SSDC-1 Occupancy-Use Readiness Manual
- SSDC-2 Human Factors In Design
- SSDC-3 Contractor Guide to Advance Preparation for Accident Investigation
- SSDC-4 MORT User's Manual
- SSDC-6 Training as Related to Behavioral Change
- SSDC-11 Risk Management Guide

*2. Accident/Incident Investigation Manual, ERDA 76-20

*3. MORT - The Management Oversight and Risk Tree, SAN 821-2

4. Kepner/Tregoe, The Rational Manager

*5. Safety Inspection Guide, Sandia Laboratories, SAND 77-0857

*Available from:

National Technical Information Service
U. S. Department of Commerce
5285 Post Royal Road
Springfield, VA 22161

GLOSSARY

Accident - An unwanted energy transfer causing property damage and/or human injury.

Occurrence - Any deviation from the planned or expected behavior or course of events in operations, if the deviation has safety, health, or environmental significance.

Hazard - The potential in an activity (condition or circumstance) for an accident, particularly an unwanted transfer of energy which can occur in random variations of normal operations or from changes in physical or human factors.

Hazard Analysis - The functions, steps, and criteria for design and plan of work which identify hazards, provide measures to reduce the probability and severity potentials, identify residual risks, and provide alternative methods of further control.

Control - A physical mechanism or an administrative procedure used to regulate, guide, or direct a machine, apparatus, system or environment.

Procedure - A written step-by-step method of performing a task.

Policy - A general statement intended to guide present and future decisions issued by the highest authority in an organization.

Barrier - A physical or administrative measure to limit, reduce, or prevent an unwanted energy flow from harming persons or objects.

Risk - The probability during a period of activity that a hazard will result in an accident with definable consequences.

Management - The collective body of those who direct an enterprise.

Investigation - A detailed systematic search to uncover facts and determine the validity and relationship of the accident factors.

Causal Factor - A person, thing, or condition which contributes significantly to an accident. A combination of simultaneous or sequential circumstances directly or indirectly contributory to an accident.

INVOLVED-vs-RESPONSIBLE

Category		Involved	Responsible
A.	Physical Work Place	27%	5%
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