Civilian Radioactive Waste
Management System

Management & Operating
Contractor

TRW Environmental Safety
Systems Inc.

YMP Site Characterization

System Safety and Human Factors

Presentation to the Nuclear Waste Technical Review Board
Arlington, VA

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June 14, 1995

Agenda

- System Safety definitions
- Extent of System Safety Analysis
- Background
- YMP System Safety Analysis (SSA) Plan
- YMP System Safety Analysis Procedure

Agenda

- Hazard tracking and risk resolution database
- Failure reporting analysis and corrective action system
- System Safety Analysis examples
- YMP Human Factors Engineering Plan
- Other activities

System Safety Definitions

- **System Safety—An engineering discipline directly related to and an integral part of design**

- **System Safety Analysis—A systematic process that identifies design-related hazards that can lead to accidents and cites specific mitigation features that are intended to eliminate or mitigate the consequences of the hazards**

- **Analysis Scope—The scope is limited to accident hazards resulting from equipment failure, design layout, or design-caused human error**

Extent of System Safety Analysis

- Construction-related work activities are excluded per DOE Order 5481.1B—Safety Analysis and Review Systems (construction organization safety)
- Designs not under M&O control such as "off-the-shelf" maintenance tools or construction equipment (construction organization safety)
- Hazards resulting from operational and maintenance procedures (these hazards are the responsibility of the M&O and are handled by way of Job Safety Analyses [JSAs])
- Non-accident related hazards such as effluent releases from normal operations and/or out-of-tolerance conditions (construction organization safety)

YMP System Safety Analysis Plan and Procedure

Background:

- 1992 Preliminary Safety Analysis Report format (non-radiological)
- 1993 Design package basis
- 1994 DOE request for System Safety Analysis Plan and Procedure

YMP System Safety Analysis Plan

Purpose:

- **Address system safety issues mandated by**
  - **DOE Order 6430.1A—General Design Criteria**
  - **DOE Order 5481.1B—Safety Analysis and Review Systems**
  - **OCRWM/YMP SEMP**
- **Describe how to accomplish objectives**

YMP System Safety Analysis Plan

General Approach:

- Based on proven analytical approaches
  - MIL-STD-882
  - SSS Handbook
- Fully developed documentation procedure and analytical process

System Safety Analysis Procedure

Describes the Following Requirements Needed to Complete a System Safety Analysis:

- **Purpose, applicability, and responsibilities**
- **Documentation procedure**
- **Analytical process**

YMP System Safety Analysis Procedure

- **Purpose**
  - **Provide methods to identify, analyze, mitigate, and monitor hazards**
- **Applicability**
  - **YMSCO and YMP teammates who accomplish or review SSAs**
- **Responsibilities**
  - **DOE, initiating organizations, M&O SS, CMO, and design**

YMP System Safety Analysis Procedure

Documentation Procedures:

- **Documentation steps**
- **Accident Analysis Summary Sheet (the key documentation being processed)**

YMP System Safety Analysis Procedure

Documentation Steps:

- **Preparing an SSA**
  - **Cover and sign-off sheets**
  - **SSWG formation**
- **Performing an SSA**
  - **Follows SSA process**
  - **Results in completed Accident Analysis Summary Sheets (scenario worksheets)**

YMP System Safety Analysis Procedure

Documentation Steps:

- **Revising an SSA**
  - **Only changed pages are issued**
  - **New Accident Analysis Summary Sheets generated where needed**

YMP System Safety Analysis Procedure

ACCIDENT ANALYSIS SUMMARY WORKSHEET (Scenario Worksheet)

SCENARIO NUMBER: SI0079 REVISION: REVISION DATE:

LOCATION:

SCENARIO:

SYSTEM/COMPONENT FAILURE:

ACCIDENT CLASSIFICATION:

Frequency Rating:

Consequence Rating:

Risk Designation:

MITIGATION/CONTROL FEATURES:

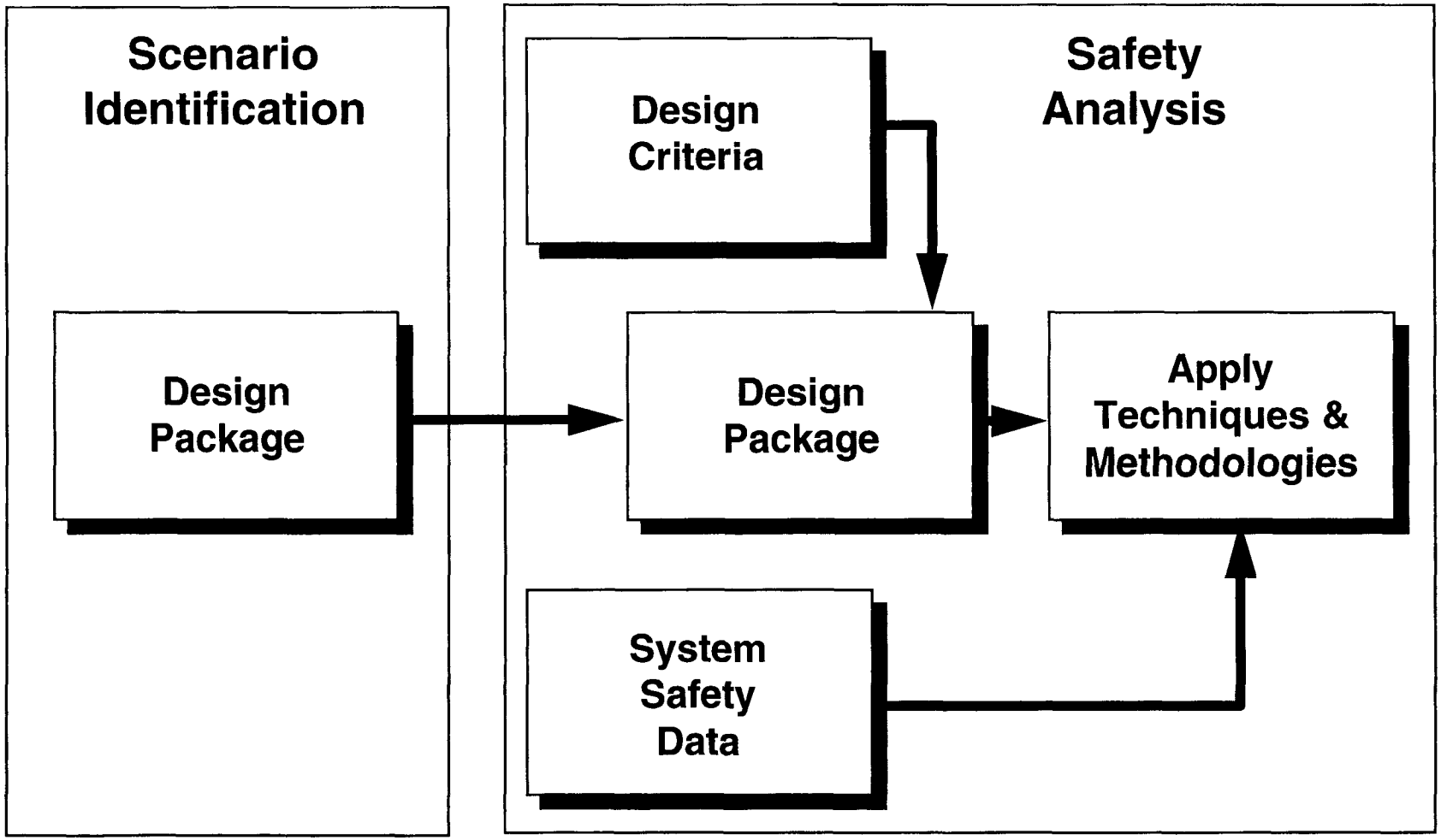
MITIGATION DOCUMENTATION:

YMP System Safety Analysis Procedure

Safety System Analysis Process:

- **Safety assessment**
- **Mitigation of hazards**
- **SSWG interfaces**

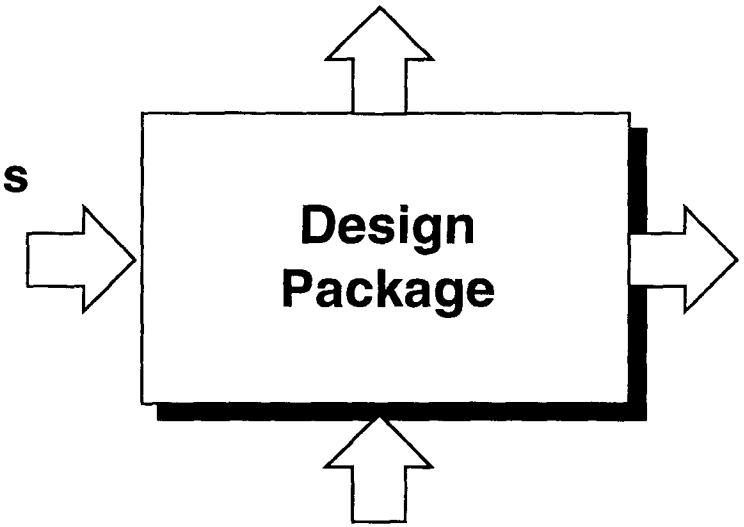
YMP System Safety Analysis Procedure
System Safety Assessment



YMP System Safety Analysis Procedure
System Safety Assessment

Scenario Identification

Type I: Accident Scenarios
Potential accidents resulting from equipment failure, design layout, or design-caused human error

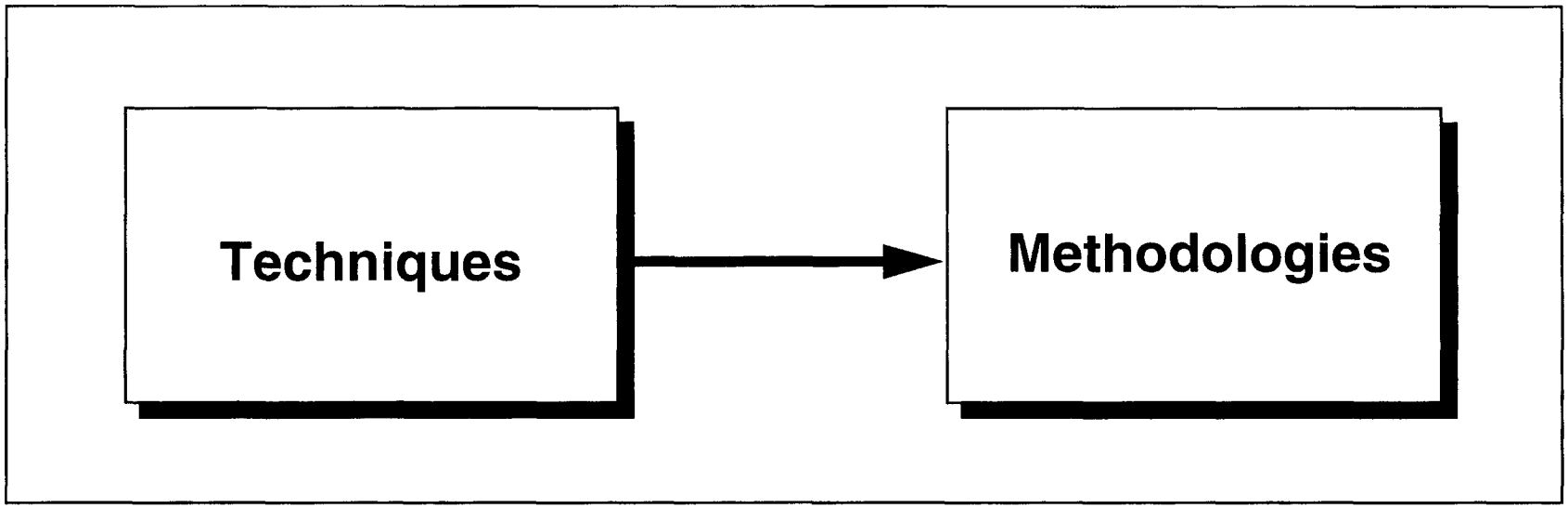


Energy and materials *unintentionally* introduced into the system

Type II: Health Scenarios
Health hazards due to normal operation or operation in out-of-tolerance conditions

Energy and materials *intentionally* introduced into the system

YMP System Safety Analysis Procedure System Safety Assessment



- Scenario analysis
- Hazards analysis
- Human factors analysis
- Failure modes effects and criticality analysis

- Comparative analysis
- Absolute analysis
- Subjective analysis

YMP System Safety Analysis Procedure
System Safety Analysis Process

System Safety Mitigation:

- Review and agreement on mitigation followed by sign-off
- Hazard control, mitigation implementation, and tracking

Hazard Tracking and Risk Resolution Database

- "Ingres" database
- Scenario worksheets
- Data entry
- Follow-up

Failure Reporting Analysis and Corrective Action Database (FRACAS)

- Maintenance centered database
- Specialized reports
- Corrective actions
- Integrated Logistics Support

System Safety Analysis Examples

TBM System Safety Analysis:

- Type of analyses
- Risk methodology
- SSWG

System Safety Analysis Examples

- System Safety Society Manual
- Type of analyses used
  - Scenario Analysis
  - Hazards Analysis
  - Human Factors Analysis
  - Failure Mode Effects and Criticality Analysis
  - Job Safety Analysis

System Safety Analysis Examples—TBM SSA

Risk Methodology:

- Fourteen steps
- Threats checklist
- Hazard frequency
- Hazard consequence
- Risk matrix

System Safety Analysis Examples—TBM SSA

System Safety Working Group:

- Establish for each System Safety Analysis
- Cross section representation
- System Safety Analysis review
- Final sign-off for technical content

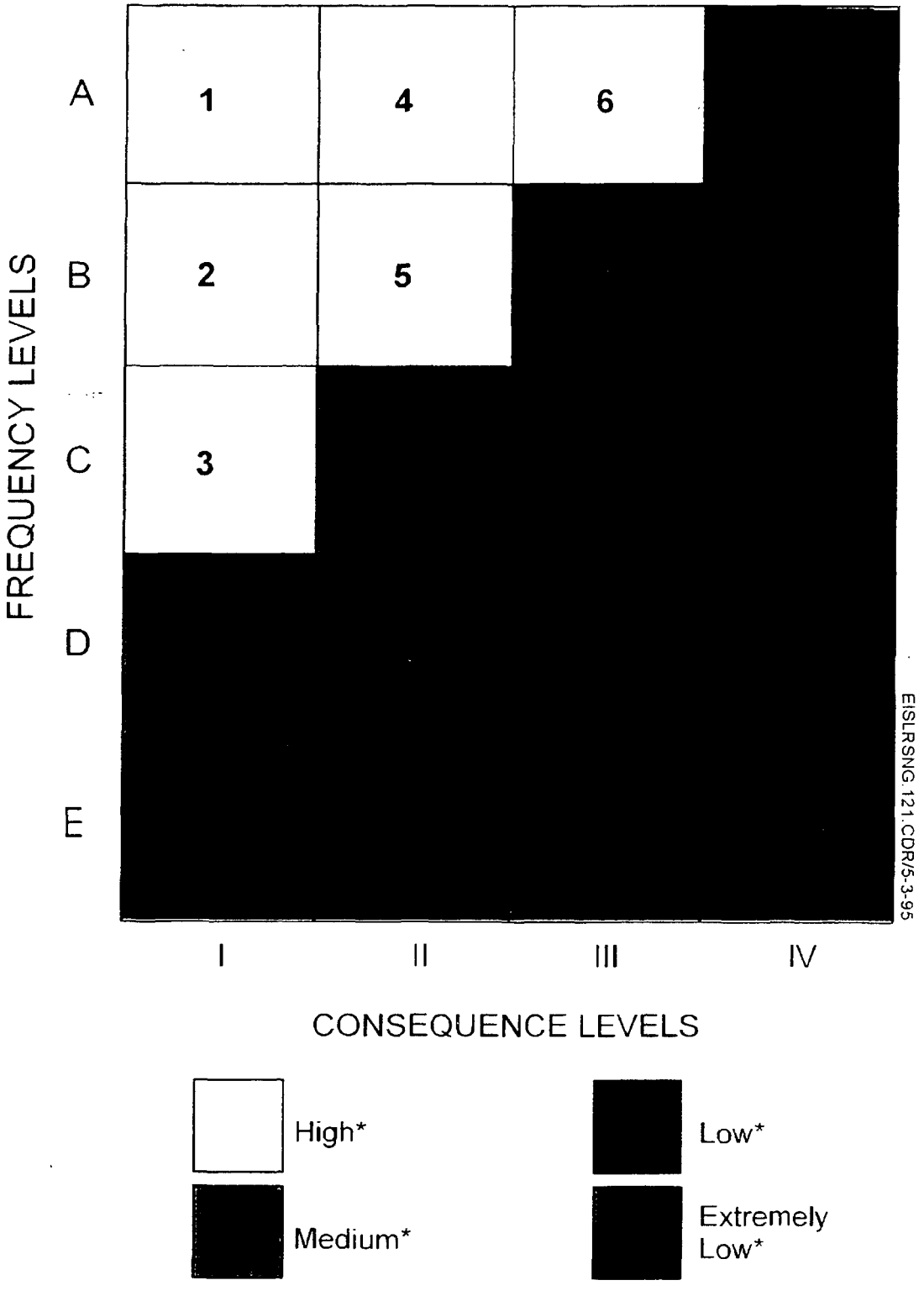
Frequency Rating Scale

Frequency	Description
A Frequent	Likely to occur frequently in the life of an SSC*
B Probable	Likely to occur several times in the life of an SSC*
C Occasional	Likely to occur some time in the life of an SSC*
D Remote	Unlikely but possible to occur in the life of an SSC*
E Improbable	So unlikely, it can be assumed occurrence may not be experienced in the life of an SSC*
	*System/structure/component
Frequent	> 4.5 occurrences or more than one occurrence per year
Probable	> 2.25 but not more than 4.5 occurrences or one or fewer occurrences per year during TBM lifetime
Occasional	> 1.0 but not more than 2.25 occurrences during TBM lifetime
Remote	> .25 but not more than 1.0 occurrence during TBM lifetime

Consequence Rating and Definition

Consequence Level		Maximum Consequence
I	Catastrophic	Death, system/equipment loss, or several environmental impact
II	Critical	Severe injury or illness, major system/ equipment or environmental damage
III	Marginal	Minor injury or illness, minor system/ equipment damage, minor delay of data collection or loss of data
IV	Negligible	Less than minor injury, occupational illness, or system damage

Risk Rating Matrix



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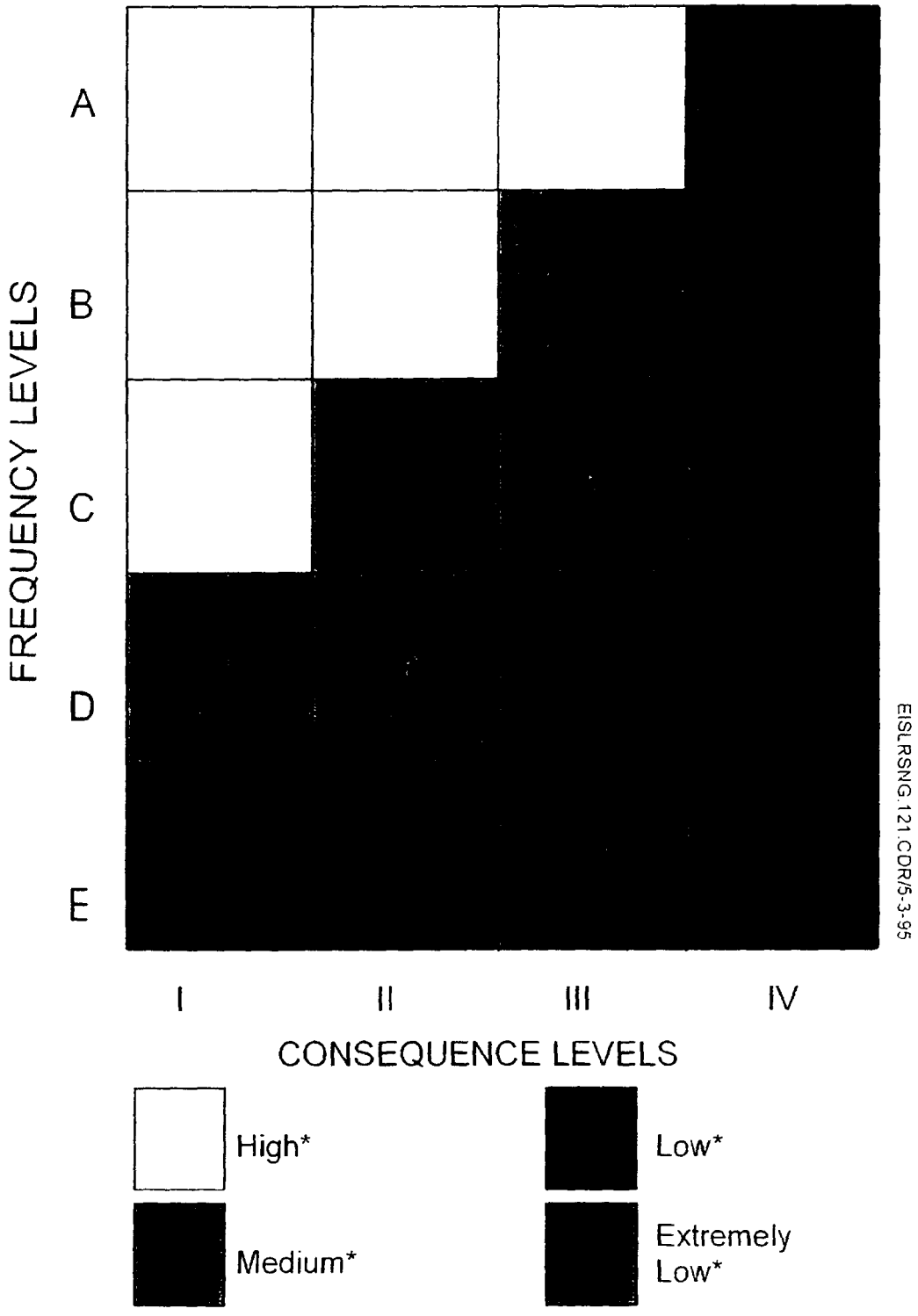
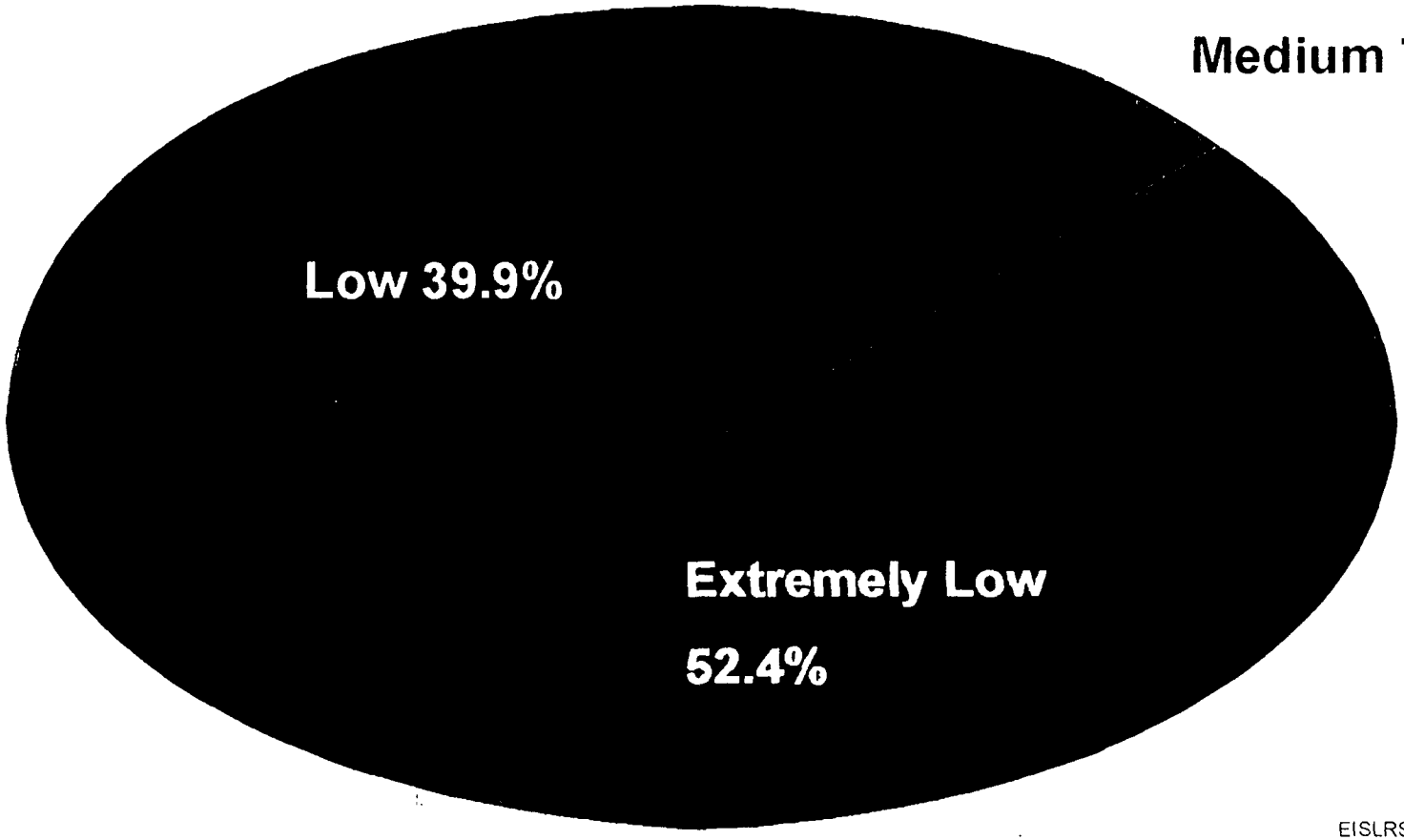
Scenarios Distributed Over Risk



Percentage of TBM Scenarios by Level of Risk



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System Safety Analysis Examples

Control Precedence:

- Eliminate hazards by design
- Addition of safety features and devices
- Use warning and alerting devices
- Establish procedures/train personnel

System Safety Analysis Examples

- TBM
- Conveyor
  - Surface
  - Subsurface

System Safety Analysis Examples

Design Package 1C:

- Surface compressed air
- Standby generators

System Safety Analysis Examples

Design Package 1D:

- Muck storage area
- Conveyor access road
- Compressed air
- Lighting, fencing, and piping
- Pads and foundations

System Safety Analysis Examples

Design Package 2B:

- Subsurface ventilation
- Subsurface trolley

System Safety Analysis Examples

Design Package 2C:

- North ramp excavation
- Support areas
- Subsurface water
- Subsurface compressed air
- Ground support
- Subsurface lighting
- Ventilation
- Subsurface rail
- Fire detection and protection
- North ramp walkway*

* Separate trade-off study

System Safety Analysis Examples

TBM:

- Additional conveyor emergency stop cord
- Relocation of segment hoist controls
- Addition of safety gates
- Labeling controls (permanent, function, settings/values)
- Definition of "master-slave" control relationship

System Safety Analysis Examples

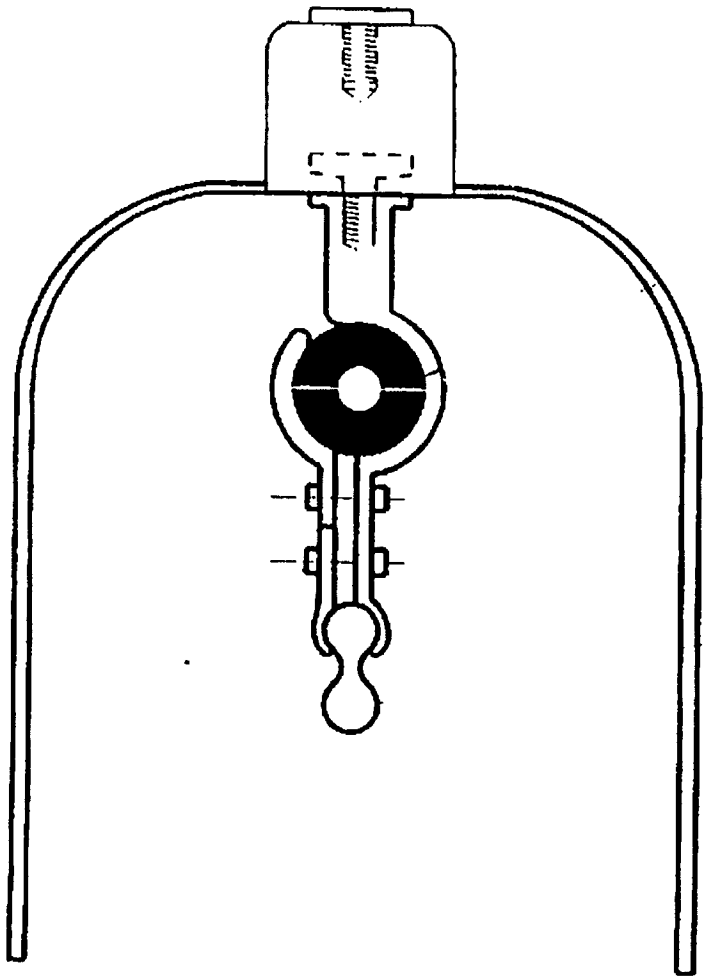
Work Platforms:

- Guardrails and handrails
- Toe kicks
- Adequate lighting
- Non-skid surfaces
- Access ladders per OSHA/MSHA

System Safety Analysis Examples

- **Ventilation system**
  - **Performance monitoring (e.g., temperature, vibration)**
  - **Fan access port to remove debris**
- **Trolley or train**
  - **Personnel and equipment restraints**
  - **"Deadman" controls**
  - **Redundant brakes**

Trolley Pentograph



Trolley Guard Insulated Fire-Retardant Material

System Safety Analysis Examples

Tunnel:

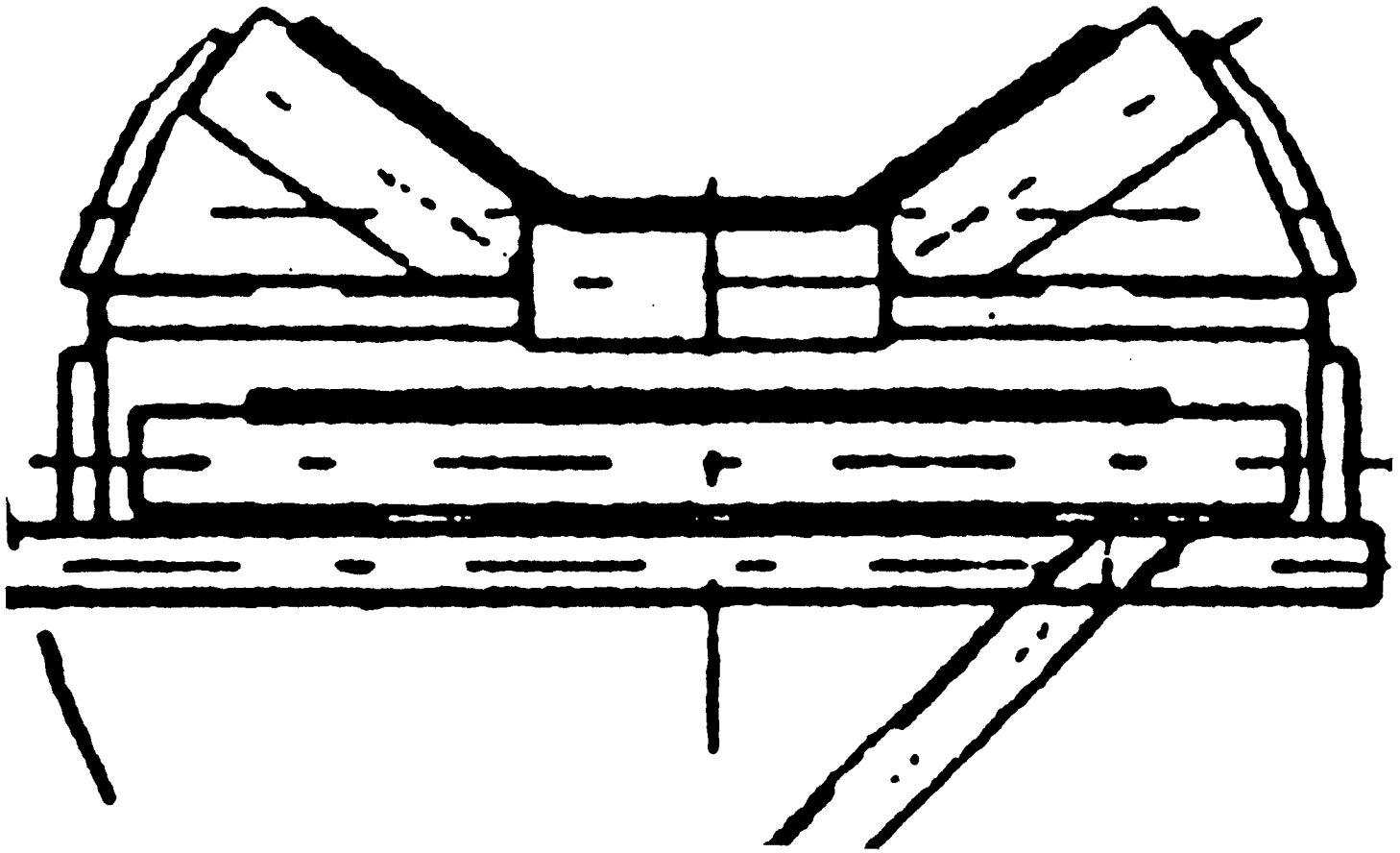
- Location of utilities and protective barriers
- Adequate lighting
- Warning signs and signals (e.g., train travel lights)
- Training and procedures
  - Personnel exclusion zones
  - Personnel access (e.g., walkways)
  - Personnel Protective Equipment
  - Vehicle travel speeds (e.g., trolley)

System Safety Analysis Examples

Conveyor:

- Emergency shut down controls
- Lockouts and tagouts
- Covers, belt angle, flashing, and load limits to prevent muck from being ejected
- Start-up signal
- Operator training

SUBSURFACE CONVEYOR



YMP Human Factors Engineering Plan

Maximize Human Performance:

- Reduce errors
- Increase productivity
- Decrease damage
- Improve safe operation and maintenance

YMP Human Factors Engineering Plan

- Address HFE issues mandated by
  - DOE Order 6430.1A—General Design Criteria
  - UCRL-AR-108791—Human Factors Engineering Standards for Use in Design, Modification, and Evaluation of DOE Nuclear Facilities: Vol. 1
- Basis
  - MIL-H-46855
  - MIL-STD-1472
  - ANSI/HFS-100/1988
  - Americans with Disabilities Act Guidelines
  - DOE-STD-1062-94 (draft)

Plans/Status

YMP Human Factors Engineering Plan:

- Being developed
- Draft completion date July 1995

Human Factors Engineering Activities

- Requirements definition and analysis
- Special and trade studies
- Design inputs
- System Safety support
- Task identification and procedure development

Other System Safety and Human Factors Engineering Activities

- Reviews
  - Specifications
  - Drawings
  - Analyses
- Configuration Control Board

Other System Safety and Human Factors Engineering Activities

- TBM walk down
- Special studies
  - Track switches
  - Walkways and niches
  - TBM mapping gantry follow-up
  - ACD

Other Activities

- Poster session
- Future plans
- Staffing