Διερευνήσεις Ατυχημάτων

Δρ. Ιωάννης Μ. Δόκας

Επίκουρος Καθηγητής

Εργαστήριο Οργάνωσης και Προγραμματισμού

Τμήμα Πολιτικών Μηχανικών ΔΠΘ

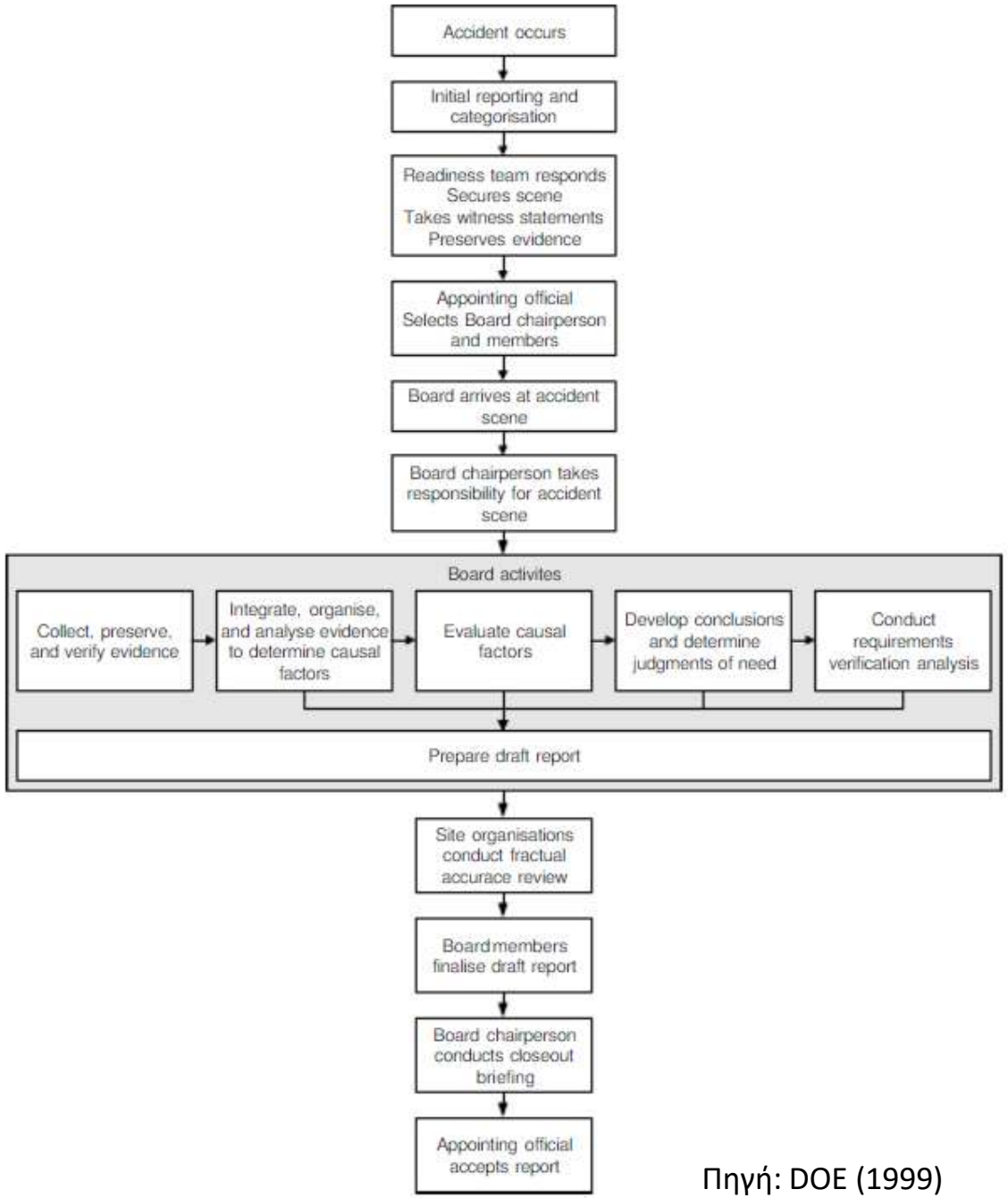
Λόγοι για Πραγματοποίηση Διερεύνησης

- Μάθηση:
  - Προσδιορισμός της πορείας των γεγονότων (τι, πότε, πως)
  - Προσδιορισμός των άμεσων και έμμεσων αιτιών / συντελεστών του ατυχήματος (γιατί)
- Πρόληψη: Προσδιορισμός διορθωτικών μέτρων
- Φταίξιμο/Αποζημίωση:
  - Ποινική Δίωξη ,
  - Αξιολόγηση του ζητήματος της ενοχής για την εκτίμηση της ευθύνης για αποζημίωση

http://158.132.155.107/posh97/private/AccidentPhenonmenon/investigation-workbook.pdf

Φάσεις

- Συλλογή αποδεικτικών στοιχείων και καταγραφή γεγονότων
- **Ανάλυση γεγονότων**
- Ανάπτυξη συμπερασμάτων - σύνταξη της έκθεσης

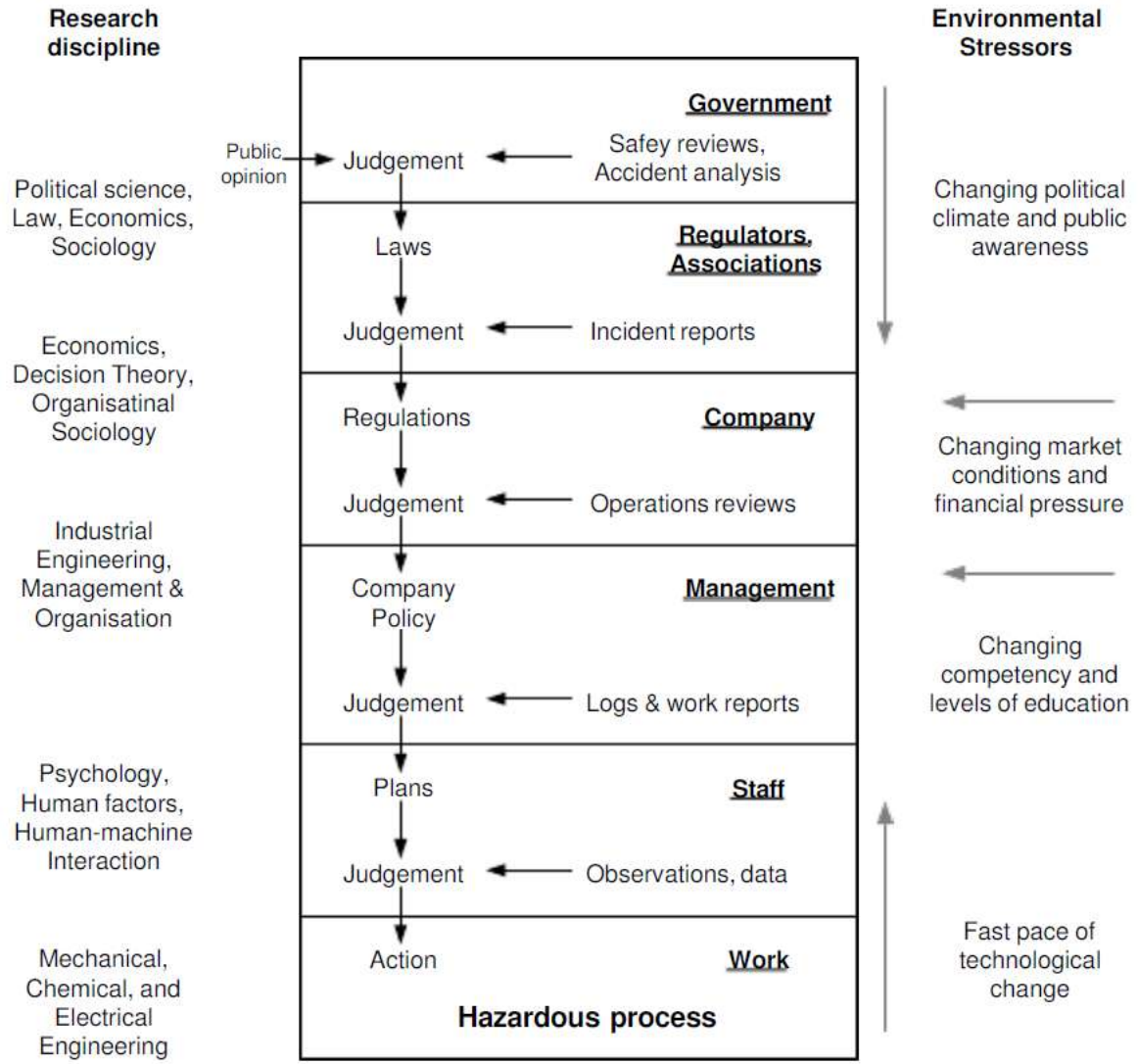


Πηγή: DOE (1999)

Ανάλυση Γεγονότων

- Ανάλυση: Βασίζεται σε κάποιο μοντέλο ατυχημάτων
- Πολλαπλοί, αλληλένδετοι παράγοντες
- Κοινωνικο-τεχνική διάσταση: Τεχνικές αστοχίες, περιβαλλοντικοί παράγοντες αλλά από το υφιστάμενο πλαίσιο ασφάλειας (ρυθμιστικές αρχές ή κυβερνήσεις)
- Ουδετερότητα και αμεροληψία

Ανάλυση Γεγονότων Κοινονικο-τεχνική Διάσταση



Πηγή: Rasmussen (1997)

Ανάλυση Γεγονότων Κοινονικο-τεχνική Διάσταση

Τρείς Προσεγγίσεις Ανάλυσης

1. Συμπερασματική: Από το γενικό στο ειδικό. Προσπάθεια να προσδιοριστούν οι τρόποι με τους οποίους η συμπεριφορά του συστήματος, του στοιχείου, του χειριστή και της οργάνωσης συμβάλλουν στην απώλεια κάνοντας χρήση γενικών μεθόδων (π.χ. FTA).

2. Επαγωγική: Από ειδικό στο γενικό. Υποθέτουμε ότι έχει συμβεί μία συγκεκριμένη απώλεια. Στη συνέχεια καθορίζεται ποια θα είναι τα αποτελέσματα της συγκεκριμένης απώλειας στη λειτουργία του συστήματος (π.χ. FMECA)

3. Η μορφολογική προσέγγιση βασίζεται στη δομή του συστήματος που μελετάται. Επικεντρώνεται άμεσα σε δυνητικά επικίνδυνες καταστάσεις με στόχο να αναλυθούν οι παράγοντες που έχουν τη μεγαλύτερη επίδραση στην ασφάλεια. Σε αυτού του είδους την ανάλυση ο αναλυτής βασίζεται στην πρότερη εμπειρία του στην διερεύνηση ατυχημάτων και περιστατικών.

Μέθοδοι Ανάλυσης

Core Analytical Techniques
Events and Causal Factors Charting and Analysis Barrier Analysis Change Analysis Root Cause Analysis
Complex Analytical Techniques *For complex accidents with multiple system failures, there may in addition be need of analytical techniques like analytic tree analysis, e.g.*
Fault Tree Analysis MORT (Management Oversight and Risk Tree) PET (Project Evaluation Tree Analysis)
Specific Analytical Techniques
Human Factors Analysis Integrated Accident Event Matrix Failure Modes and Effects Analysis Software Hazards Analysis Common Cause Failure Analysis Sneak Circuit Analysis 72-Hour Profile Materials and Structural Analysis Scientific Modelling (e.g., for incidents involving criticality and atmospheric despersion)

Πηγή: DOE (1999)

Μέθοδοι Ανάλυσης

Investigation method
Accident Anatomy method (AAM)
Action Error Analysis (AEA)
Accident Evolution and Barrier Analysis (AEB)
Change Evaluation/Analysis
Cause-Effect Logic Diagram (CELD)
Causal Tree Method (CTM)
Fault Tree Analysis (FTA)
Hazard and Operability Study (HAZOP)
Human Performance Enhancement System (HPES)[1]
Human Reliability Analysis Event Tree (HRA-ET)
Multiple-Cause, Systems-oriented Incident Investigation (MCSOII)
Multilinear Events Sequencing (MES)
Management Oversight Risk Tree (MORT)
Systematic Cause Analysis Technique (SCAT)[1]
Sequentially Timed Events Plotting (STEP)
TapRoot™ Incident Investigation System[1]
Technique of Operations Review (TOR)
Work Safety Analysis

Πηγή: CCPS (1992)

Αιτιατοί Παράγοντες

Τρεις τύποι αιτιατών παραγόντων:

- Άμεσα αιτία
- Έμεσα αιτίες
- Γενεσιουργά αίτια

Αίτια και Παράγοντες

Τρεις τύποι αιτιατών παραγόντων:

■ Άμεσα αιτία

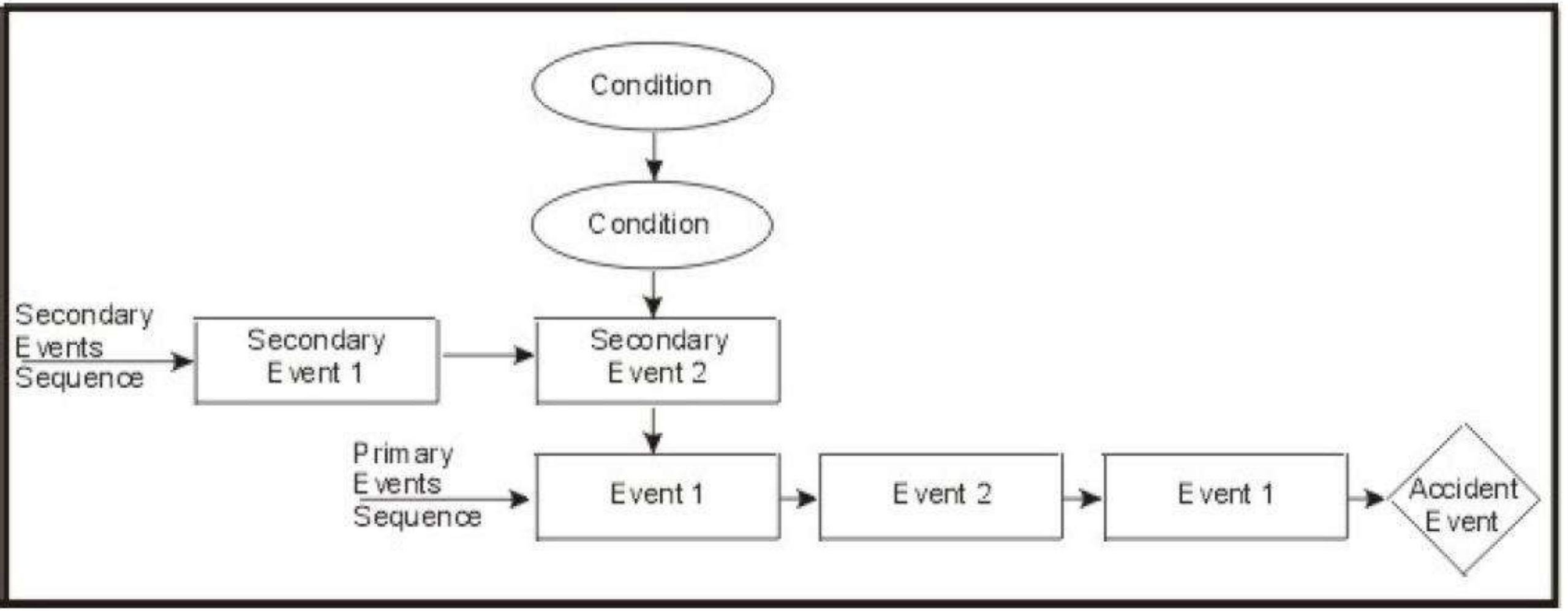
Τα άμεσα αναγνωρίσιμα γεγονότα ή συνθήκες που προκάλεσαν το ατύχημα

■ Έμεσα αίτια

Γεγονότα ή συνθήκες που συλλογικά με άλλες αιτίες επέδρασσαν ενισχυτικά στην πρόκληση ενός ατυχήματος

■ Γενεσιουργά αίτια Οι παράγοντες που, εάν διορθωθούν, θα αποτρέψουν την επανάληψη των ίδιων ή παρόμοιων ατυχημάτων. (Συνήθως παθογένειες ανεπάρκειες του συστήματος διαχείρισης ασφάλειας του συστήματος ή της διοίκησης του οργανισμού)

Events and Causal Factors Charting



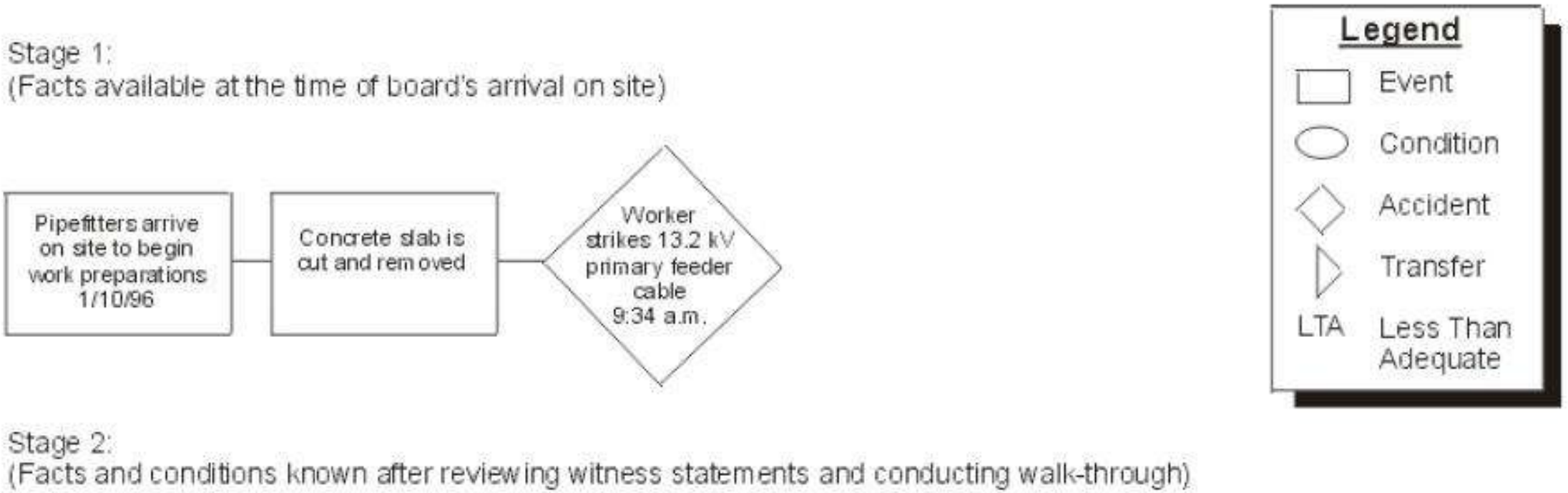
Πηγή: DOE (1999)

Events and Causal Factors Charting

Symbols	■ □ — Events ■ ◇ — Accidents ■ ⬭ — Conditions ■ ::: — Presumptive events ■ ⬭→ — Presumptive conditions or assumptions ■ → — Connect events ■ - -> — Connect conditions ■ ▷ — Transfers one line to another ■ LTA — Less than adequate; a judgment of the board
Events	■ Are active (e.g., "crane strikes building") ■ Should be stated using one noun and one active verb ■ Should be quantified as much as possible and where applicable (e.g., "the worker fell 26 feet," rather than, "the worker fell off the platform") ■ Should indicate the date and time of the event, when they are known ■ Should be derived from the event or events and conditions immediately preceding it.
Conditions	■ Are passive (e.g., "fog in the area") ■ Describe states or circumstances rather than occurrences or events ■ As practical, should be quantified ■ Should indicate date and time if practical/applicable ■ Are associated with the corresponding event.
Primary Event Sequence	Encompasses the main events of the accident and those that form the main events line of the chart.
Secondary Event Sequence	Encompasses the events that are secondary or contributing events and those that form the secondary line of the chart.

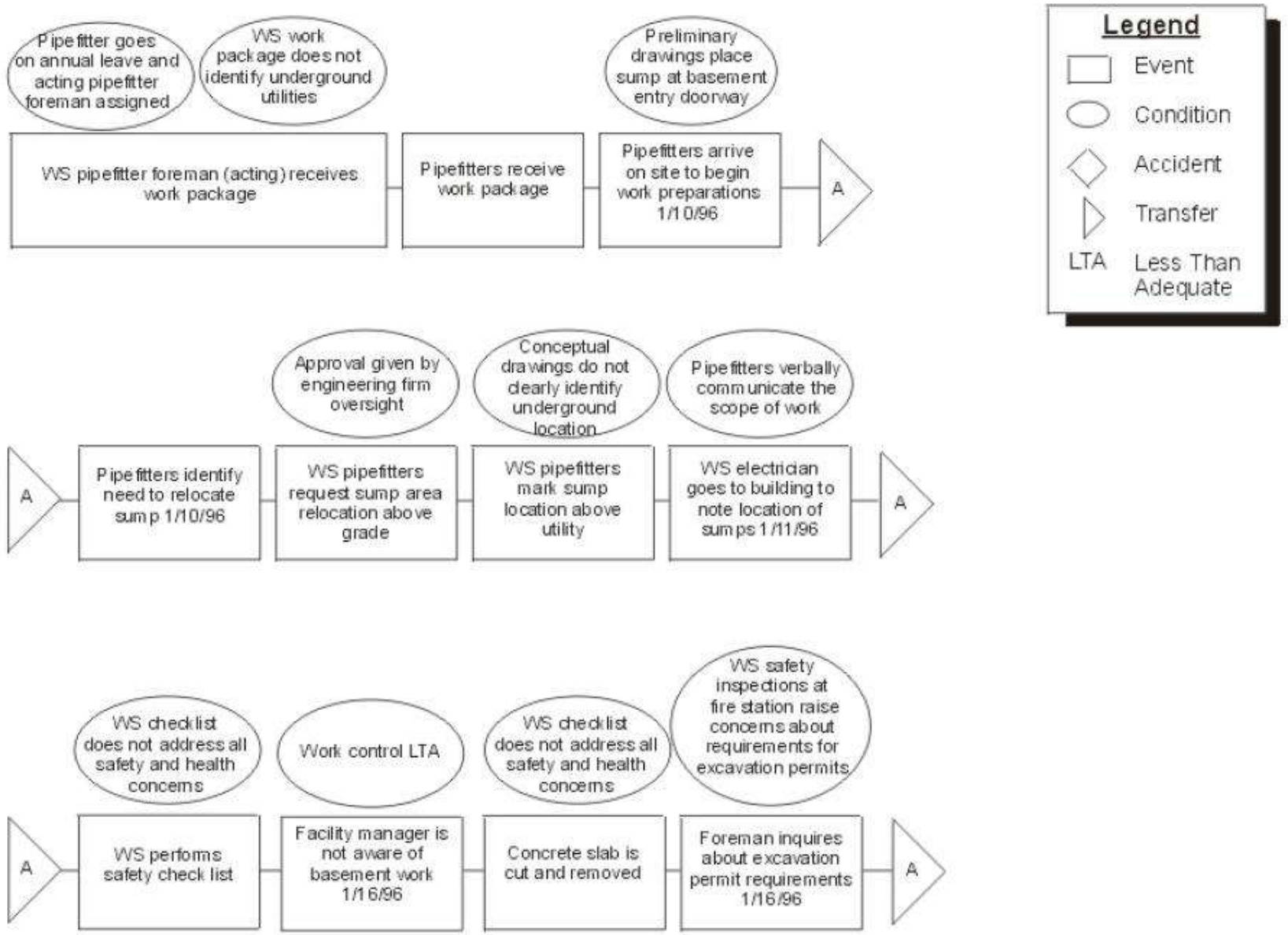
Πηγή: DOE (1999)

Events and Causal Factors Charting



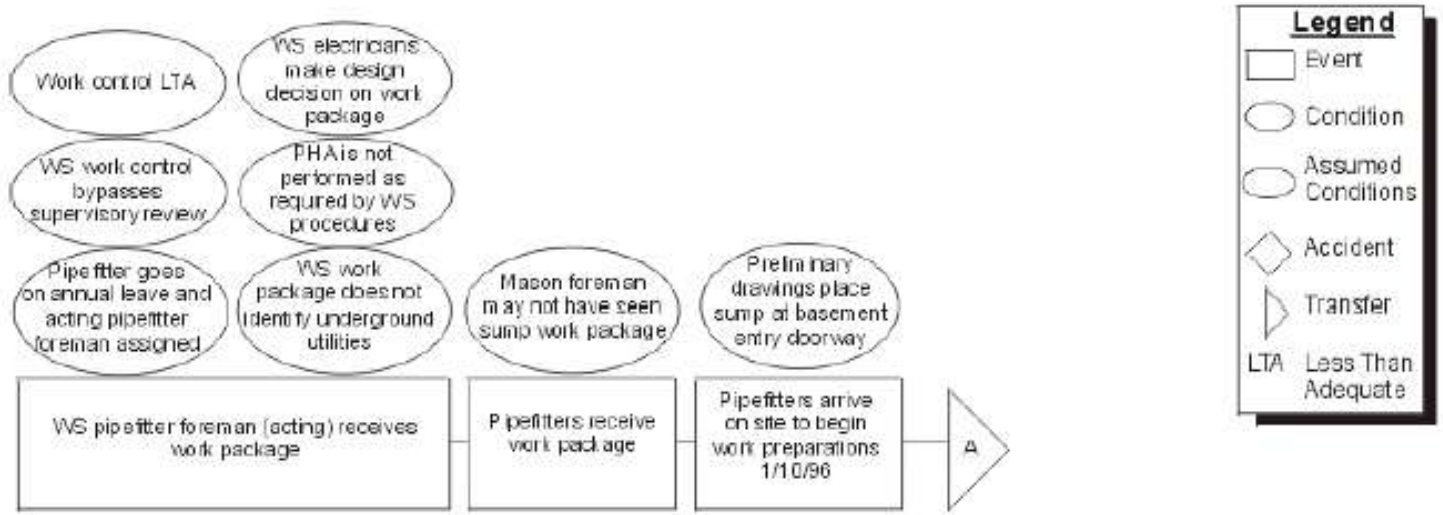
Πηγή: DOE (1999)

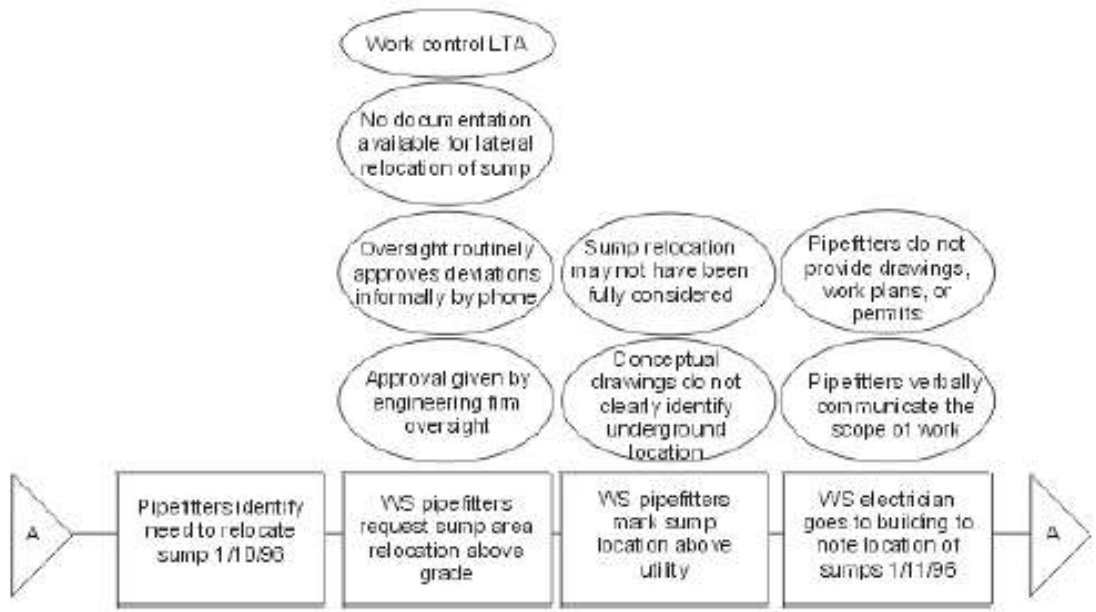
Stage 4:
(Facts and conditions known after interviews, reviews of documentary evidence)



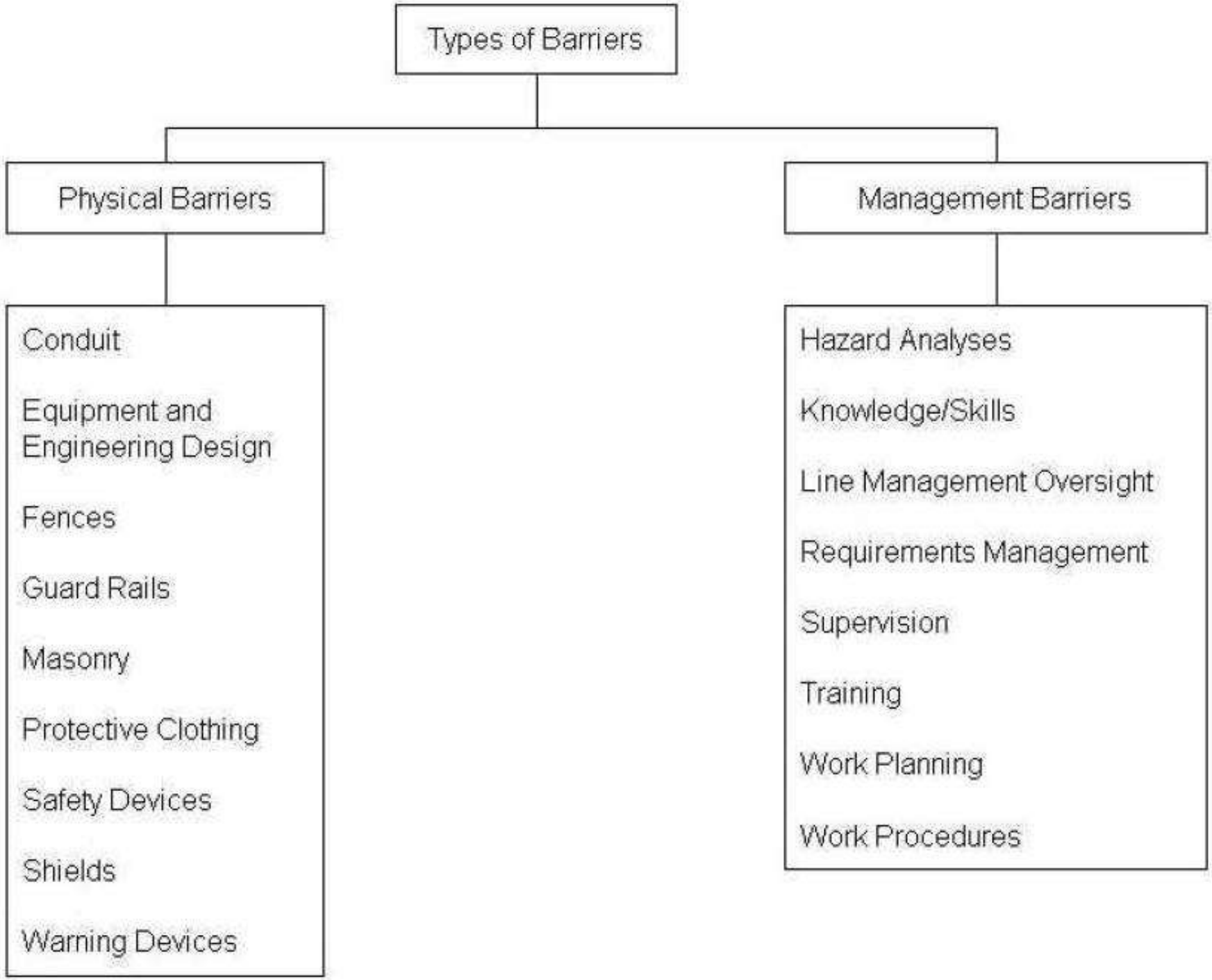
Πηγή: DOE (1999)

Stage 5
(Information known at the end of the investigation, edited to include only major events and conditions)





Πηγή: DOE (1999)

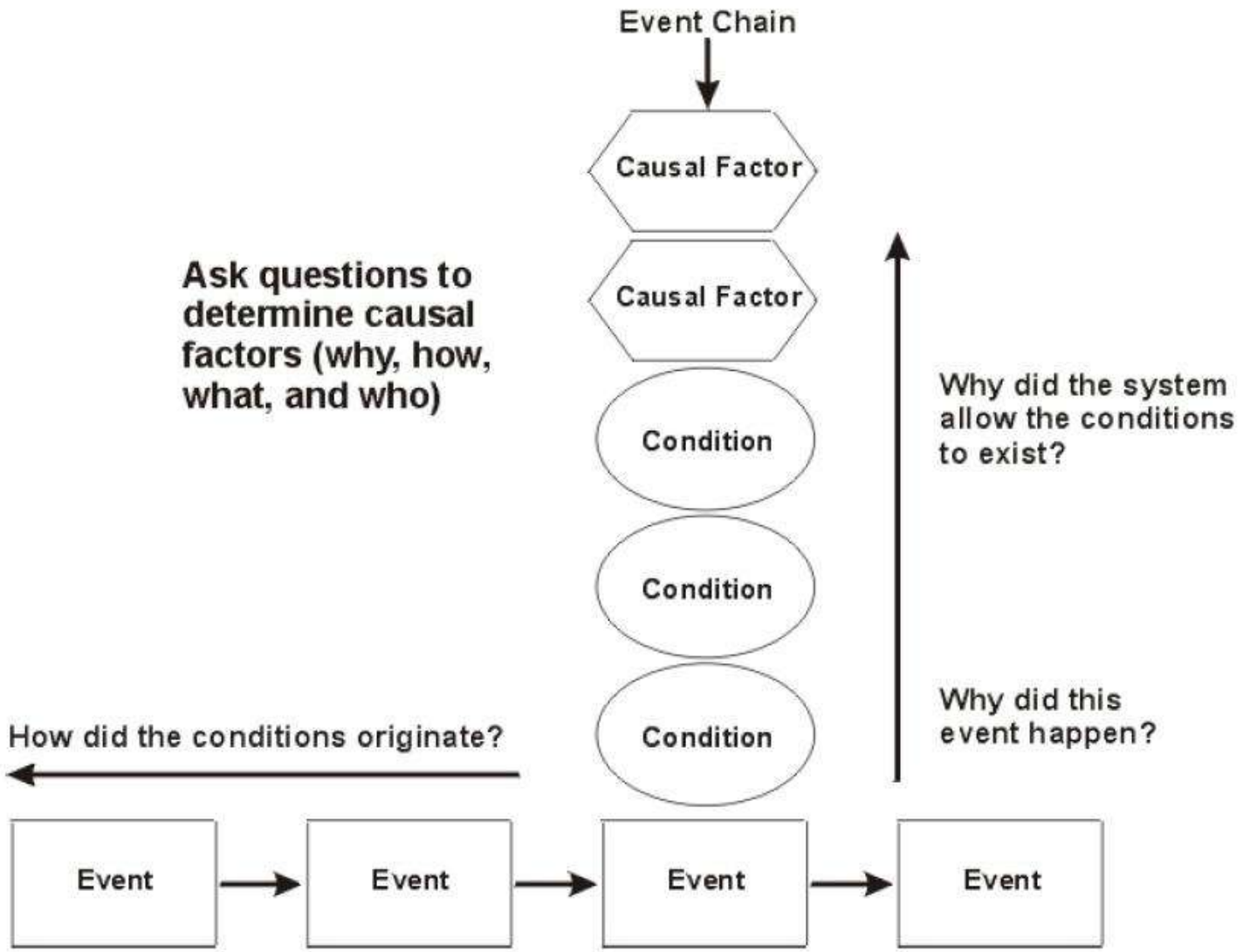

Types of Barriers
Physical Barriers
Conduit
Equipment and Engineering Design
Fences
Guard Rails
Masonry
Protective Clothing
Safety Devices
Shields
Warning Devices
Management Barriers
Hazard Analyses
Knowledge/Skills
Line Management Oversight
Requirements Management
Supervision
Training
Work Planning
Work Procedures

Barrier Analysis

Hazard: 13.2 kV electrical cable		Target: Acting pipefitter	
What were the barriers?	**How did each barrier perform?**	**Why did the barrier fail?**	**How did the barrier affect the accident?**
Engineering drawings	Drawings were incomplete and did not identify electrical cable at sump location	Engineering drawings and construction specifications were not procured Drawings used were preliminary No as-built drawings were used to identify location of utility lines	Existence of electrical cable unknown
Indoor excavation permit	Indoor excavation permit was not obtained	Pipefitters and utility specialist were unaware of indoor excavation permit requirements	Opportunity to identify existence of cable missed
Personal protective equipment	Personal protective equipment was not used	No hazard controls were required for jackhammering	Pipefitter not protected from electric shock

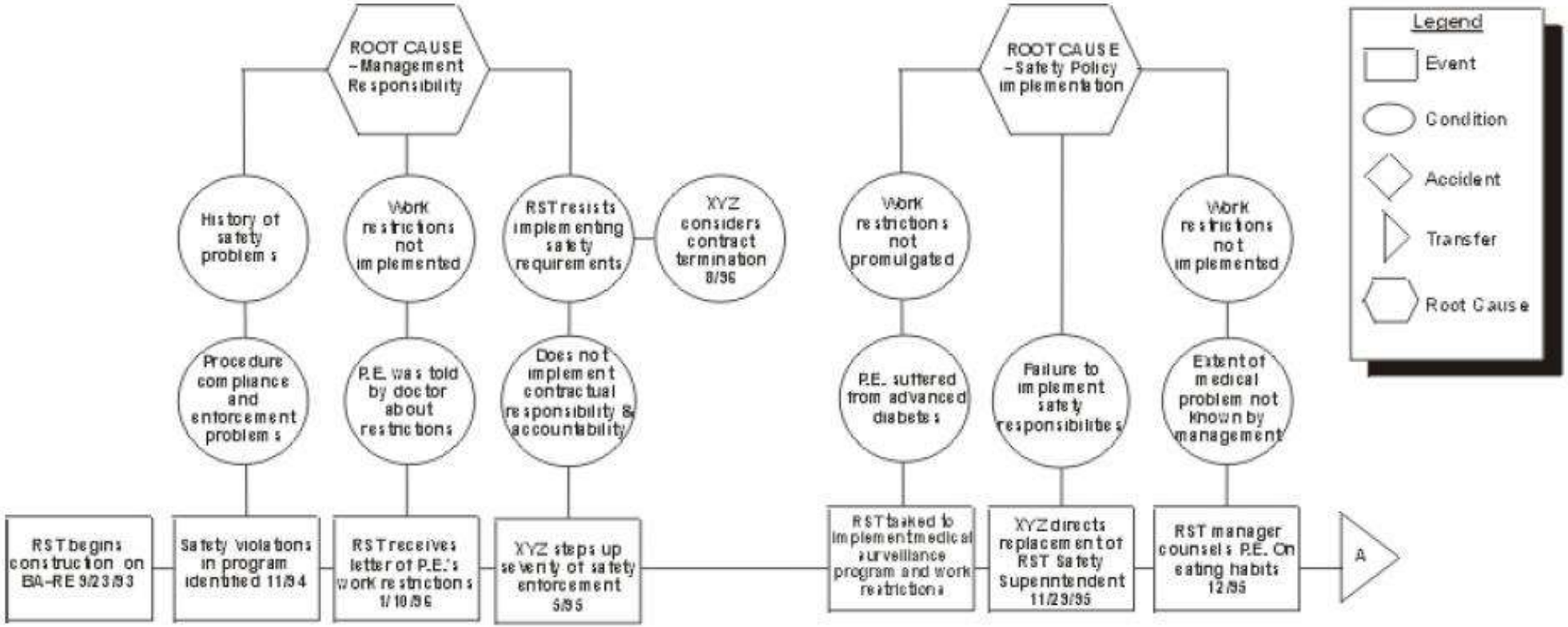
Πηγή: DOE (1999)

Events and Causal Factor Analysis



Πηγή: DOE (1999)

Events and Causal Factor Analysis

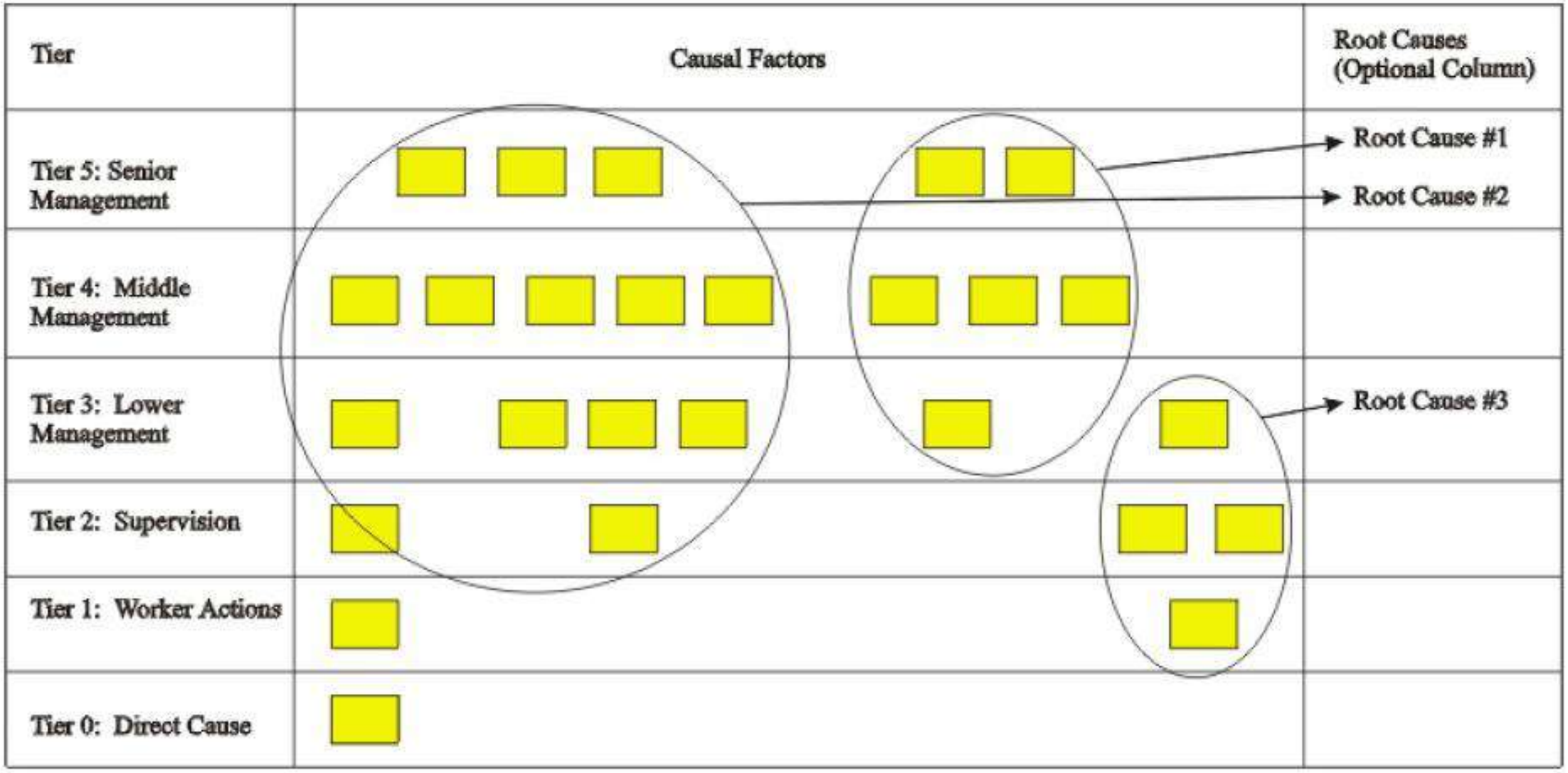


TIP

Not all event chains will produce causal factors. However, it is important to prepare a complete set of events in order to understand the circumstances leading up to the accident and to assure that all significant events have been identified.

Πηγή: DOE (1999)

Route Cause Analysis



Πηγή: DOE (1999)

Route Cause Analysis

Tier	Typical Integrated Safety Management Responsibilities	Sample Questions for Consideration in Assigning Causal Factors to Management Levels
Tier 3: Lower Management	■ Develop procedures to implement plans and programs ■ Ensure hazard awareness and communication ■ Oversee work planning and execution ■ Solicit and use worker input ■ Implement corrective actions	■ Were required procedures developed and kept current to assure a safe worker environment? ■ Did management implement required programs for worker safety? ■ Was management aware of problems regarding procedure implementation and compliance? ■ Was management involved in the work planning, control, and execution process? ■ Did management have a system for eliciting feedback on work-related hazards? ■ Did management take timely corrective actions when problems occurred or were identified? ■ Did management have a system for identifying and disseminating work process lessons learned? ■ Was stop-work authority defined for first line supervisors and their staff?
Tier 2: Supervision	■ Control the work scope ■ Identify hazards ■ Implement hazard controls ■ Authorize job/tasks ■ Provide feedback and lessons learned	■ Were supervisor's work instructions adequate to allow the work to be performed safely? ■ Was the work environment safe? ■ Were required procedures provided or communicated to the worker by supervision? ■ Did the supervisor provide feedback to management on prior incidents and/or safety concerns? ■ Did the supervisor discuss job hazards with the worker prior to starting work? ■ Did the supervisor implement timely corrective actions based on previous incidents? ■ Did the supervisor confirm the readiness to perform work prior to the execution of work? ■ Did the supervisor provide the worker with the proper tools and equipment to perform the work safely? ■ Did the supervisor define stop-work authority for workers?

Πηγή: DOE (1999)