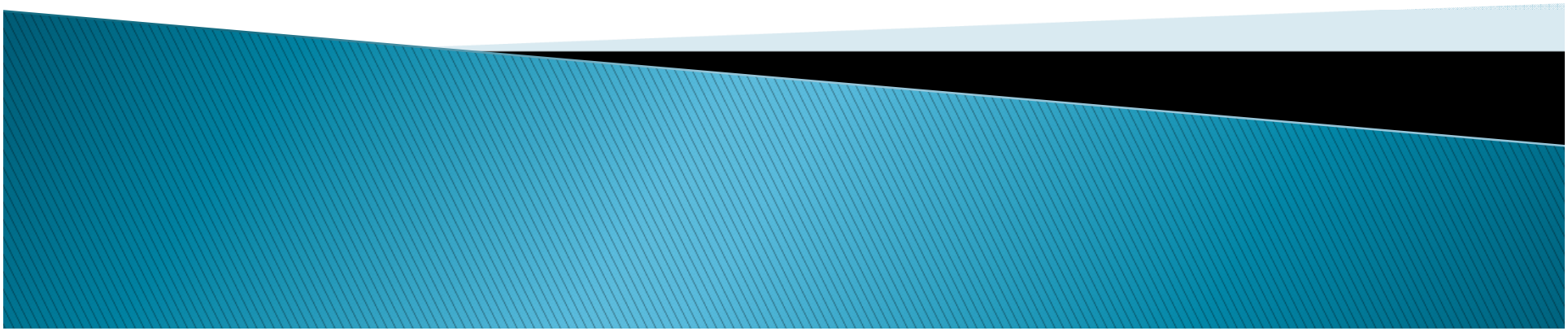
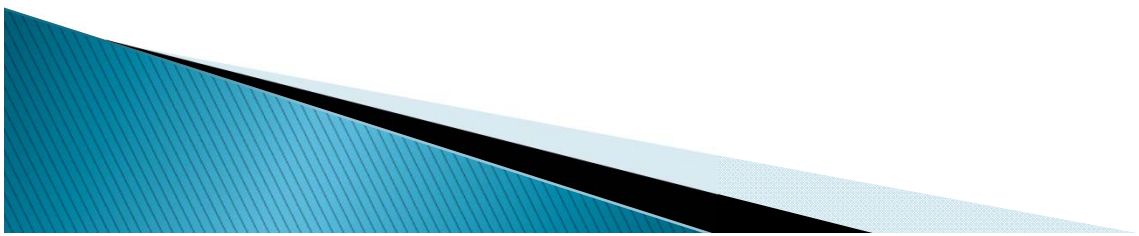
DC Metro Red Line Train Crash

Alix Martin



Washington Metro

- It is administered by the Washington Metropolitan Area Transit Authority (WMATA)
- Metro is the second-busiest rapid transit system in the United States in number of passenger trips, after the New York City Subway
- The 103-mile (166 km), 83-station system



2009 Washington Metro train collision

- Both six-car trains were headed toward downtown Washington. The first train, No. 214, stopped because a third train in front had stopped at the Fort Totten platform
- The second train, No. 112, came up behind it and "for reasons we do not know, plowed into that train".
- The Red Line is the busiest line on the Metro, and this crash reportedly initially caused by a six-car train happened around 5 pm, at the height of rush hour.
  - in between Takoma and Fort Totten

Investigation

- Possible failure of Metro's computerized signal system, which is designed to prevent trains from coming close enough to collide,

- Operator error, according to former Metro relatively inexperienced, ranking 18th from the bottom on the seniority list of 523 train operators. Had been a Metro employee since 2007

- There was no maintenance work scheduled in the relatively long, flat section of track between the stations. For many weeks, trains were slowed because of a weakness in the track bed that Metro said it repaired in spring.

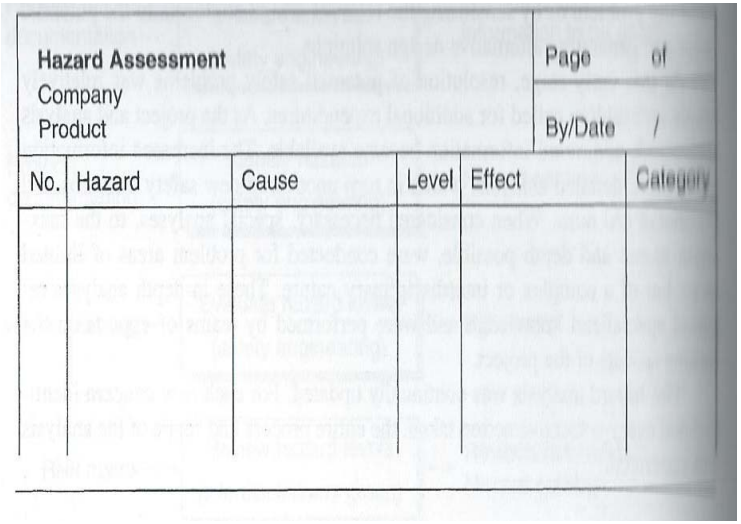
- Nine people died and dozens were injured when one train slammed into a stopped one.

- This is a really weird accident for two reasons:
  1) The system is pretty automated and will automatically stop the train if it gets too close to another one.
  2) The train operator should have applied the brakes long before the collision.

- Investigation
  1) The signal cables weren't working (same problem occurred on the blue/yellow line last week).
  2) The train operator was either texting or asleep.
  3) The breaks failed

An Underground Rail Station

- Hazard Identification and Assessment
  - Hazardous characteristics of the system (malfunctions or environmental).
  - A list of questions, called a *ticker list*, was used to help uncover hazards.
  - Hazard identification includes:
    - The hazards
    - The causes
    - The levels – six levels representing relative probability of occurrence of cause: Frequent, Moderate, Occasional, Remote, Unlikely, Impossible
    - The effects – four categories representing severity of effect: Catastrophic, Critical, Marginal, Negligible
    - The categories – establishes priorities for identified hazards.
  - The number in the boxes represent the criticality.
  - An arbitrary breakpoint called the protection level helps define the in depth risk reduction efforts will be for concentrated hazards.

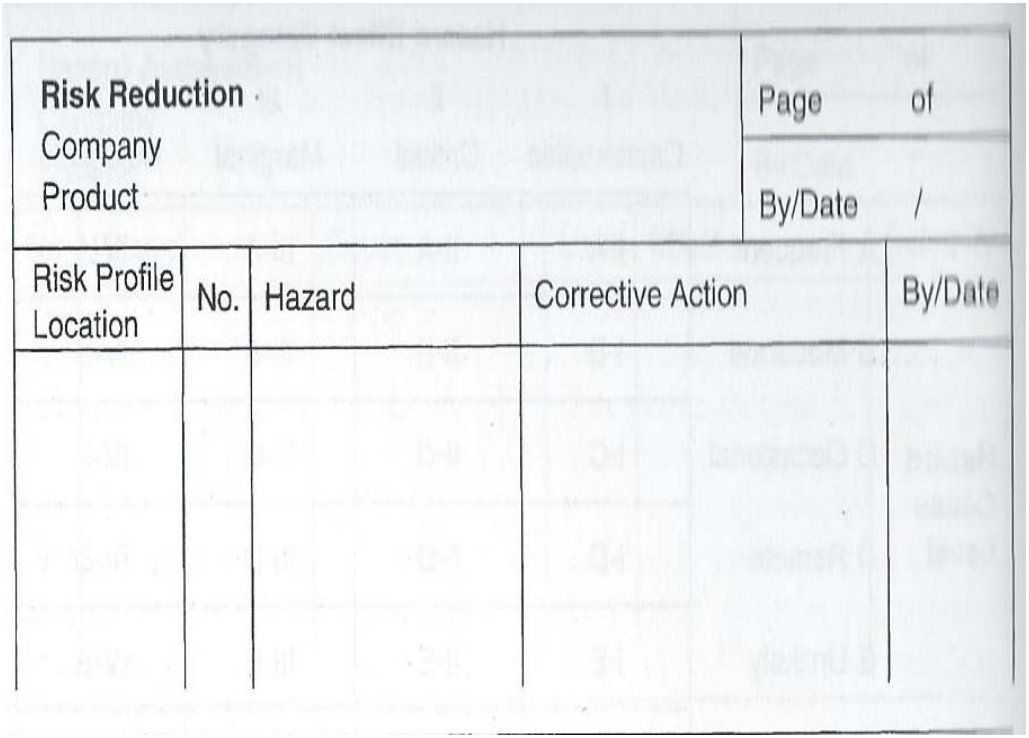


Hazard Assessment				Page of
Company				
Product				By/Date /
No.	Hazard	Cause	Level	Effect	Category

Hazard Cause Level	Hazard Effect Category I Catastrophic	II Critical	III Marginal	IV Negligible
A Frequent	I-A	II-A	III-A	IV-A
B Moderate	I-B	II-B	III-B	IV-B
C Occasional	I-C	II-C	III-C	IV-C
D Remote	I-D	II-D	III-D	IV-D
E Unlikely	I-E	II-E	III-E	IV-E
F Impossible	I-F	II-F	III-F	IV-F

An Underground Rail Station

- Risk Reduction
  - Efforts are made to protect against the possible hazardous conditions or events.
  - Each hazard is documented and assigned to specialists or departments that can help risk reduction.
  - Recommended risk reduction measures are cataloged with corrective actions.



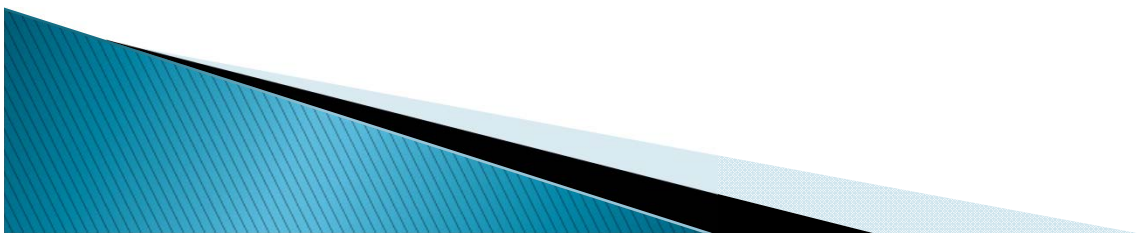
Risk Reduction Company Product			Page of By/Date /	
Risk Profile Location	No.	Hazard	Corrective Action	By/Date

Hazard Analysis Techniques

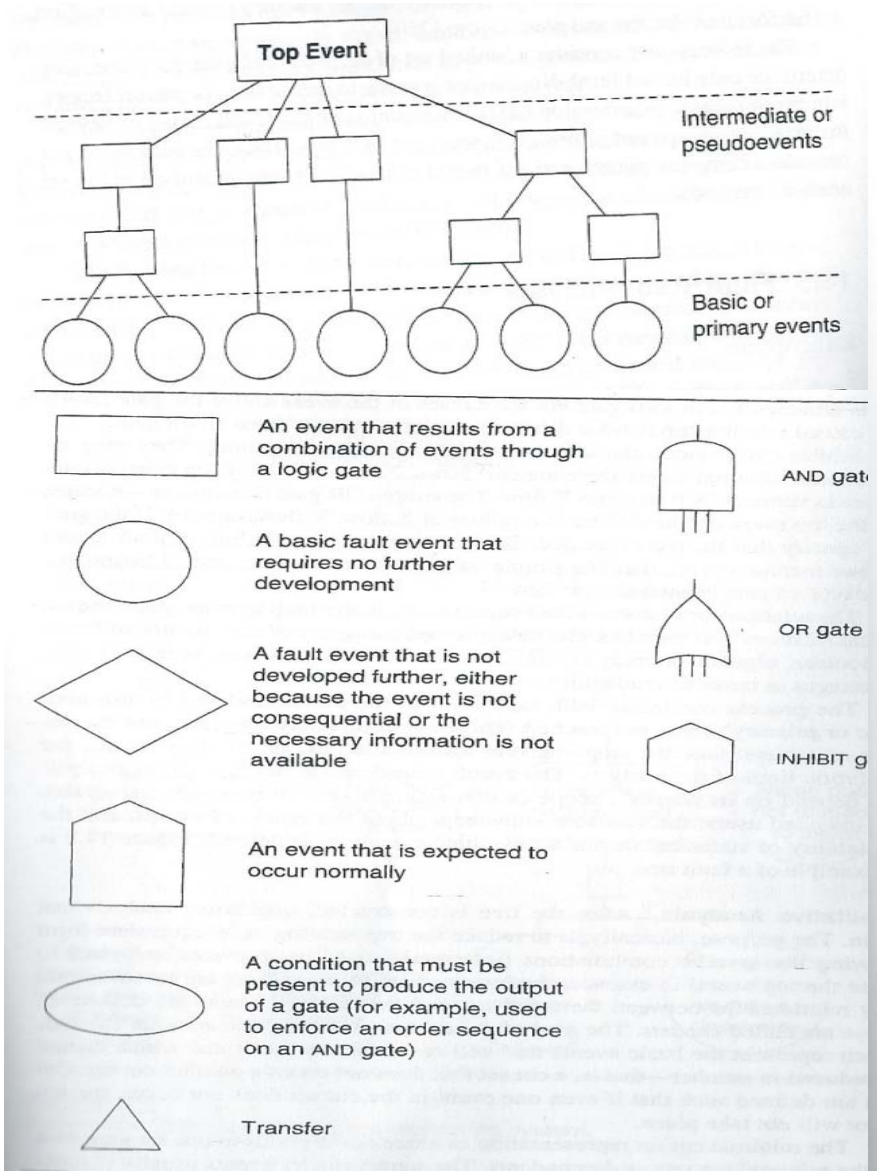
- Auto mode when they crashed, which means there was a failure of the trackside monitoring devices
  - coupled with an operator who was either distracted or impaired in such a way so as to prevent her from hitting the emergency brake.

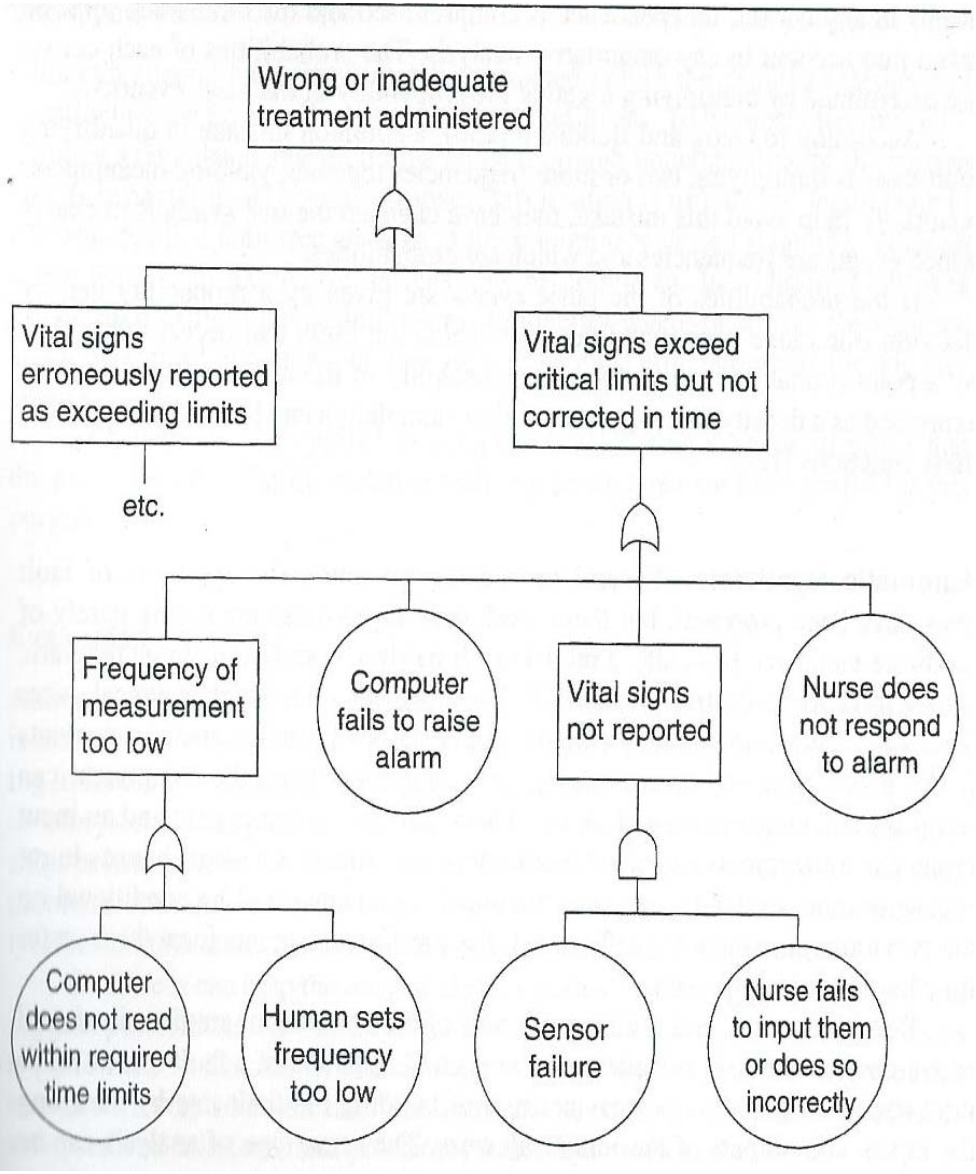
- But was hazard analysis conducted on reported system malfunctions?
  - No. If hazard analysis was conducted systematically on all reported malfunctions there would have been a better safety culture.

- Do you have a top 10 list of actions to improve safety?
  - and, if so, 'Why those 10'



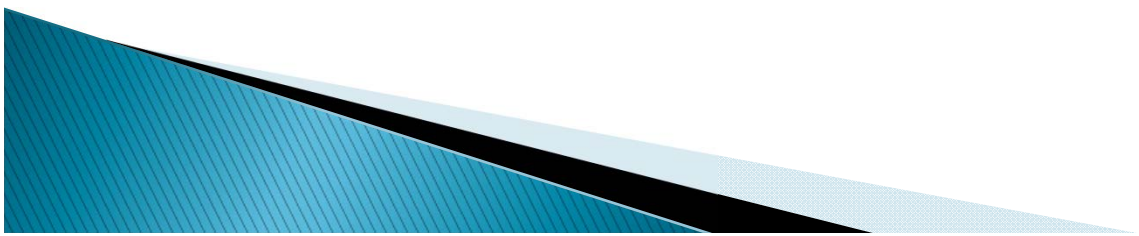
Fault Tree Analysis



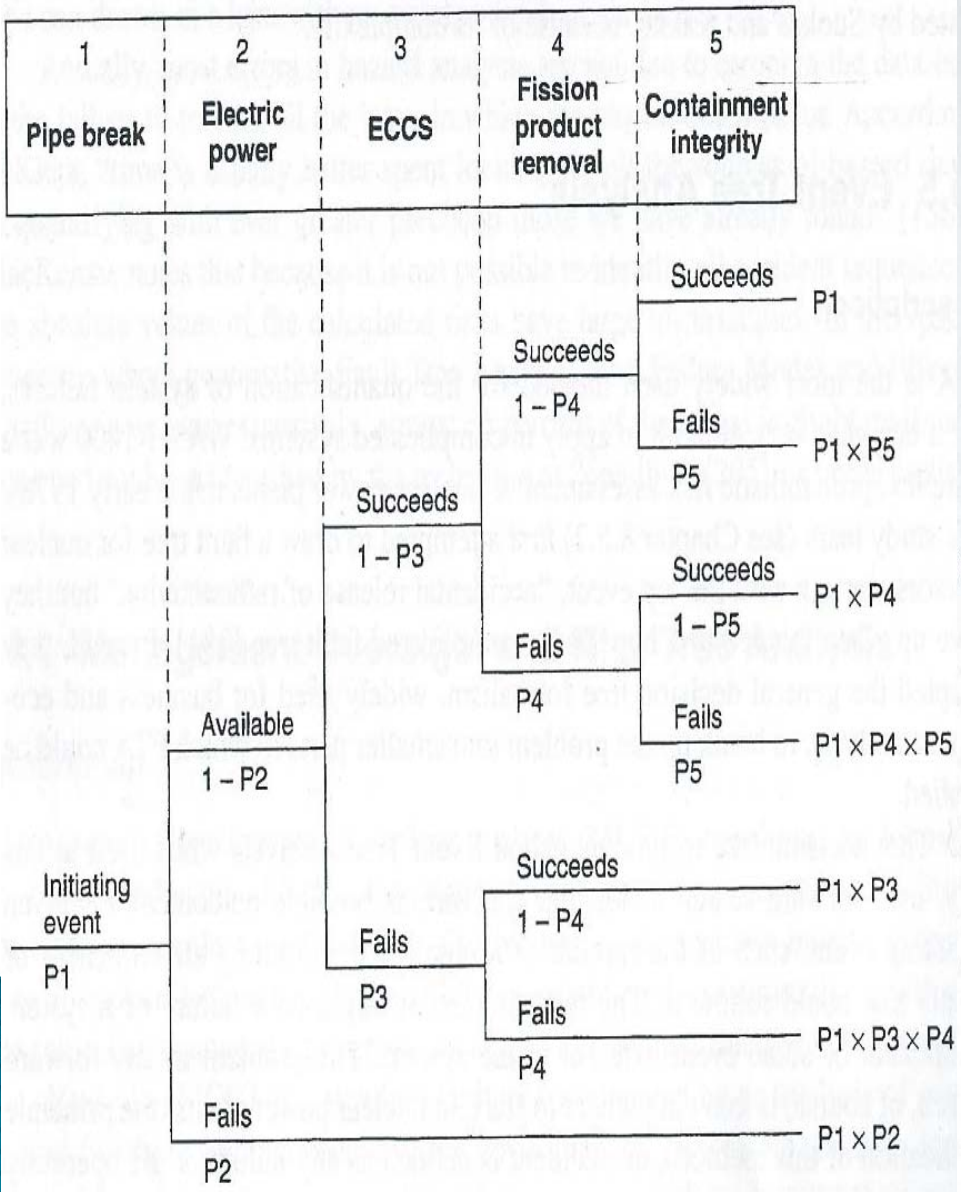


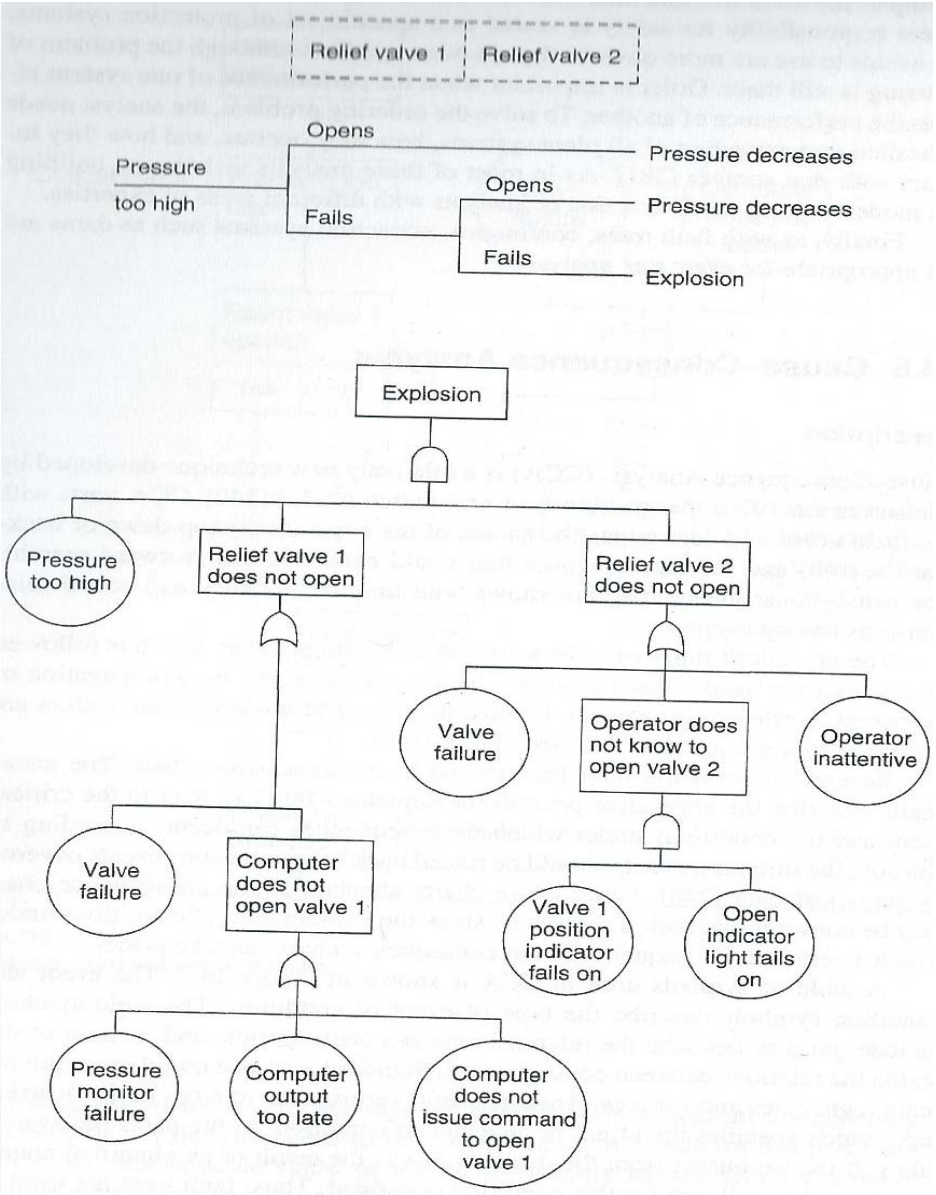
Management Oversight and Risk Analysis

- MORT developed for the U.S Nuclear Regulatory Agency
  - Used for accident investigation, hazard analysis
  - Emphasis on management and human factors
- Assumes accidents are caused by mishandled changes to the system leading to uncontrolled energy
- MORT is a fault tree arranged by
  - Analysis of managerial functions
  - Human behavior
  - Environmental factors
- Yields useful information on planning and coordination of activities (Maintenance team, Design and plan team, Information systems)



Event Tree Analysis

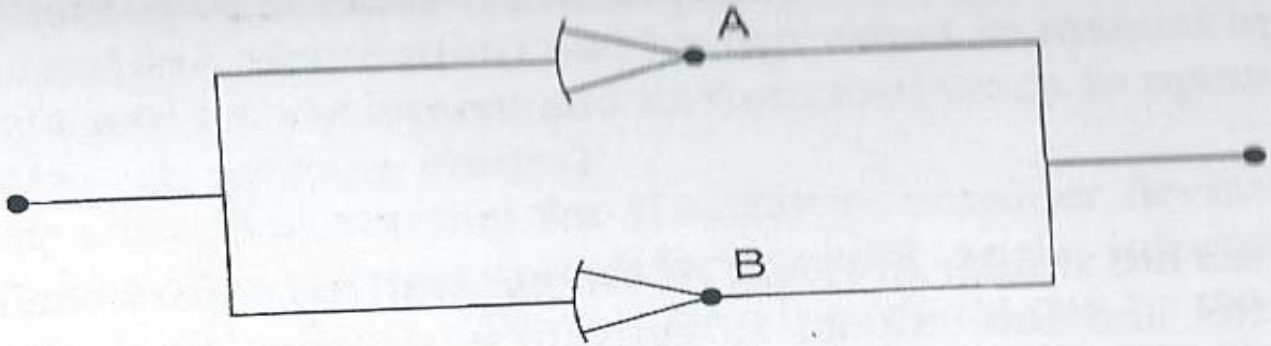




Failure Modes and Effects Analysis

- Initiating events are failures of individual components
- List all components and their failure modes
- For their failure mode, the effect on components or whole system
- Then probabilities and seriousness of each failure mode are calculated
- Results are documented in a table with column headings
- Great for hardware items, effective for analyzing single unit failures to enhance individual item integrity

Failure Modes and Effects Analysis



Critical	Failure probability	Failure mode	% failures by mode	Effects	
				Critical	Noncritical
A	1×10^{-3}	Open	90		X
		Short	5	5×10^{-5}	
		Other	5	5×10^{-5}	
B	1×10^{-3}	Open	90		X
		Short	5	5×10^{-5}	
		Other	5	5×10^{-5}	

Failure Modes, Effects, and Criticality Analysis

- More detailed analysis of the criticality of the failure
- Displays description of means of control
- Sometime Critical Items List (CIL) are

Failure Modes and Effects Criticality Analysis

Subsystem _____ Prepared by _____ Date _____

Item	Failure Modes	Cause of Failure	Possible Effects	Prob.	Level	Possible Action to Reduce Failure Rate or Effects
Motor Case	Rupture	a. Poor workmanship b. Defective materials c. Damage during transportation d. Damage during handling e. Overpressurization	Destruction of missile	0.0006	Critical	Close control of manufacturing processes to ensure that workmanship meets prescribed standards. Rigid quality control of basic materials to eliminate defectives. Inspection and pressure testing of completed cases. Provision of suitable packaging to protect motor during transportation.

Conclusion

- Hazard analysis, conducted systematically, is the central discipline in safety management, and it is missing at WMATA…
- Improvements and updates on past techniques have been applied.
- The National Transportation Safety Board deemed the problem to be a lack of safety culture.