

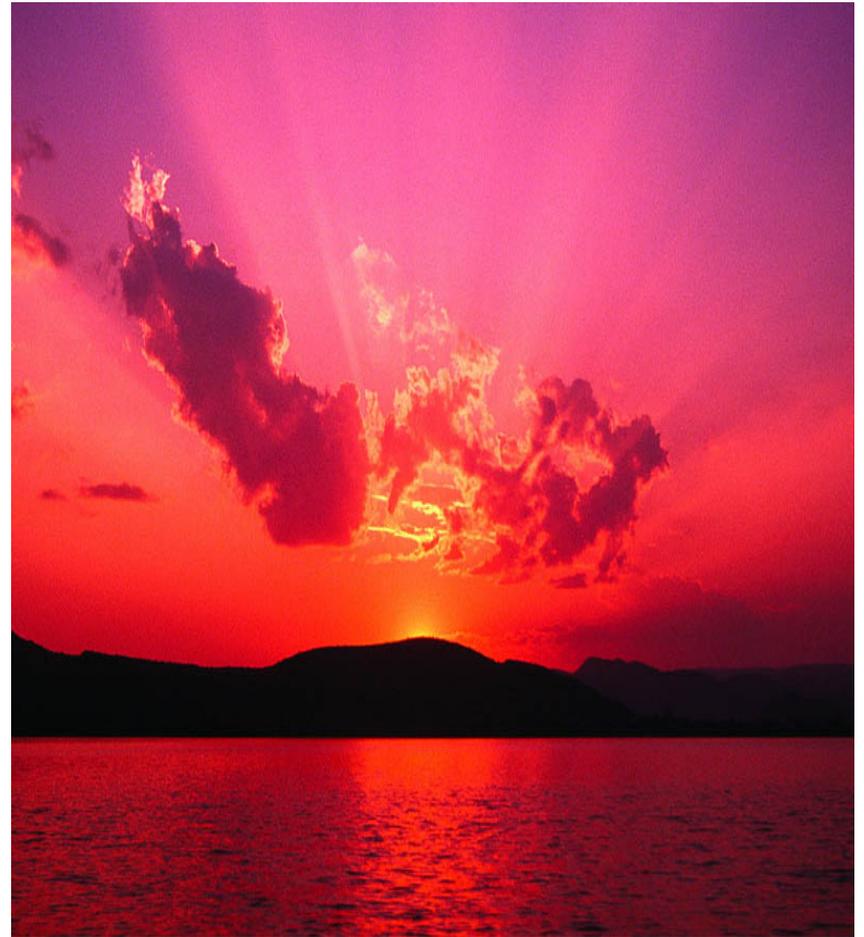
# Starting With the End in Mind

## A Systematic Approach to Producing Better EALs, Beginning With the EPHA

Jim Jamison

SAIC

Richland, Washington



# Starting With the End In Mind

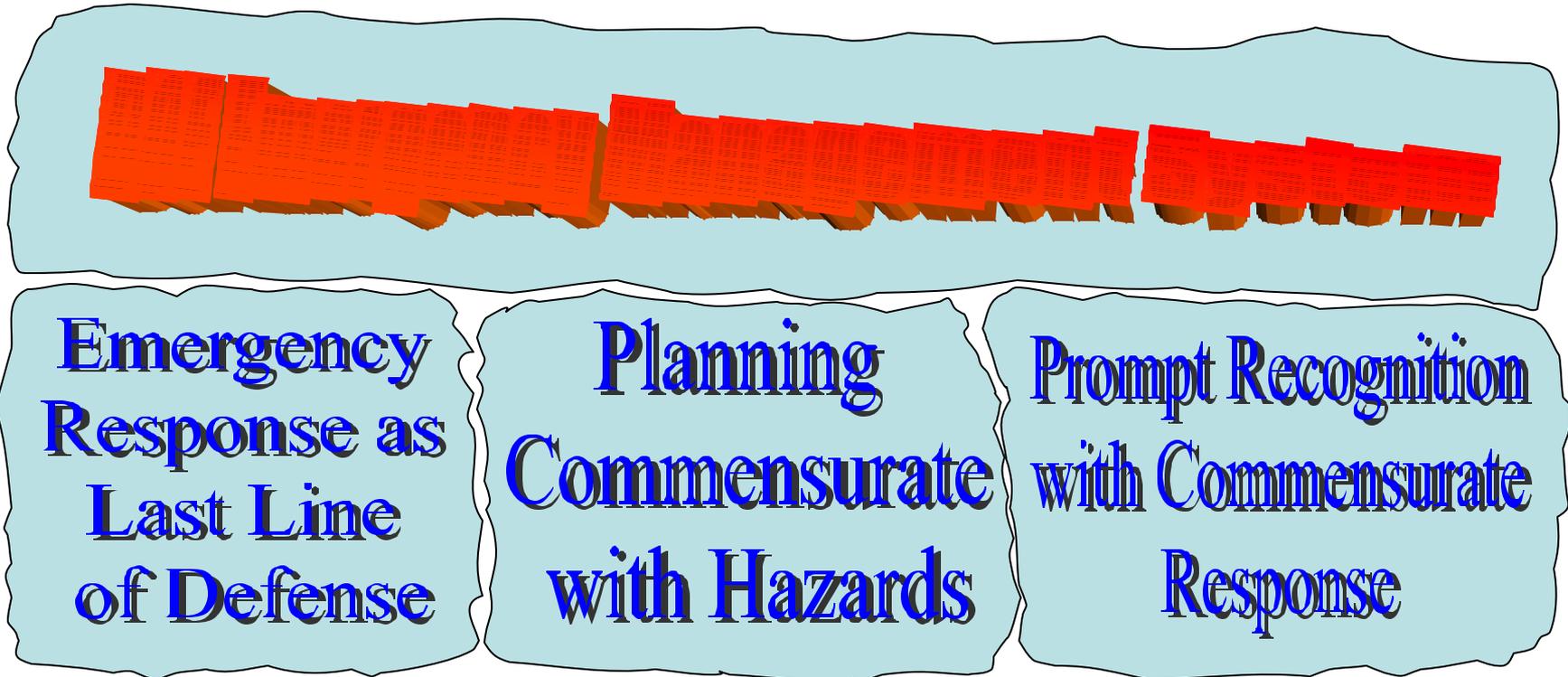


**Emergency  
Response as  
Last Line  
of Defense**

**Planning  
Commensurate  
with Hazards**

**Prompt Recognition  
with Commensurate  
Response**

# Starting With the End In Mind



# Objective



Improve EAL Quality and Performance by:

- Selecting best EPHA analysis cases
- Documenting logical basis for EALs
- Reducing EAL structural and human factors flaws

# Outline



1. The Destination: Where we are headed
2. Recurring EAL Quality and Performance Issues
3. Selecting EPHA Analysis Cases
4. Documenting the logical basis for EALs
5. Making EALs that Work

# Part 1: The Destination



*Where we are headed?*

# The Destination



## *Why classify emergencies?*

1. Initiate a set of actions appropriate to all events of a given class
2. Activate analytical and decision-making capabilities
3. Help keep conditions from becoming more severe

# The Destination



*Classification should provide for*

1. Prompt notification of minor events
2. Mobilization of resources to manage the event/arrest safety degradation
3. Lead time to activate response facilities and prepare for protective actions
4. Protection of public and employees in event of release
5. Prompt and accurate flow of information

# The Destination



*A good classification system should be*

**Timely:** If possible, classification of a degrading safety condition should occur early enough in the progression of events that effective use of emergency response resources can arrest the degradation or reduce consequences.

# The Destination



*A good classification system should be*

**Reliable:** Classification should be based upon indications that are consistently associated with the event/condition, and have whenever possible, a direct correlation to the severity of the event.

# The Destination



*A good classification system should be*

**Internally consistent:** Different events of a similar severity should result in the same classification. Different indications of the same event/condition should lead to the same classification decision.

# The Destination



*A good classification system should be*

**Anticipatory:** Classification should be based on a conservative projection of the likely progression and future consequences of an event or condition, not just the situation as it exists at the time it is recognized.

# The Destination



*A good classification system should be*

**Redundant:** If possible, there should be several different indications and criteria by which any given emergency condition can be recognized and classified.

# The Destination



*A good classification system should be*

**Complete:** The event classification system should provide for recognition and classification of the full range of emergency events and conditions that are identified for a facility/site.

# The Destination



*A good classification system should be*

**Conservative:** Where detailed or quantitative information is lacking, events should be classified on the basis of conservative estimates of conditions and consequences.

# The Destination



*A good classification system should be*

**Usable:** Event classification methods should incorporate sound human engineering principles (e.g., express EALs in units consistent with instrument readings and standard usage, use consistent and familiar format, place all necessary information and references in one location, use color coding or other pointers).

# The Destination



*A good classification system should be*

**Integrated:** Event recognition and classification should be integrated with normal and off-normal operations practices. Entry points into the event classification procedure should be identified in procedures. Instrument readings, checklists, safety notes and precautionary statements in procedures, and other operational practices that support emergency recognition/classification should be identified.

# Part 2: Bumps in the Road



EAL Quality and Performance Issues

# EAL Quality/Performance Issues



## EALs: One component of a System

### 1. The decisionmaker

- Qualifications & Experience
- Scope of classification responsibility
- Training
- Practice, practice, practice

# EAL Quality/Performance Issues



## One component of a System (cont.)

### 2. The EAL procedure

- Structure and organization of EALs (tables, etc.)
- Instructions for finding & using EALs
- Interpretation, conflict resolution

# EAL Quality/Performance Issues



## One component of a System (cont.)

3. The decision environment
  - Information availability?
  - Support staff availability?
  - Conflicting priorities & duties?

# EAL Quality/Performance Issues



## **Availability and timeliness of inputs:**

EALs need to be expressed in terms of indications and data that will be available and accessible to the decisionmaker before, during or very soon after the event or condition occurs.

# EAL Quality/Performance Issues



Example (Availability and timeliness of inputs)

*Confirmed earthquake of magnitude 7.0.  
Building collapse, releasing (hazardous material) from (containers and equipment).*

# EAL Quality/Performance Issues



**Specificity and clarity:** EALs need to leave as little latitude as possible for interpretation (or misinterpretation).

# EAL Quality/Performance Issues



Example (Specificity and clarity)

*Unmitigated fire – combustible loading allows fire to continue and (hazardous material) close enough to fire to be affected.*

# EAL Quality/Performance Issues



**Detail/complexity (vs ease of use):** Expressing EALs in terms of several different facts and logical (and/if/or) connections makes it more difficult to use and subject to error or misuse.

# EAL Quality/Performance Issues



Example (Detail/complexity – part 1 of 3)

*Explosion in the (tank 1, 2 or 3) with releases from the building at ground level, indicated by:*

- *Confirmation of an explosion in a tank via:  
Tank pressure spike range high (Tank 1 pressure: P11234), Tank 2 pressure: P15678)*

**OR**

- *Blast sounds*

# EAL Quality/Performance Issues



Example (part 2 of 3)

## **AND**

- *Confirmation of unfiltered ground level release via:*

*Filter Inlet Plenum Pressure PAH (DCS: PI1357:  
Local: PIC2468)*

## **AND**

- *Loss of building/ventilation system confinement*

# EAL Quality/Performance Issues



Example (part 3 of 3)

**OR**

- *Confirmation of a filtered ground level release via:*

*Filter Inlet Plenum Pressure (DCS: PI9932;  
Local: PI9945)*

**AND**

- *Loss/bypass of stack*

# EAL Quality/Performance Issues



**EAL specific to analyzed case:** An EAL that reflects a very specific analyzed scenario may not be very useful for slightly different conditions having the same consequences.

# EAL Quality/Performance Issues



Example (EAL specific to analyzed case)

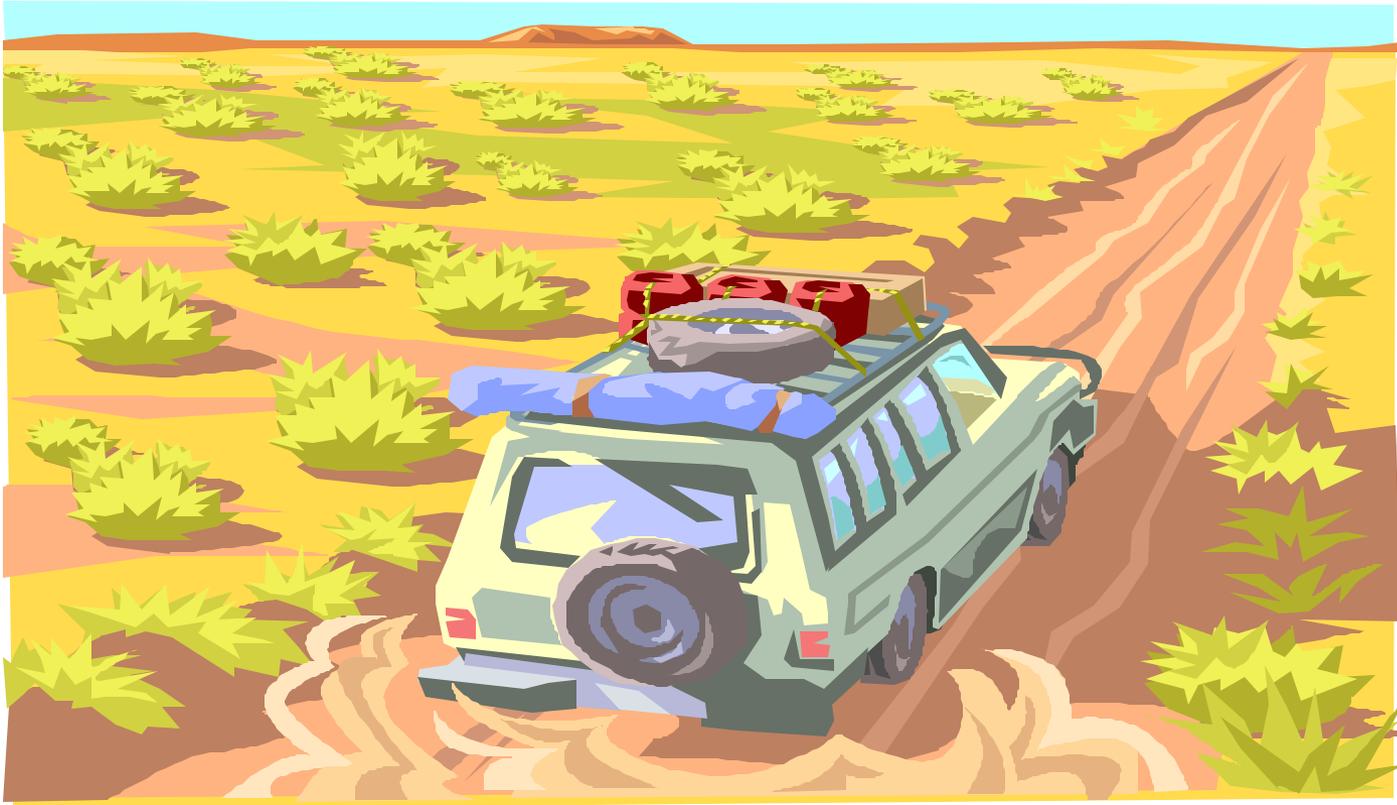
*Seismic or Wind Event Causes Building to Collapse and a Hydraulic Oil Fire*

*(1) Leak on hydraulic system sprays oil at high pressure*

*(2) Resulting fire impinges on the sample*

*(3) (Hazardous material) sample melts and partially vaporizes*

# Part 3: Starting Right



## Selecting EPHA Analysis Cases

# Selecting EPHA Analysis Cases



## Background

- EAL flaws due to EPHA analysis cases
- EPHA case selection often intuitive
- Defense of EPHA case selection

# Selecting EPHA Analysis Cases



## Background

- Improve EPHA cases → better EALs
- Improve case selection → more complete EAL coverage
- Improve selection process → defensible planning basis

# Selecting EPHA Analysis Cases



Select EPHA cases by considering:

- MAR & barrier
- Barrier failure mode
- Initiating event
- Release path/release conditions
- Recognition factors (indications)
- Consequences

# Selecting EPHA Analysis Cases



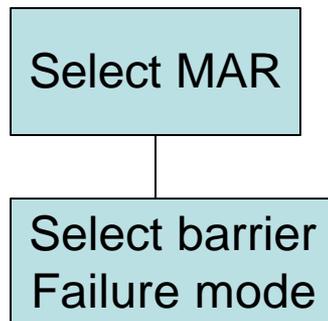
Model approach

Select MAR

# Selecting EPHA Analysis Cases



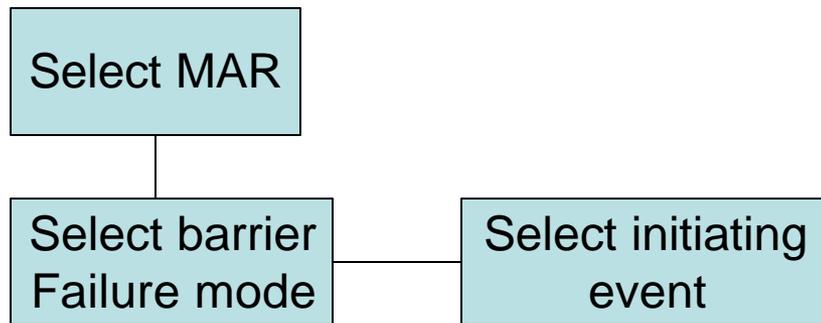
## Model approach



# Selecting EPHA Analysis Cases



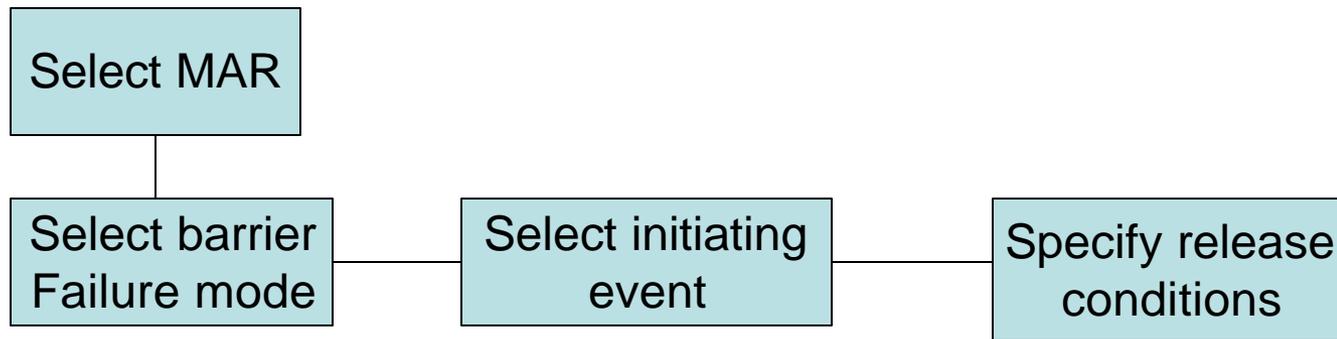
## Model approach



# Selecting EPHA Analysis Cases



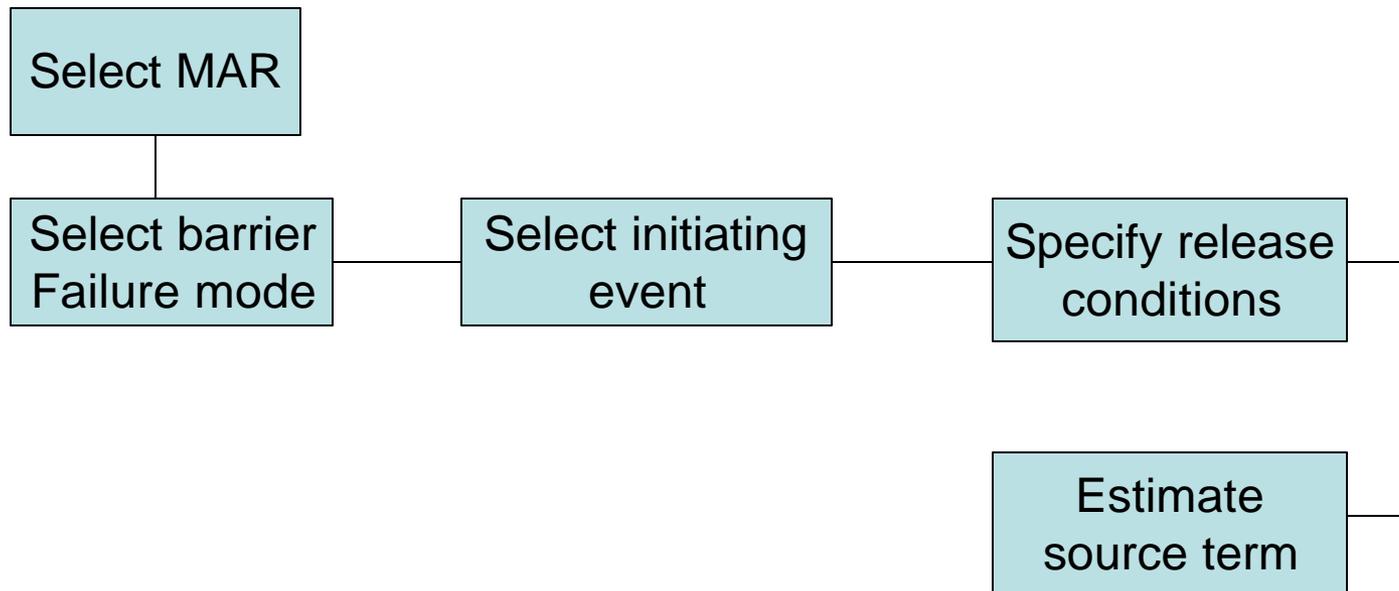
## Model approach



# Selecting EPHA Analysis Cases



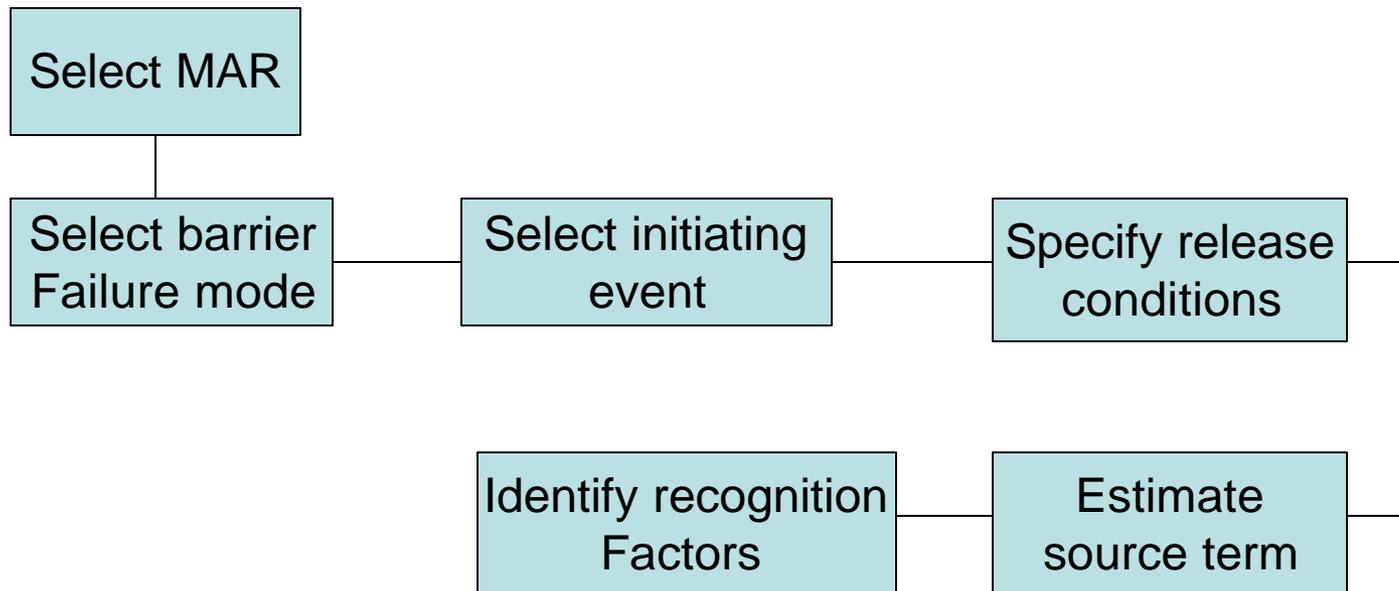
## Model approach



# Selecting EPHA Analysis Cases



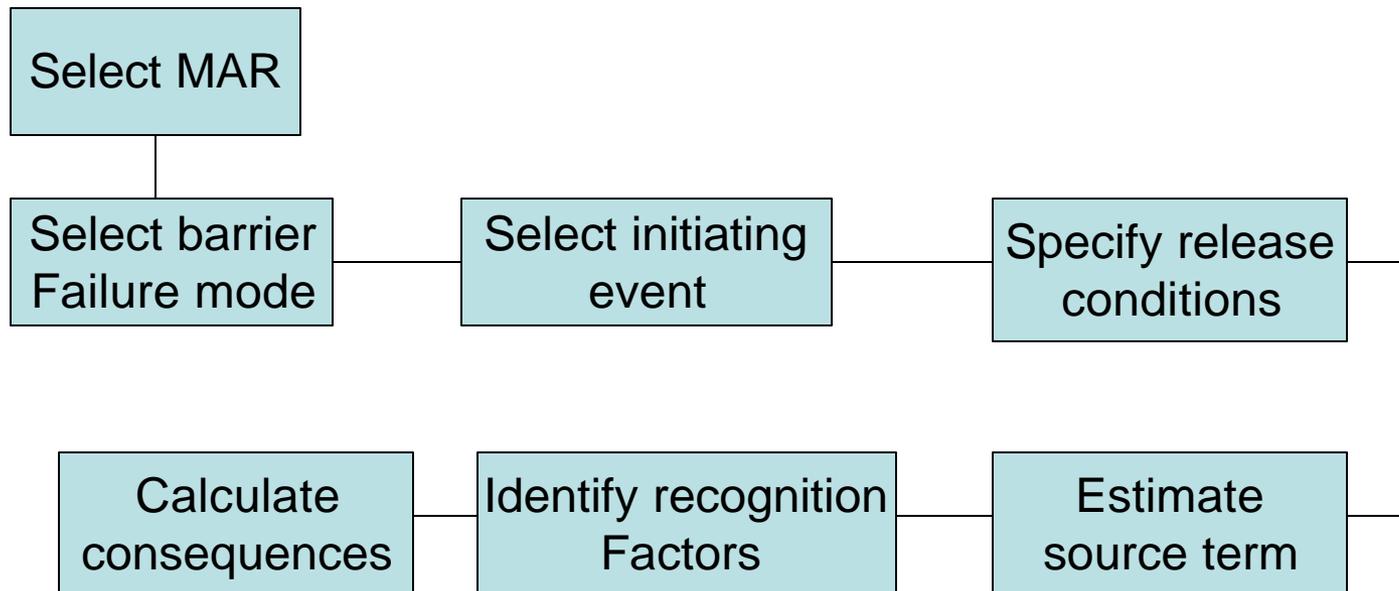
## Model approach



# Selecting EPHA Analysis Cases



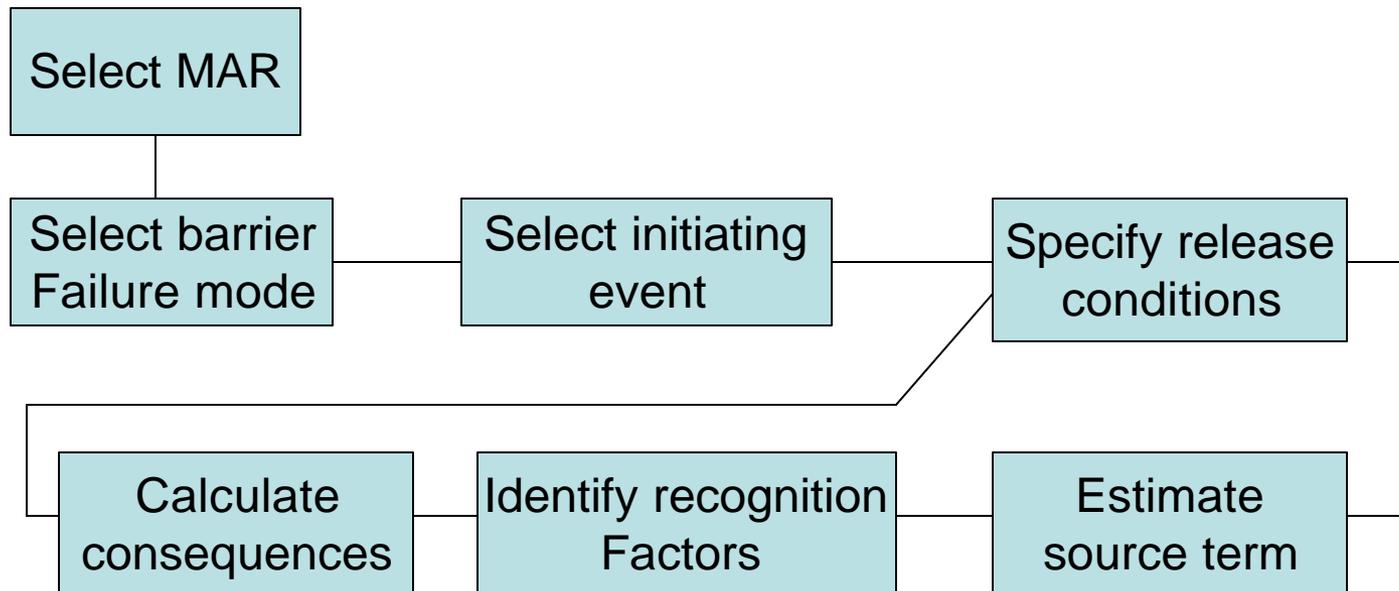
## Model approach



# Selecting EPHA Analysis Cases



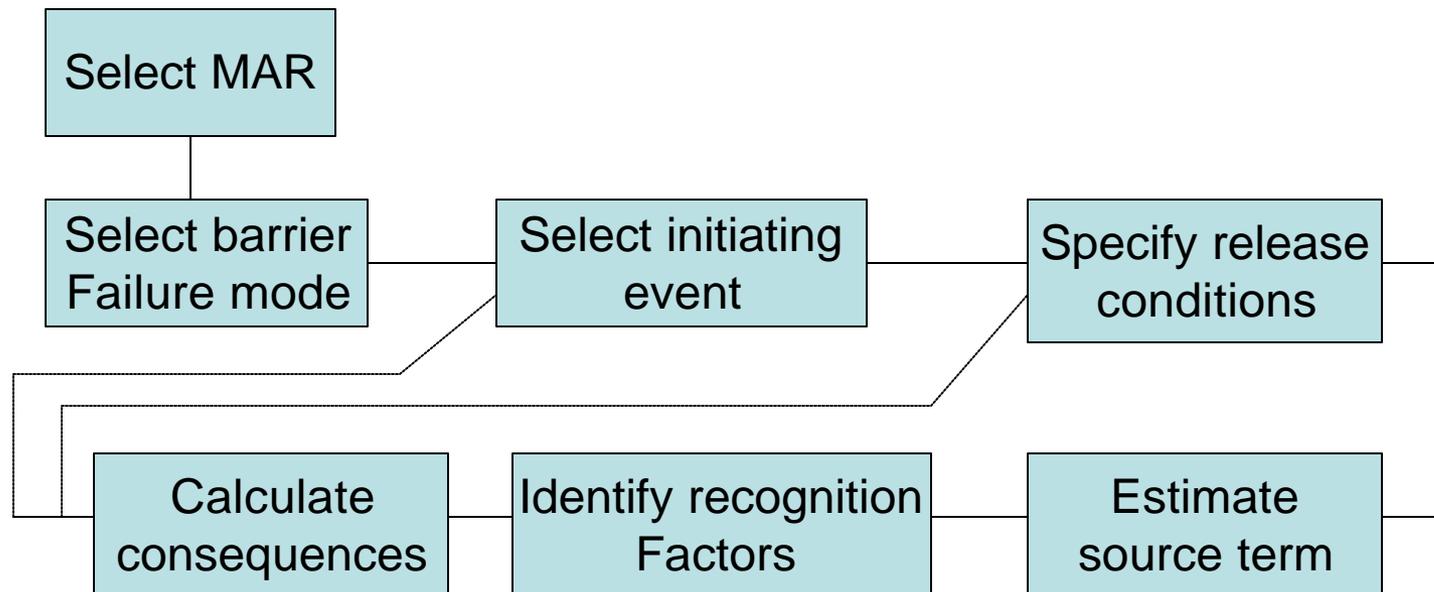
## Model approach



# Selecting EPHA Analysis Cases



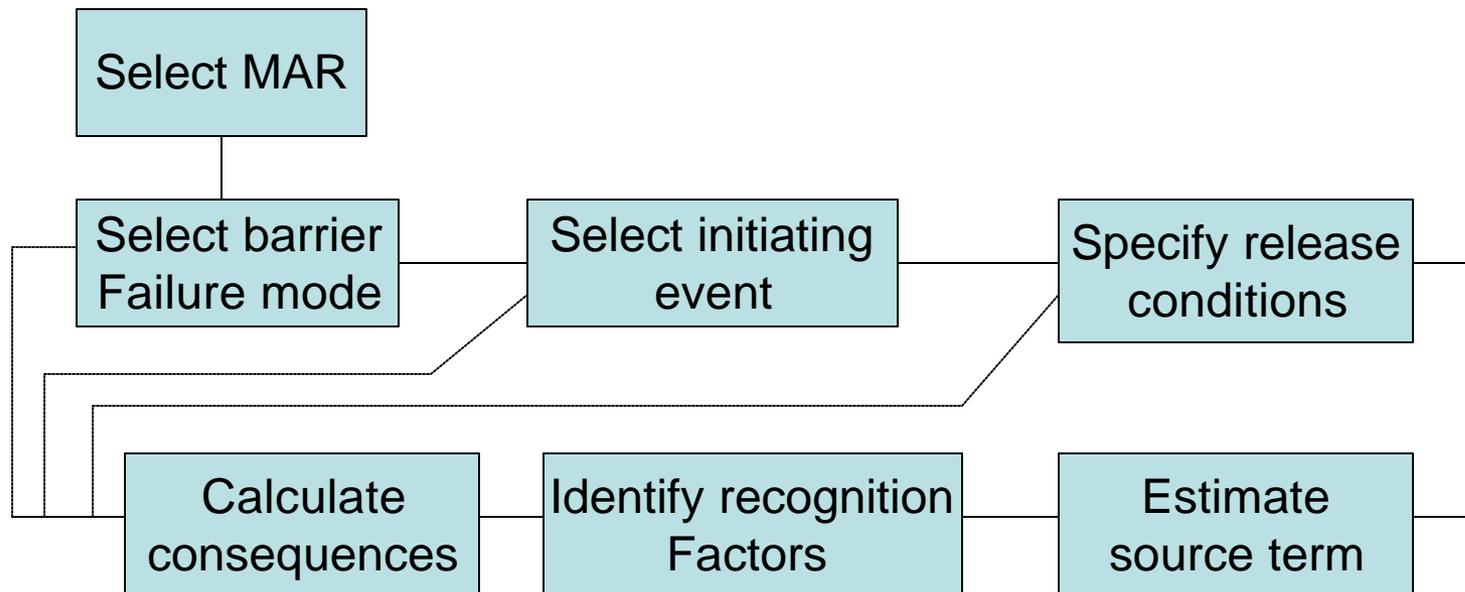
## Model approach



# Selecting EPHA Analysis Cases



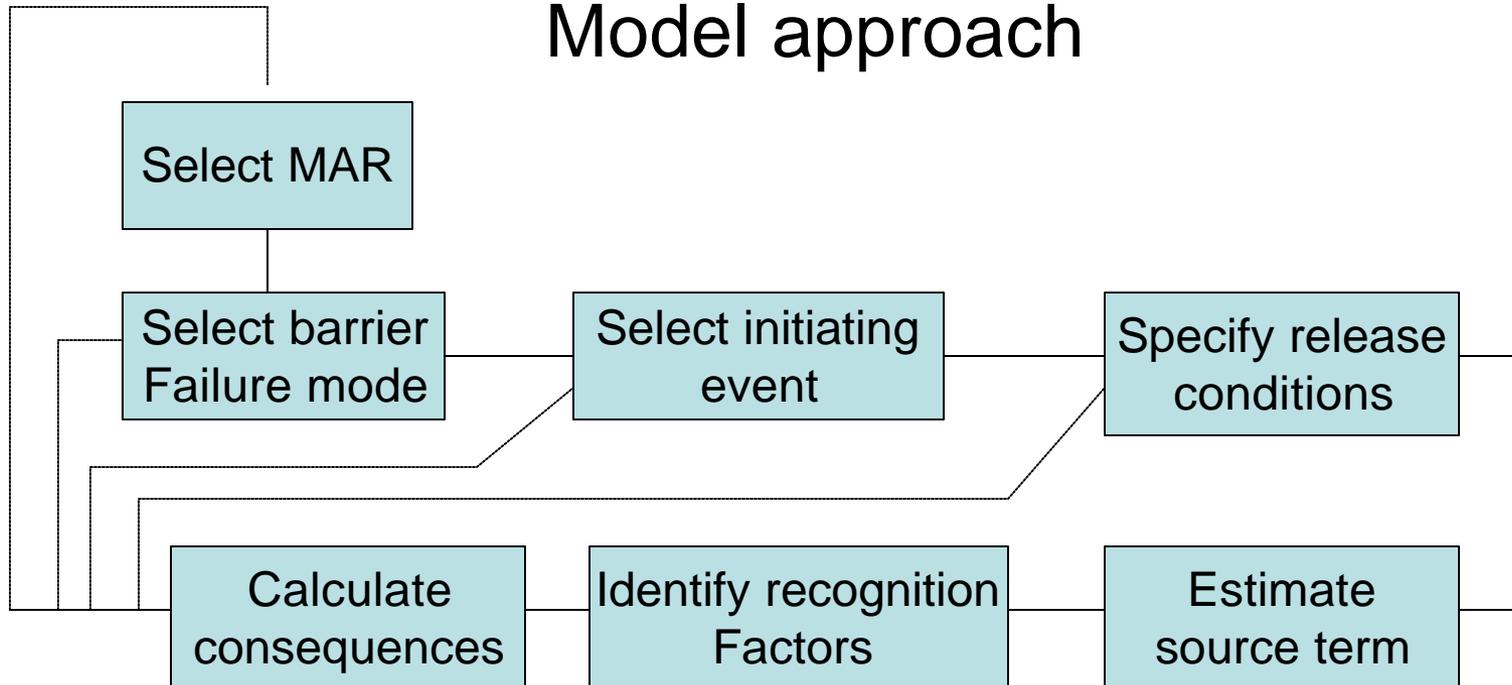
## Model approach



# Selecting EPHA Analysis Cases



## Model approach



# Selecting EPHA Analysis Cases



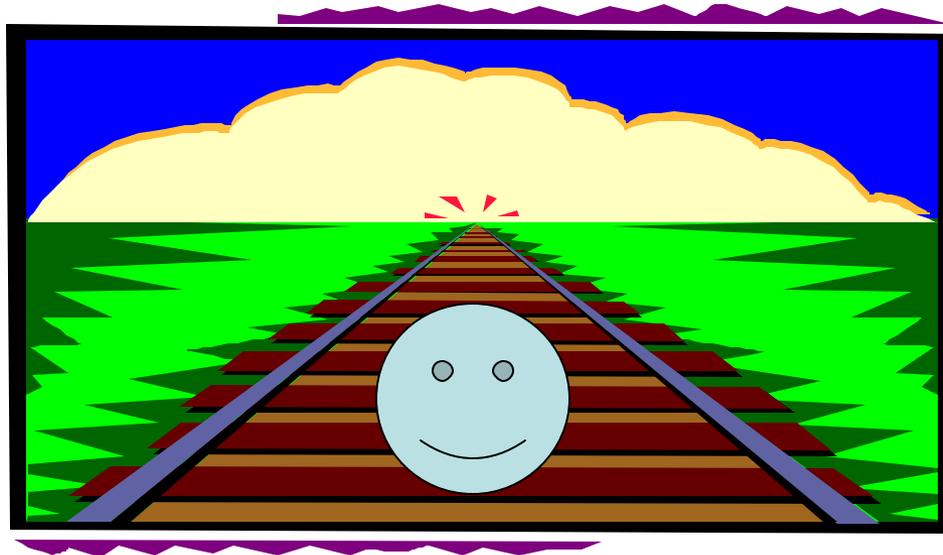
## Model approach

- Methodical and rigorous
- “Pairing” each MAR with other factors
- Proof that “spectrum” fully considered

# Selecting EPHA Analysis Cases



Recognition factors and case selection, or



How will I recognize this train if it's coming at me?

# Selecting EPHA Analysis Cases



And what happens if I don't?

# Selecting EPHA Analysis Cases

Mode 1 (puncture, lid loss)	
Mode 2 (crush)	

# Selecting EPHA Analysis Cases

Mode 1 (puncture, lid loss)	IC11
	IC12
Mode 2 (crush)	IC21
	IC22

# Selecting EPHA Analysis Cases

Mode 1 (puncture, lid loss)	IC11	RC111
		ST/ CONS111 RF111
	IC12	RC121
		ST/CONS121 RF121
Mode 2 (crush)	IC21	RC211
		ST/CONS211 RF211
	IC22	RC221
		ST/CONS221 RC221

# Selecting EPHA Analysis Cases

Mode 1 (puncture, lid loss)	IC11	RC111	RC112
		ST/ CONS111	ST/ CONS112
		RF111	RF112
	IC12	RC121	RC122
		ST/CONS121	ST/CONS122
		RF121	RF122
Mode 2 (crush)	IC21	RC211	RC212
		ST/CONS211	ST/CONS212
		RF211	RF212
	IC22	RC221	RC222
		ST/CONS221	ST/CONS222
		RC221	RC222

# Selecting EPHA Analysis Cases

Mode 1 (puncture, lid loss)	IC11	RC111	RC112	RC113
		ST/ CONS111	ST/ CONS112	ST/ CONS113
		RF111	RF112	RF113
	IC12	RC121	RC122	RC123
		ST/CONS121	ST/CONS122	ST/CONS123
		RF121	RF122	RF123
Mode 2 (crush)	IC21	RC211	RC212	RC213
		ST/CONS211	ST/CONS212	ST/CONS213
		RF211	RF212	RF213
	IC22	RC221	RC222	RC223
		ST/CONS221	ST/CONS222	ST/CONS223
		RC221	RC222	RC223

# Selecting EPHA Analysis Cases

Mode 1 (puncture, lid loss)	IC11	RC111	RC112	RC113
		ST/CONS111	ST/CONS112	ST/CONS113
	IC12	RF111	RF112	RF113
		RC121	RC122	RC123
Mode 2 (crush)	IC21	ST/CONS121	ST/CONS122	ST/CONS123
		RF121	RF122	RF123
	IC22	RC211	RC212	RC213
		ST/CONS211	ST/CONS212	ST/CONS213
IC22	RF211	RF212	RF213	
	RC221	RC222	RC223	
IC22	ST/CONS221	ST/CONS222	ST/CONS223	
	RC221	RC222	RC223	

# Selecting EPHA Analysis Cases

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		RF121	RF122	RF123
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	RC221	RC222	RC223	

# Selecting EPHA Analysis Cases

Mode 1 (puncture, lid loss)	IC11	RC111	RC112	RC113
		ST/CONS111	ST/CONS112	ST/CONS113
		RF111	RF112	RF113
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		ST/CONS121	ST/CONS122	ST/CONS123
		RF121	RF122	RF123
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		ST/CONS211	ST/CONS212	ST/CONS213
		RF211	RF212	RF213
	IC22	RC221	RC222	RC223
		ST/CONS221	ST/CONS222	ST/CONS223
		RC221	RC222	RC223

# Selecting EPHA Analysis Cases

Mode 1 (puncture, lid loss)	IC11	RC111	RC112	RC113
		ST/CONS111	ST/CONS112	ST/CONS113
		RF111	RF112	RF113
	IC12	RC121	RC122	RC123
		ST/CONS121	ST/CONS122	ST/CONS123
		RF121	RF122	RF123
Mode 2 (crush)	IC21	RC211	RC212	RC213
		ST/CONS211	ST/CONS212	ST/CONS213
		RF211	RF212	RF213
	IC22	RC221	RC222	RC223
		ST/CONS221	ST/CONS222	ST/CONS223
		RC221	RC222	RC223

# Selecting EPHA Analysis Cases

MAR	Failure mode	Initiator	Release condition	Source term	Recog. factor	Consequence
			RC111	ST111	RF111	CONS111
	FM1	IC11	RC112	ST112	RF112	CONS112
			RC113	ST113	RF113	CONS113
		IC12	RC121	ST121	RF121	CONS121
			RC122	ST122	RF122	CONS122
			RC123	ST123	RF123	CONS123
		FM2	IC21	RC211	ST211	RF211
	RC212			ST212	RF212	CONS212
	IC22		RC213	ST213	RF213	CONS213
			RC221	ST221	RF221	CONS221
			RC222	ST222	RF222	CONS222
				RC223	ST223	RF223

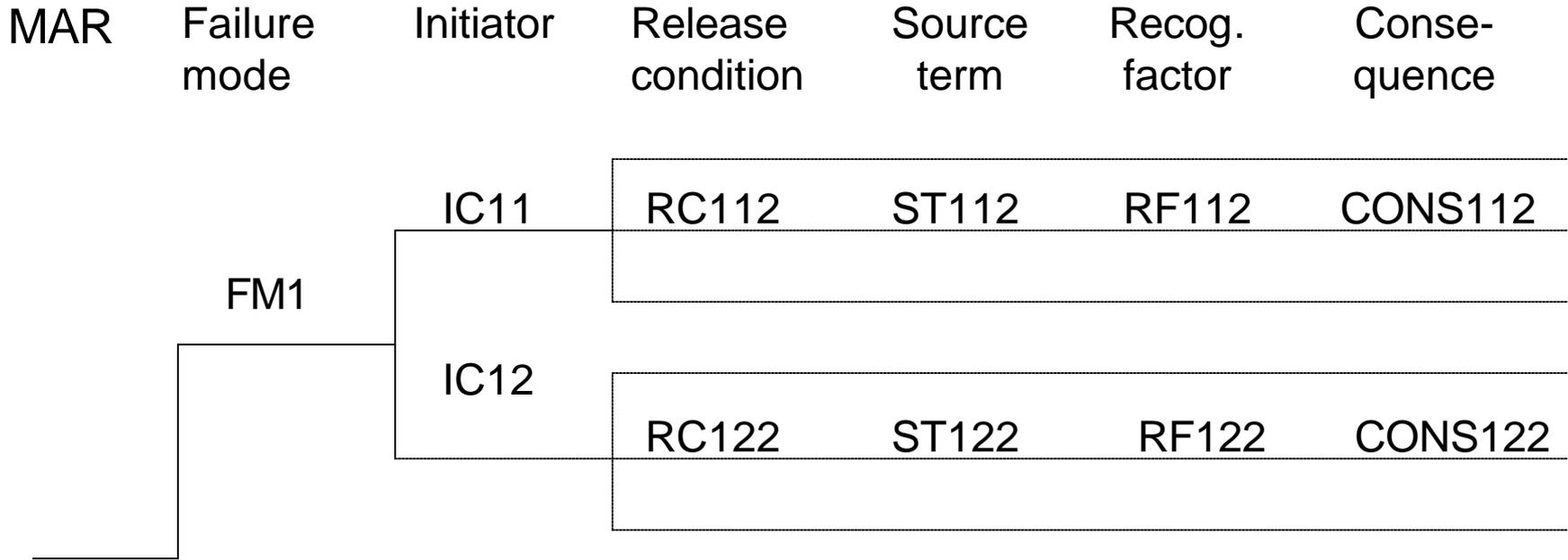
# Selecting EPHA Analysis Cases

MAR	Failure mode	Initiator	Release condition	Source term	Recog. factor	Consequence
	FM1	IC11	RC112	ST112	RF112	CONS112
		IC12	RC121	ST121	RF121	CONS121
				RC122	ST122	RF122

***Test 1: Are consequences sufficiently different from cases already selected that it would be classified at a different level?***

***Test 2: Could this case be distinguished from others already selected for analysis?***

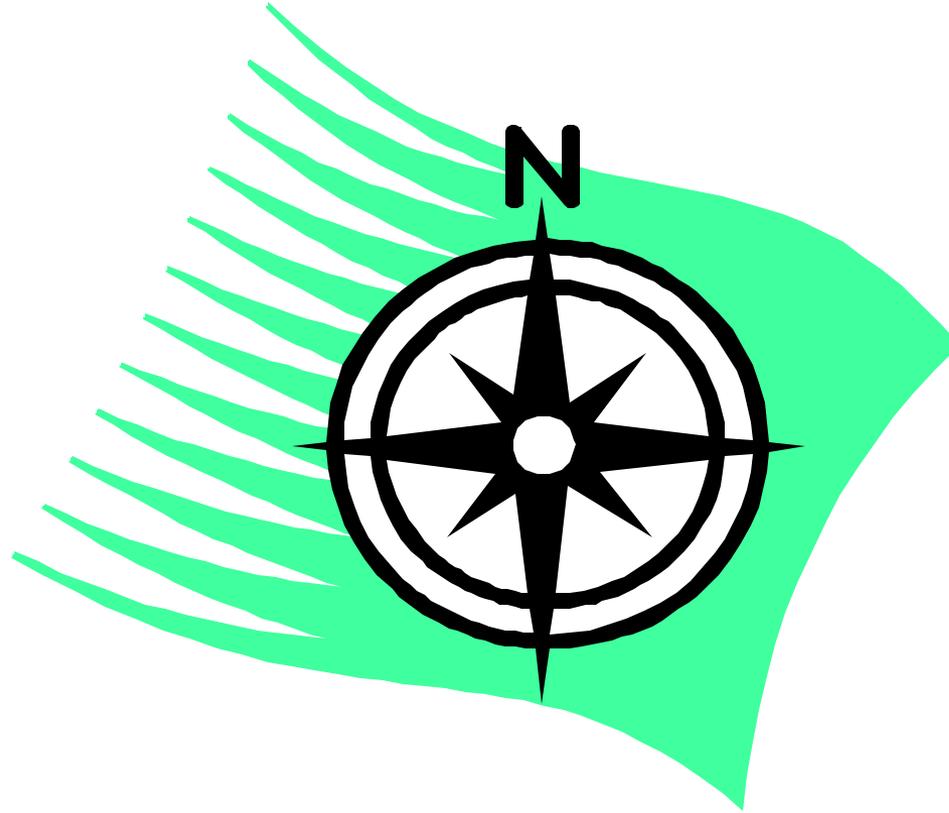
# Selecting EPHA Analysis Cases



***Test 1: Are consequences sufficiently different from cases already selected that it would be classified at a different level?***

***Test 2: Could this case be distinguished from others already selected for analysis?***

# Part 4: Staying on Course



Documenting the logical basis for EALs

# Documenting the EAL basis



Why do it?

- EALs usually NOT developed by EPHA analyst
- Analyst has valuable knowledge & insights
  - Indications
  - Analyzed scenario elements
  - Relationships

# Documenting the EAL basis



## Why is it important?

- Coherence and completeness
- Enhance review, feedback, acceptance
- Defending EALs to users and others
- Frame of reference for future change

# Documenting the EAL basis



## How to do it

- Select a “recognition category/group”
- List analyzed cases and classification
- For each class, discuss analyzed cases
  - MAR
  - Initiator
  - Release pathway
  - Indications

# Documenting the EAL basis



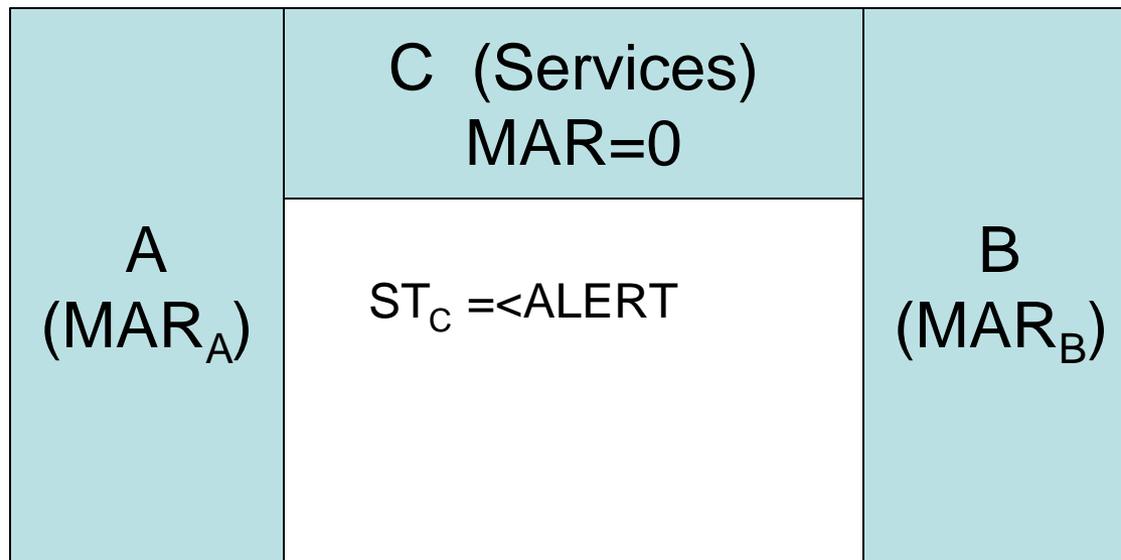
How to do it (cont.)

- Generalize from the specific analyzed cases
- Create “basis” statement/summary

# Documenting the EAL basis



Example: Structure fire, radiological facility



ST<sub>A</sub> = ALERT

ST<sub>B</sub> = GE

# Documenting the EAL basis



*Discuss analyzed cases*

- MAR
- Initiator
- Release pathway
- Indications

# Documenting the EAL basis



*Generalize from specific cases analyzed*

- Extrapolate from analyzed case
- Note/record indications

# Documenting the EAL basis



## *Basis statement/summary*

- GE - fire in B Wing (analyzed case)
- SAE - A & C wing fire (safety degraded)
  - threat to services
  - proximity to Wing B
  - common cause?
- Alert – fire in either A or C Wing
  - A Wing (analyzed case)
  - C Wing (degraded safety re. B wing)

# Part 5: Finishing Strong



Making EALs That Work

# Making EALs That Work



## *Event types/recognition categories*

- Meaning must be self-evident
- Invite user organization input
- Tailor categories to user knowledge and needs

# Making EALs That Work



## *Available data/indications*

- Timeliness (coincident with recognition)
- Certainty (always available, probably, may be)
- Actions needed to determine fact/data
  - None (condition is self-evident)
  - Minimal (read the alarm panel)
  - Minor (call and confirm)
  - Significant (direct sample/analysis of effluent)
  - Major (complex measurement, dose calc., etc.)

# Making EALs That Work



## *Ambiguity/subjectivity*

- Same indications, different decisions
  - Qualitative descriptions (“small”, “major”, etc.)
  - Decisionmaker qualifications & knowledge
- Quantitative vs qualitative indications
- Specify source of EAL data/indication
- “Decisionmaker opinion” EALs

# Making EALs That Work



## *Human factors Considerations*

- Outside range of personal experience
  - Simple EALs = better
  - Minimize opportunities to fail
- Denial, avoidance
  - “Worst first”
  - Specific symptoms/indications
- “Decisionmaker opinion” EALs
  - Classification within criteria-based structure

# Making EALs That Work



## *Redundancy*

- Different routes to same decision
  - Other data/indications
  - Separate EALs
  - Different recognition categories

# Making EALs That Work



## *Testing, validation, feedback*

- Pre-deployment testing
  - Analysts
  - Planners
  - Prospective users (decisionmakers)
- Validation
- User feedback from drills, exercises

# Summary



**Prompt recognition & commensurate response**



**High quality EALs**



**Logical & consistent EAL derivation**



**Rigorous Selection of Analysis cases**



5/25/2004



***You have arrived at  
your destination***

***THE END***