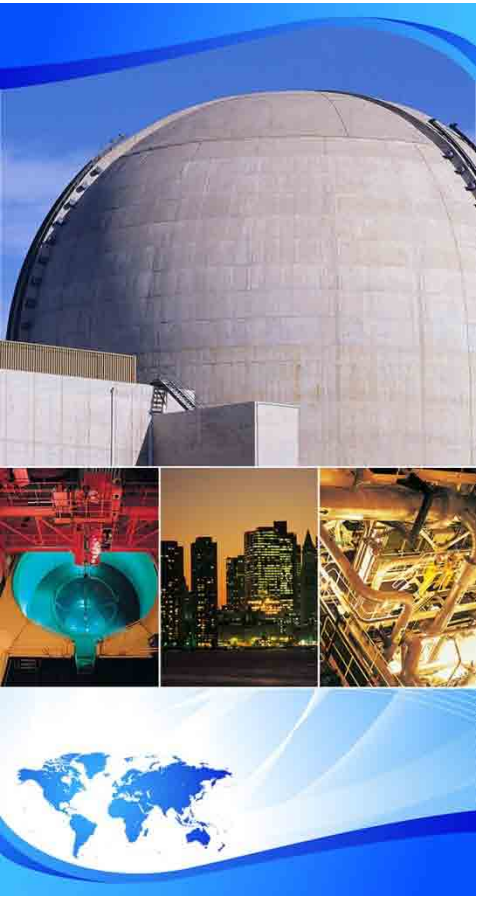


EPRI/NRC-RES FIRE PRA METHODOLOGY
Task 12 – Fire HRA

Scoping Quantification Approach

Joint NRC-RES/EPRI Fire PRA Workshop 2012
Bethesda, MD

A Collaboration of U.S. NRC Office of Nuclear Regulatory Research (RES) & Electric Power Research Institute (EPRI)

Outline of the Presentation

1. Overview of the EPRI/NRC Fire HRA Guidelines
2. Identification and definition of fire human failure events
3. Qualitative analysis
4. Quantitative analysis
   a) Screening
   b) Scoping
   c) EPRI approach (detailed)
   d) ATHEANA (detailed)
5. Recovery analysis
6. Dependency analysis
7. Uncertainty analysis

Three General Approaches to HRA Quantification

- Screening: Slightly modified from NUREG/CR-6850 (EPRI 1011989) to cover late (after fire is out) events
- **Scoping fire HRA quantification approach (new)**
  - Less conservative than screening, but designed to be slightly more conservative than detailed approaches
  - Some actions may not be able to meet some of the criteria (result in an HEP of 1.0)
- Two detailed fire HRA quantification approaches, modified for application in fire scenarios
  - EPRI Cause-Based Decision Tree (CBDT) & HCR/ORE; THERP
  - ATHEANA

Purpose of Scoping Approach

- Provide less conservative HEPs for HFEs surviving screening
  - Straightforward approach without too much detailed analysis
- Intent is to provide HEPs that are more realistic, and therefore, some detailed analysis required
  - HEPs thought to be somewhat more conservative than might be obtained with more detailed analysis
  - Expected to limit need for detailed analyses for many HEPs
- Relies on assessment of feasibility of actions and a time margin to account for many of the uncertainties associated with fire scenarios (e.g., per NUREG-1852)
- Requires simple judgments about PSFs

Categories of Actions Addressed in Scoping Flowcharts

- New and existing main control room (MCR) actions
- New and existing ex-control room (local) actions
- Actions associated with using alternate shutdown means
  - due to MCR habitability issues, or
  - due to difficulties in controlling the plant from the MCR because of the effects of the fire
- Recovery of Errors of Commission (EOCs) or Errors of Omission (EOOs) due to spurious instrumentation
  - Supports addressing spurious instrument effects as described in Part 4 (Internal Fires) of ASME/ANS Combined PRA Standard (HLR-ES-C1 and C2)

Categories of Actions NOT Addressed in Scoping Flowcharts

- Complex diagnosis should not be addressed with the Scoping Method
  - Simplified approach not appropriate for cognitively complex or challenging scenarios

- Example of cognitively complex or challenging scenarios:
  - Cues directly relevant to the action being modeled do not match the procedural guidance
  - Plants that implement SISBO procedures
  - Actions pertaining to deciding to abandon the MCR*
  - Scenarios that may include potentially distracting spurious operations

*scoping approach may be used to quantify HFEs subsequent to the decision to abandon.

Steps for Using Scoping Fire HRA Approach

1. Ensure minimum criteria are met
2. Assess feasibility of operator actions
3. Calculate time margin
4. Assess key conditions and PSFs
5. Use flowcharts to quantify - Search scheme directs to one of the following:
    - INCR = In MCR actions
    - EXCR = ex-MCR actions (actions normally performed locally)
    - ASD = Alternate Shutdown (including MCR Abandonment due to habitability or transferring command and control to outside the MCR due to an inability to control the plant)
    - SPI = recovery of errors due to spurious instrumentation

Minimum Criteria

1. Procedures
   - Procedures should match the scenario
   - Plant procedures covering each operator action being modeled should be present
   - Support both diagnosis & execution of the action
   - Exceptions:
     - Execution of skill-of-the-craft actions
     - Recovery of EOO or EOC in some cases related to self- or crew-recovery for inappropriate response to spurious indications

2. Training – on the procedures and the actions

3. Availability and Accessibility of Equipment

Assessment of Feasibility

- Feasibility assessments during scoping HRA quantification typically examine further details regarding the action, context, scenario and timing
- Refer to Qualitative Analysis presentation sections on Tools for Feasibility Assessment and conducting Talk- and Walk-throughs, as well as NUREG-1921 sections:
  - **4.3 Feasibility Assessment**
  - **4.11 Reviews with Plant Operations**
- Scoping method effectively implements a feasibility assessment on the basis of time and environmental conditions (dense smoke)

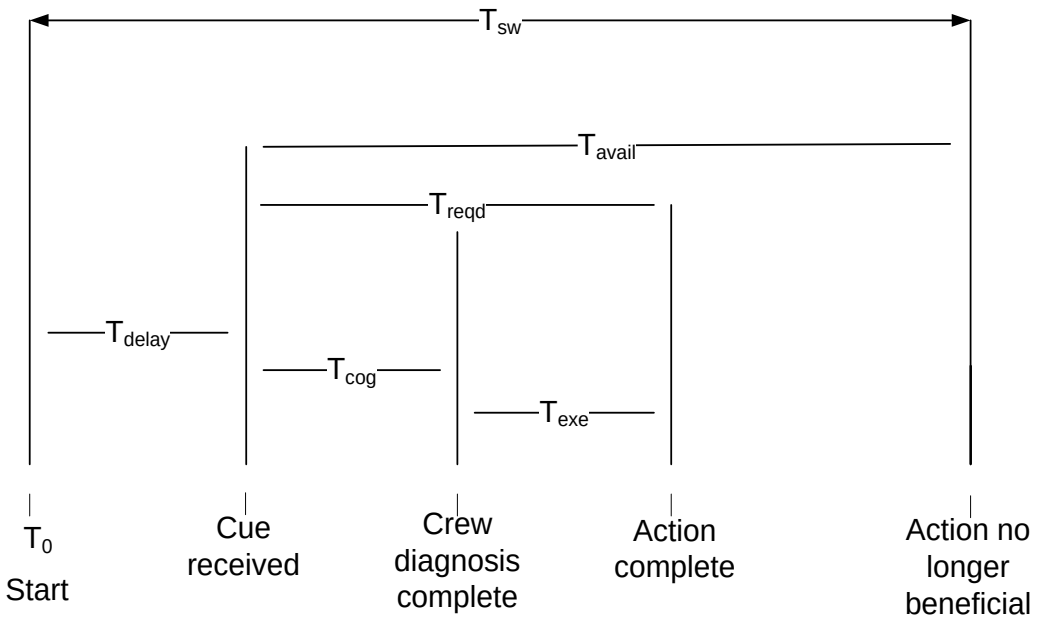
Qualitative Assessment Tools … - Feasibility Assessment

- Example guidance for feasibility assessment factors:
  - Sufficient time (Section 4.3.4.1 with Section 4.6.2 (PSF – Timing))
    - Timeline used to model operator performance
    - Sources of timing information (e.g., job performance measures [JPMs], training exercises, Appendix R or NFPA 805 feasibility demonstrations)
  - Sufficient manpower (both inside and outside control room)
  - Primary cues available/sufficient (e.g., is a fire impact?)
  - Proceduralized and trained (plus certain *skill-of-the-craft* actions)
  - Accessible location (both travel path and action location; effects of environmental and security measures must be considered)
  - Equipment and tools available and accessible, e.g.,
    - Keys for locked doors
    - Radios, ladders, flashlights, protective clothing, SCBA

Time Margin

- Extra time included to account for potential unexpected fire effects and variabilities such as:
  - Uncertainties in the demonstrations and conditions unable to be simulated
  - Potential variability in crew response times and individual differences
  - Variations in fire type and related plant conditions
- Within the scoping approach, time margins are required to be calculated for all actions or set of actions.
- Similar to guidance in NUREG-1852

Calculation of Time Margin



$$Time\ Margin\ (TM) = \frac{T_{AVAIL} - T_{reqd}}{T_{REQD}} * 100\% = \frac{[(T_{sw} - T_{delay}) - (T_{COG} + T_{EXE})]}{(T_{COG} + T_{EXE})} * 100\%$$

Calculation of Time Margin (2)

- Times used should be based on realistic times

- Some actions may involve either (or a mix of both) serial and parallel actions, with overlapping tasks. In these cases, determination of the time margin may not be as straightforward as illustrated. For more guidance, see Appendix A of NUREG-1852.

Calculation of Time Margin (3)

- Range of times should be collected in addition to the point estimate of an average crew
  - Especially important when required time is close to available time
  - Potential uncertainty in timing data important when a small change in the estimated time required could make the action infeasible
- "Tipping Points": a few additional minutes of estimated time results in different HEP in scoping method
  - Recommendation is to initially choose the conservative estimate of time; Refine data later if significantly impacts fire PRA model quantification results
  - Alternative: run several test cases to evaluate the impact of timing variability and quantify the HFE with separate timing cases if the impact is strong enough to warrant it

Assessing Key Conditions & PSFs within the Scoping Flowcharts

- How well the procedures match the scenario
  - The procedures should be relatively easy to follow given the pattern of indications
  - Serves as a proxy for diagnostic complexity

- Response execution complexity
  - Assessed as high or low
  - Complexity is usually considered **low** if:
    - Requires a single step
    - Performed by a single crew member
    - Multiple simple steps performed by single crew members working independently
    - Clear procedures or skill-of-craft
  - Complexity is usually considered **high** if:
    - Multiple steps that may be ambiguous or difficult
    - Multiple crew members performing coordinated steps
    - Multiple location steps if coordination/communication required
    - Multiple functions (e.g., both electrical and mechanical alignment)

Assessing Key Conditions & PSFs within the Scoping Flowcharts (2)

- Timing of cues for the action relative to expected fire suppression time.
  - If fire type unknown, fire suppression assumed to be 70-minutes ("all fires")
  - If fire type is known, may use the 99th %ile value (yellow) from FAQ 08-0050
  - Fire must be considered on-going for the fire types in red

Time (min)	T/G fires	High energy arcing	Outdoor transformers	Flammable gas	Oil fires	Electrical fires	Transient fires	PWR containment	Welding	Control Room	Cable fires	All Fires
0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
5	0.883	0.947	0.836	0.881	0.684	0.602	0.531	0.687	0.392	0.189	0.446	0.714
10	0.780	0.897	0.698	0.776	0.468	0.362	0.282	0.472	0.153	0.036	0.199	0.510
15	0.689	0.850	0.584	0.683	0.320	0.218	0.150	0.325	0.060	0.007	0.089	0.364
20	0.609	0.805	0.488	0.602	0.219	0.131	0.080	0.223	0.024	0.001	0.040	0.260
25	0.538	0.762	0.408	0.530	0.150	0.079	0.042	0.153	0.009	*	0.018	0.186
30	0.475	0.722	0.341	0.467	0.102	0.048	0.023	0.105	0.004	*	0.008	0.133
35	0.419	0.684	0.285	0.411	0.070	0.029	0.012	0.072	0.001	*	0.004	0.095
40	0.370	0.647	0.238	0.362	0.048	0.017	0.006	0.050	*	*	0.002	0.068
45	0.327	0.613	0.199	0.319	0.033	0.010	0.003	0.034	*	*	*	0.048
50	0.289	0.581	0.166	0.281	0.022	0.006	0.002	0.024	*	*	*	0.035
55	0.255	0.550	0.139	0.248	0.015	0.004	*	0.016	*	*	*	0.025
60	0.226	0.521	0.116	0.218	0.010	0.002	*	0.011	*	*	*	0.018
65	0.199	0.493	0.097	0.192	0.007	0.001	*	0.008	*	*	*	0.013
70	0.176	0.467	0.081	0.169	0.005	*	*	0.005	*	*	*	0.009
75	0.155	0.443	0.068	0.149	0.003	*	*	0.004	*	*	*	0.006
80	0.137	0.419	0.057	0.131	0.002	*	*	0.002	*	*	*	0.005
85	0.121	0.397	0.047	0.116	0.002	*	*	0.002	*	*	*	0.003
90	0.107	0.376	0.040	0.102	0.001	*	*	0.001	*	*	*	0.002
95	0.095	0.356	0.033	0.090	*	*	*	*	*	*	*	0.002
100	0.084	0.337	0.028	0.079	*	*	*	*	*	*	*	0.001

Assessing Key Conditions & PSFs within the Scoping Flowcharts (3)

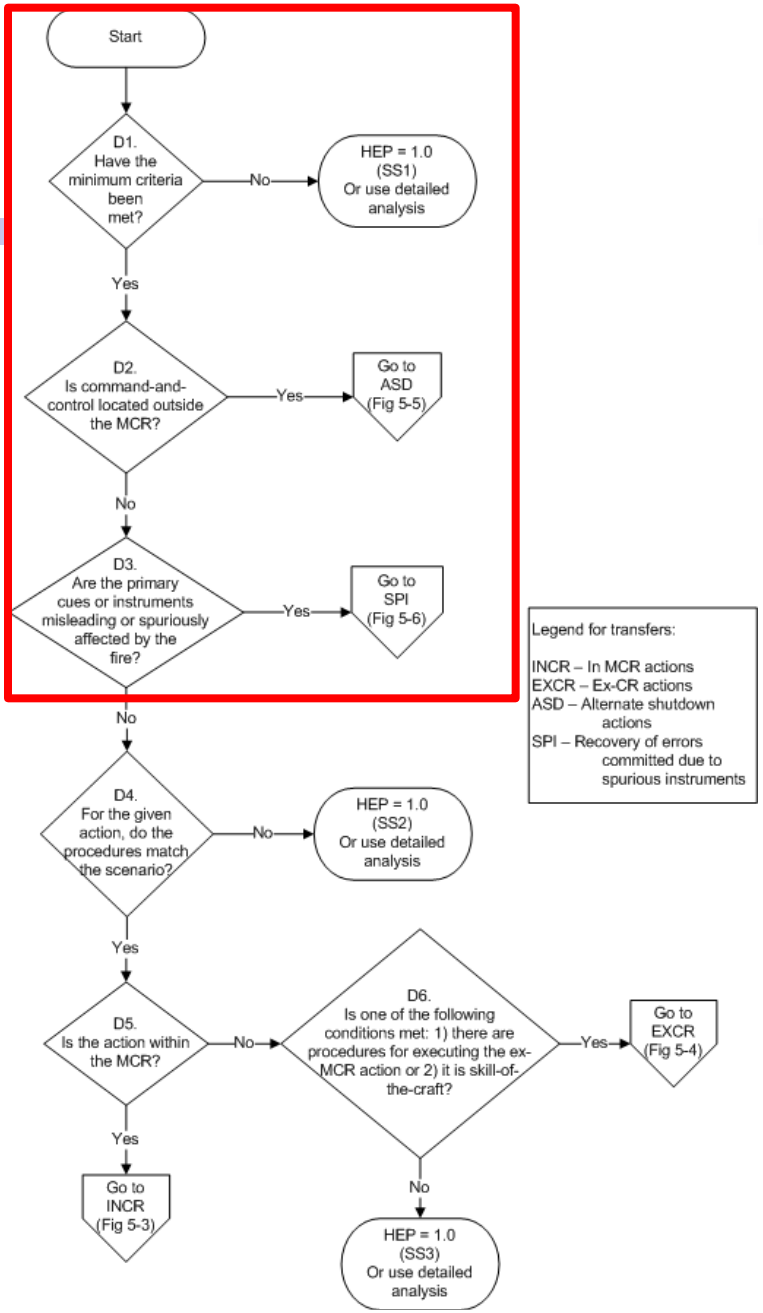
- Action time window
  - Time from the occurrence of the cues for action until the action is no longer beneficial
  - Short time window = 30 minutes or less
  - Long time window = greater than 30 minutes
- Level of smoke and other hazardous elements in the action areas
  - Need for special equipment (e.g., SCBA)
  - Impairment of vision or prevention of the execution of the action
- Accessibility
  - Location of action
  - Travel path

Use of Scoping Flowcharts

- HFEs quantified based on:
  - Assessment of key PSFs
  - Location of the actions associated with the HFE
  - Condition of relevant instrumentation
- A *Search Scheme* directs the analyst to the correct flowchart for quantification:
  - In-MCR action (INCR)
  - Ex-MCR action (EXCR)
  - Alternate Shutdown (ASD)
  - Recovery of error due to spurious instrumentation (SPI)
- Some HFEs quantified within the Search Scheme lead to HEP = 1.0

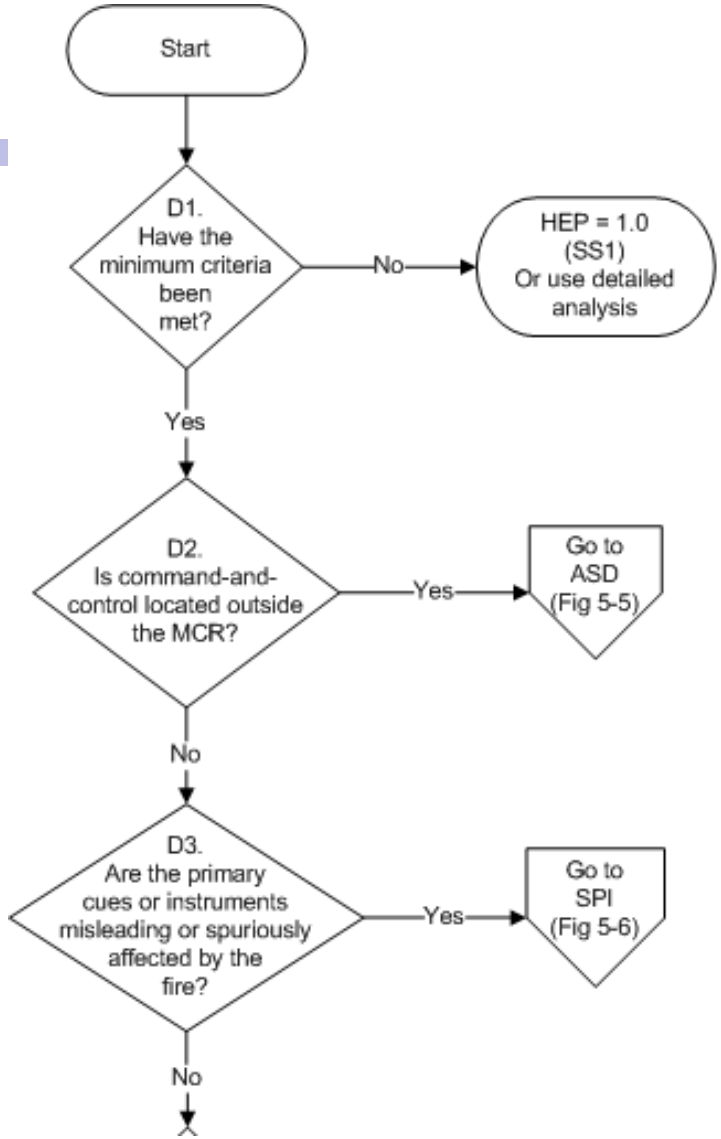
Search Scheme

- Directs analyst to correct quantification flowchart



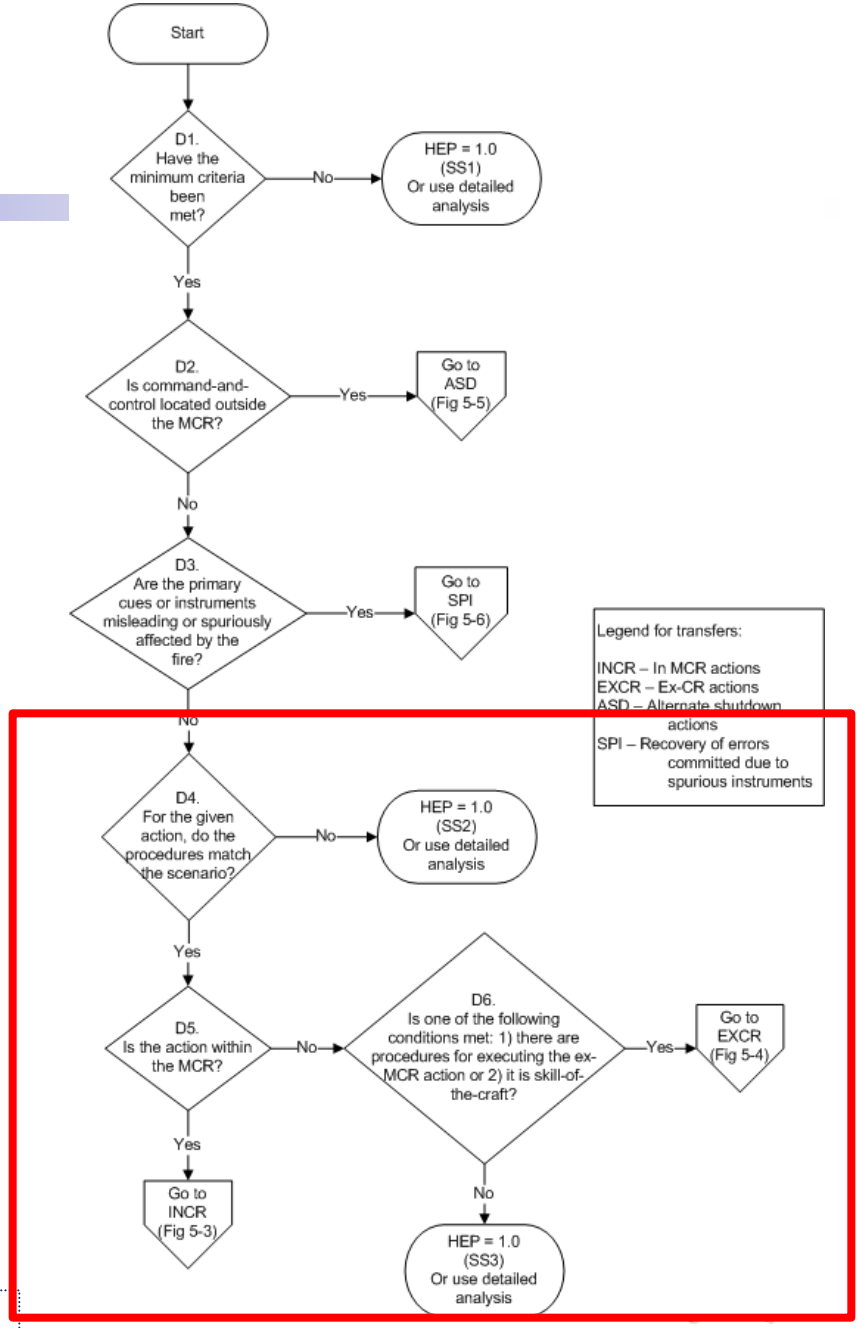
Search Scheme

- Direct to ASD or SPI tree
- Cues are not necessary to answer yes to D1, but likely their absence will still result in HEP = 1.0 later on

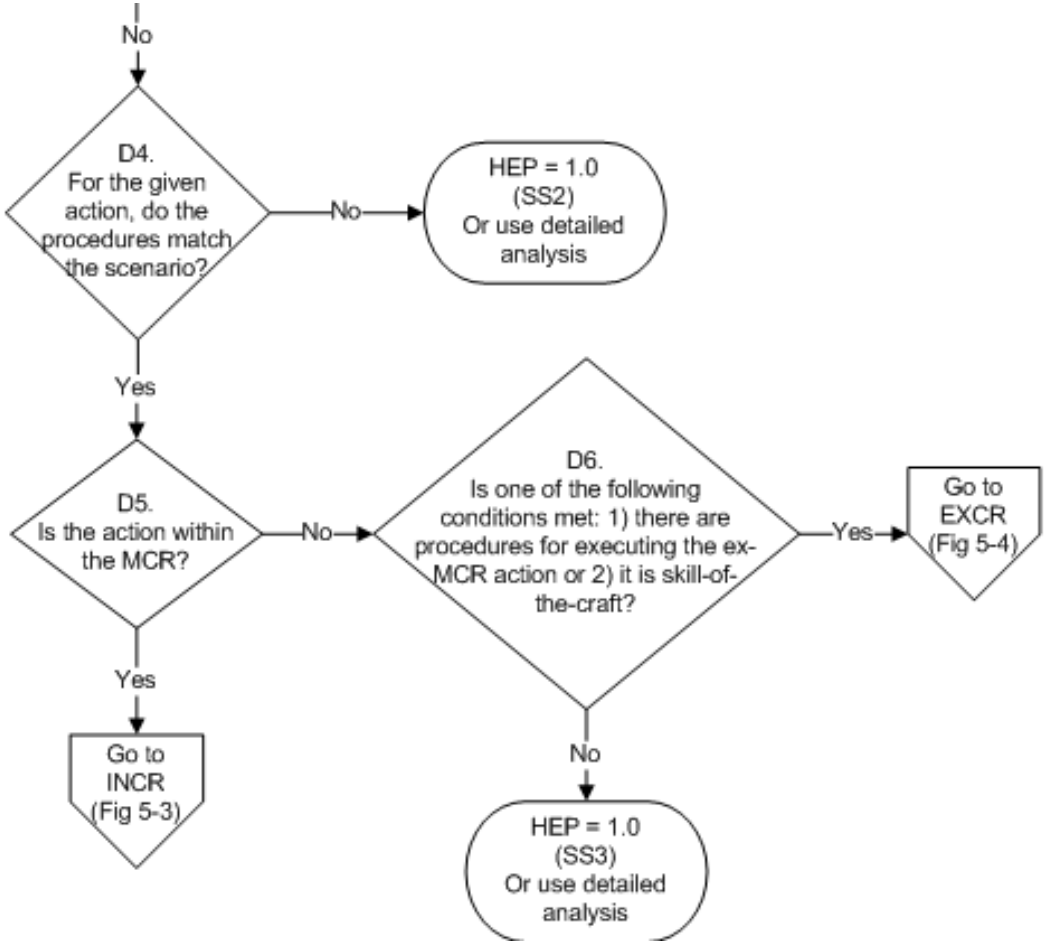


Search Scheme

- Directs analyst to correct quantification flowchart



Search Scheme



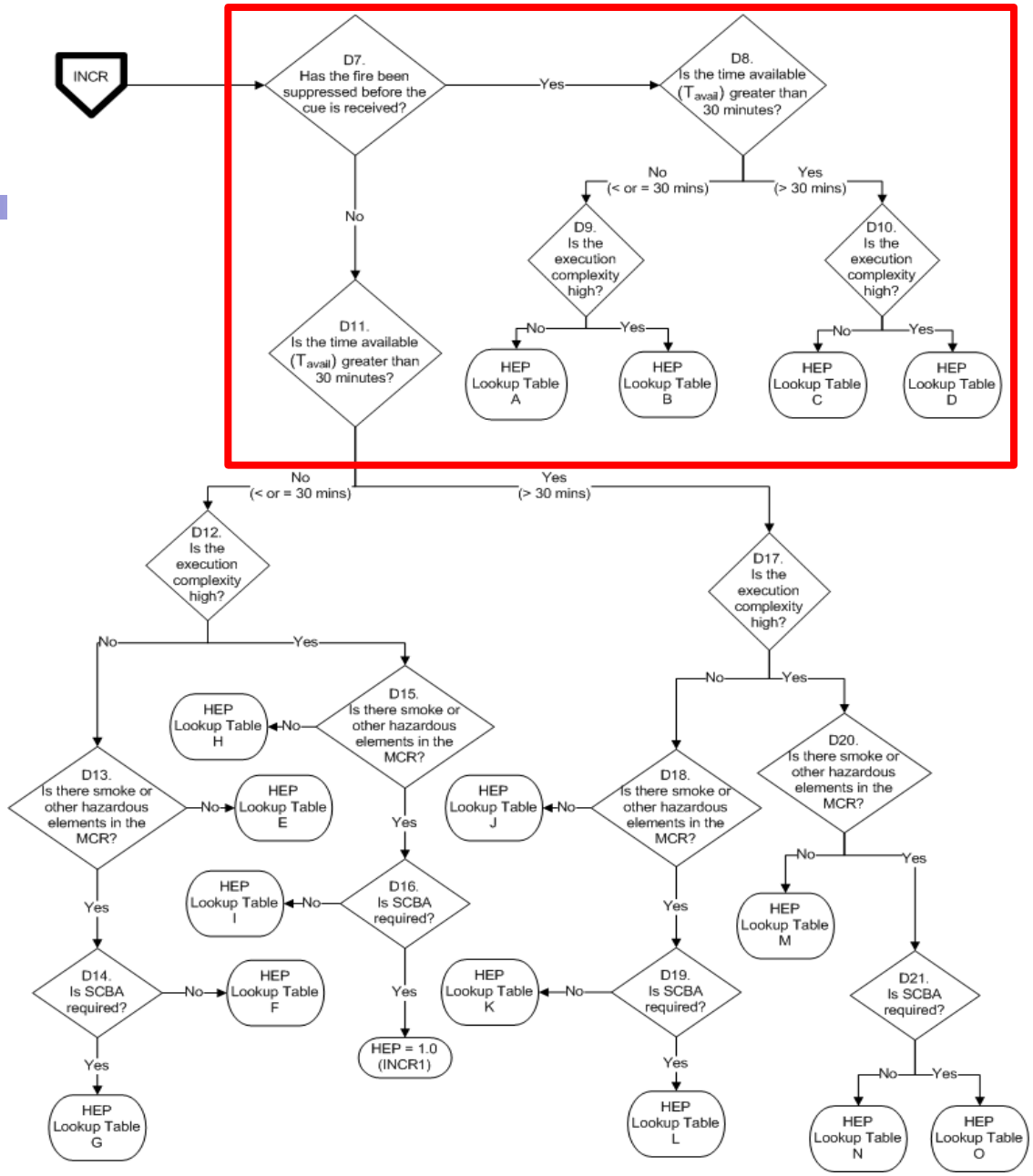
- Direct to INCR or EXCR

INCR – In-MCR Actions

- Used for the following HFEs:
  - New HFEs identified outside the Internal Events PRA
  - Existing HFEs from the Internal Events that survive quantitative screening
- Addresses diagnosis and execution of the action in the MCR
  - Presumes no challenge to MCR habitability or functionality from fire (see ASD)

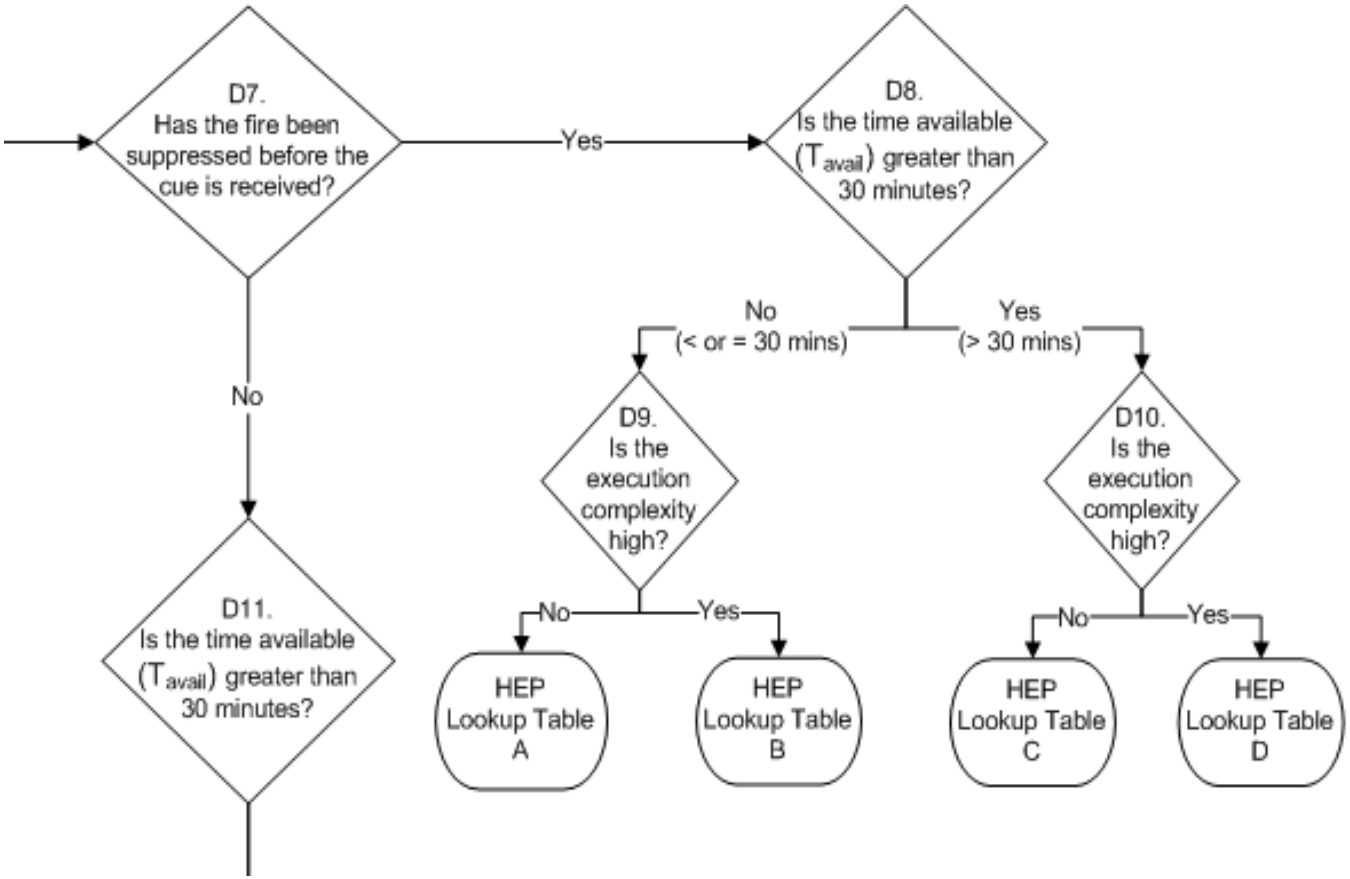
INCR

- Scoping HRA for in MCR Actions



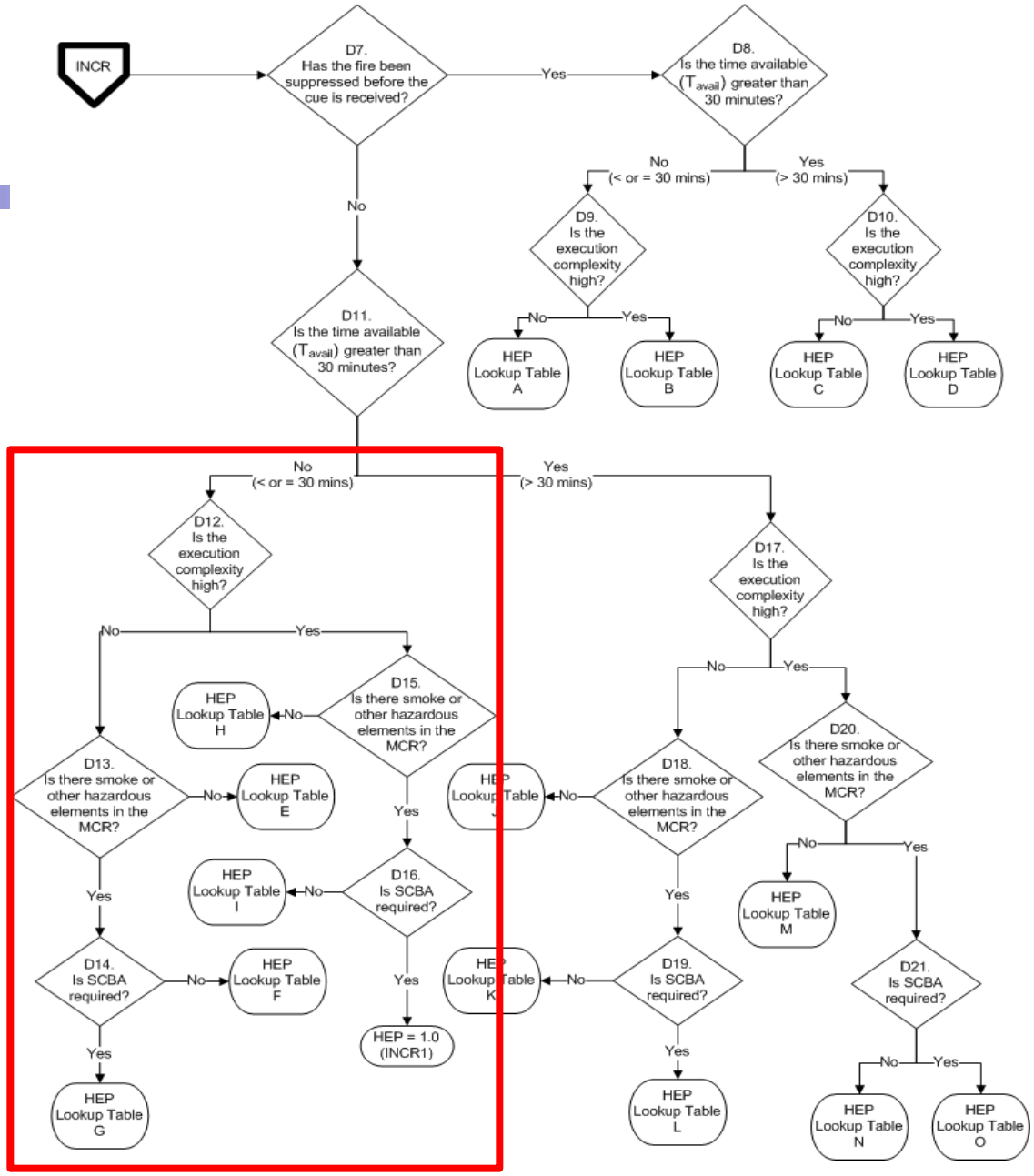
INCR

- Fire Suppressed?
  - 70 minutes from reactor trip
  - Fire specific timing [FAQ-08-0050]
  - Challenging fires (e.g., turbine generator fires) assume fire has not been suppressed.



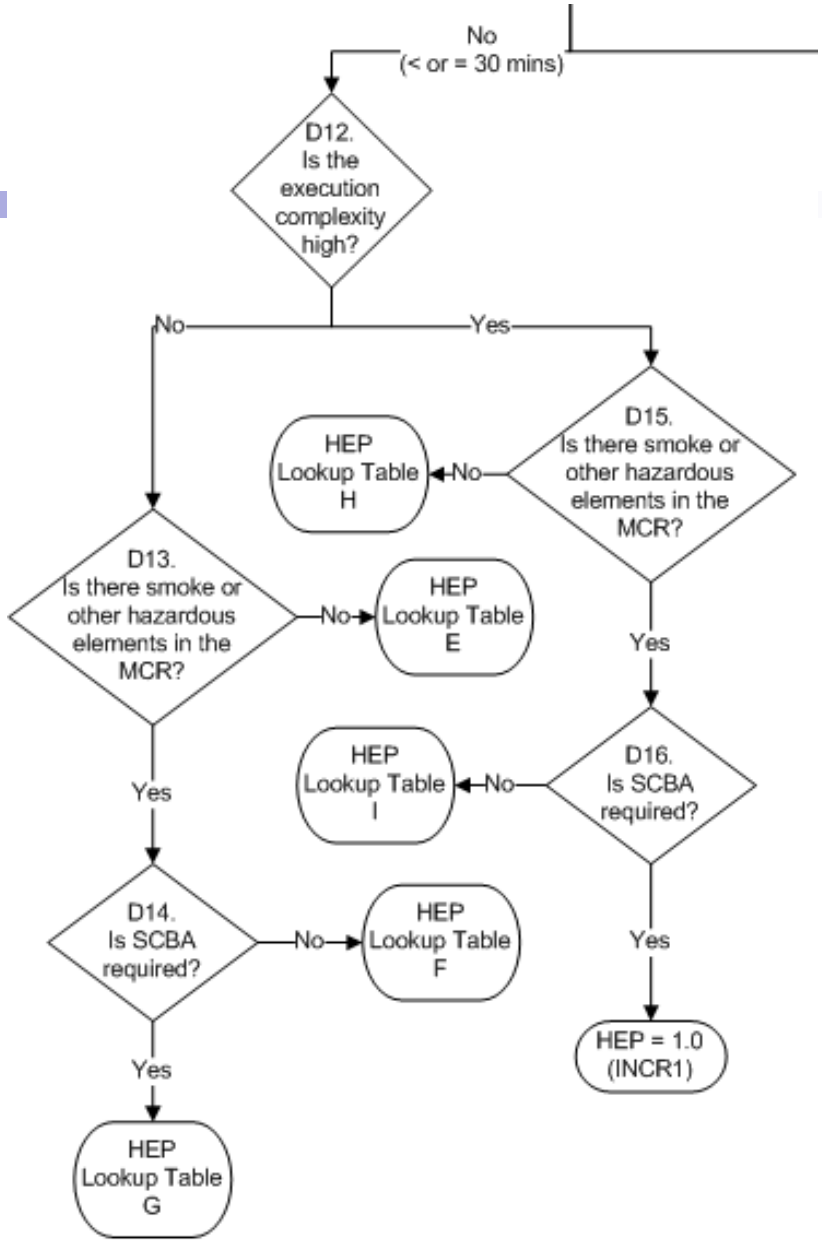
INCR

- Scoping HRA for in MCR Actions



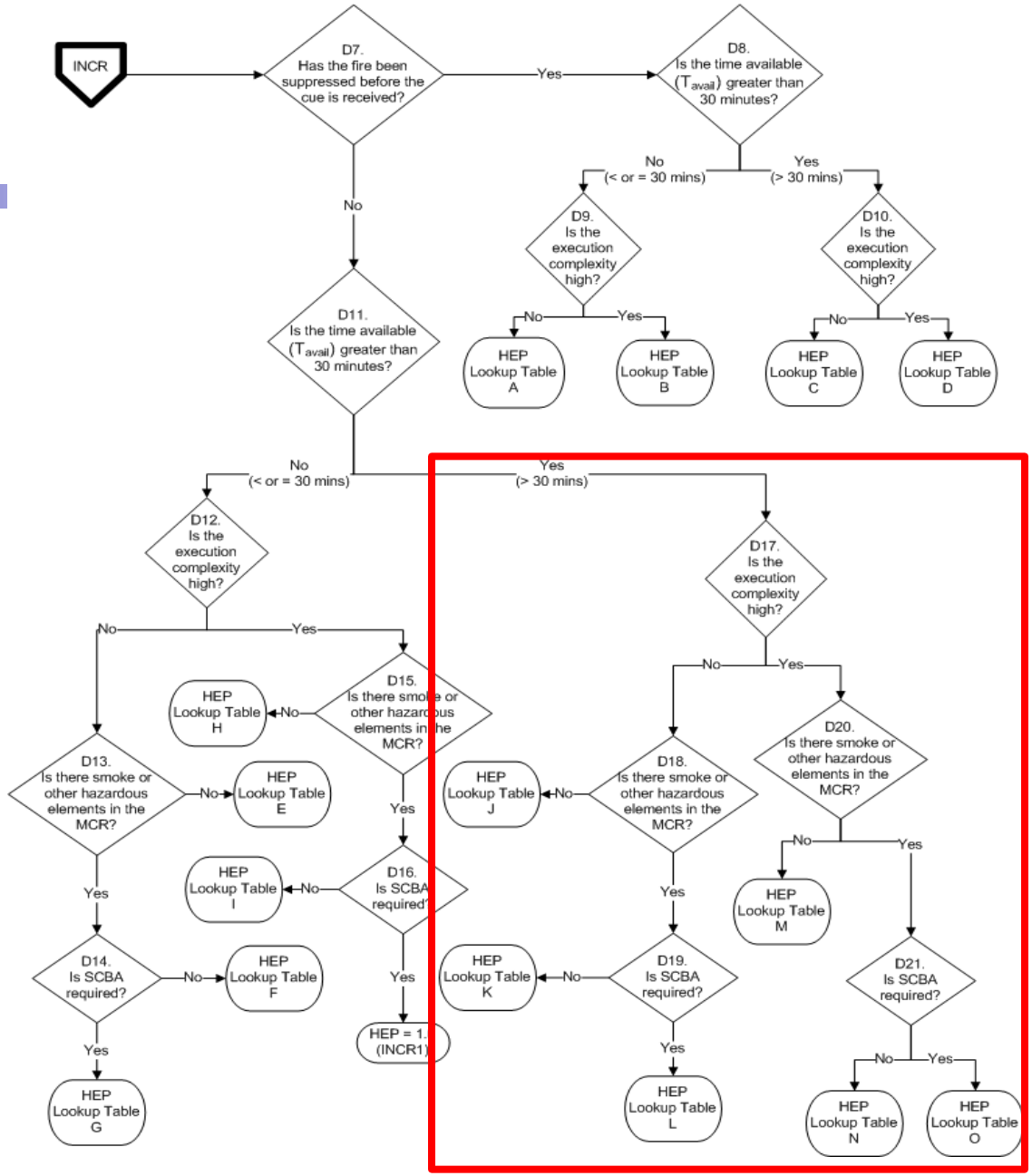
INCR

- Fire on-going
- Short time window (<30 min)



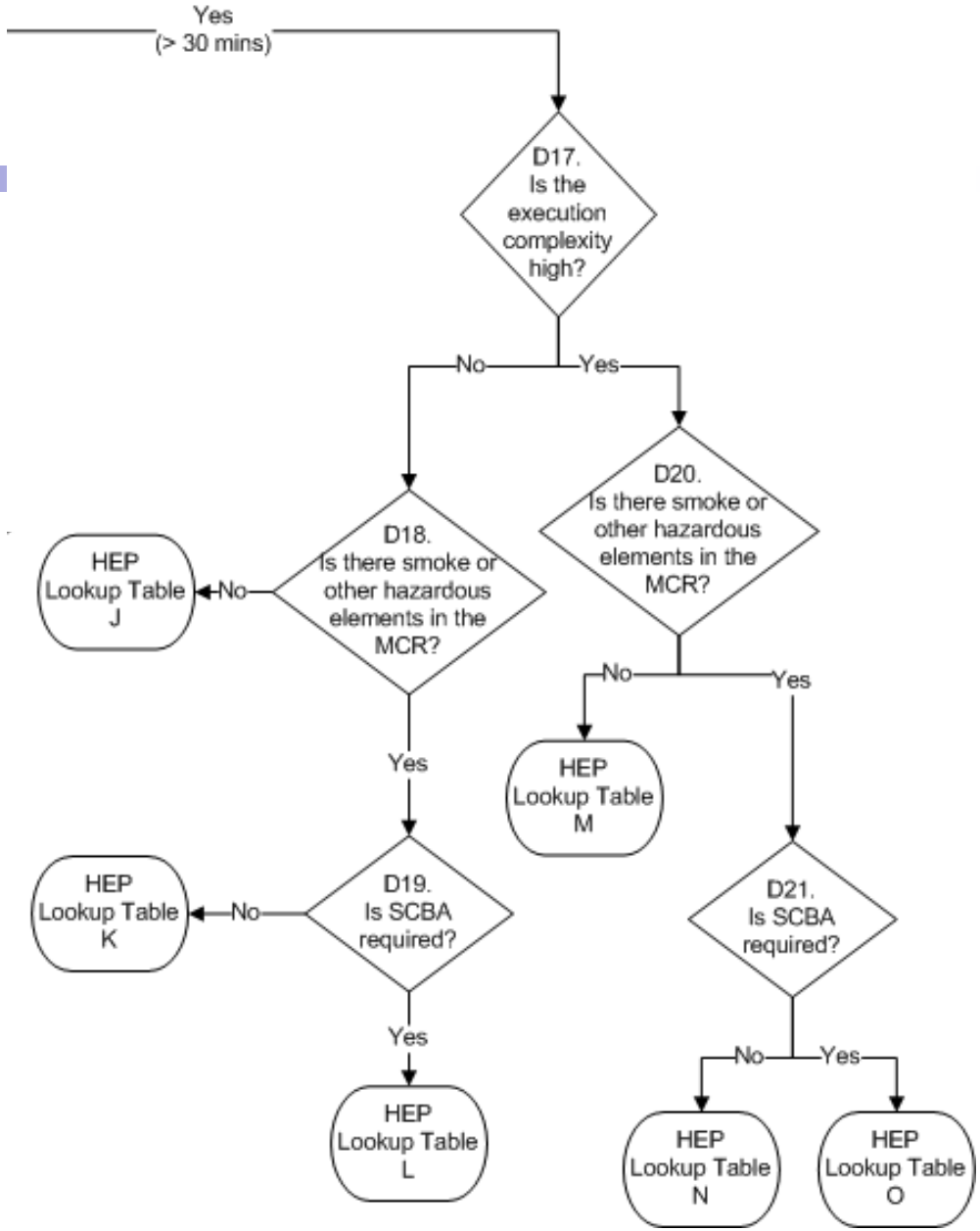
INCR

- Scoping HRA for in MCR Actions



INCR

- Fire on-going
- Long time window (>30 min)

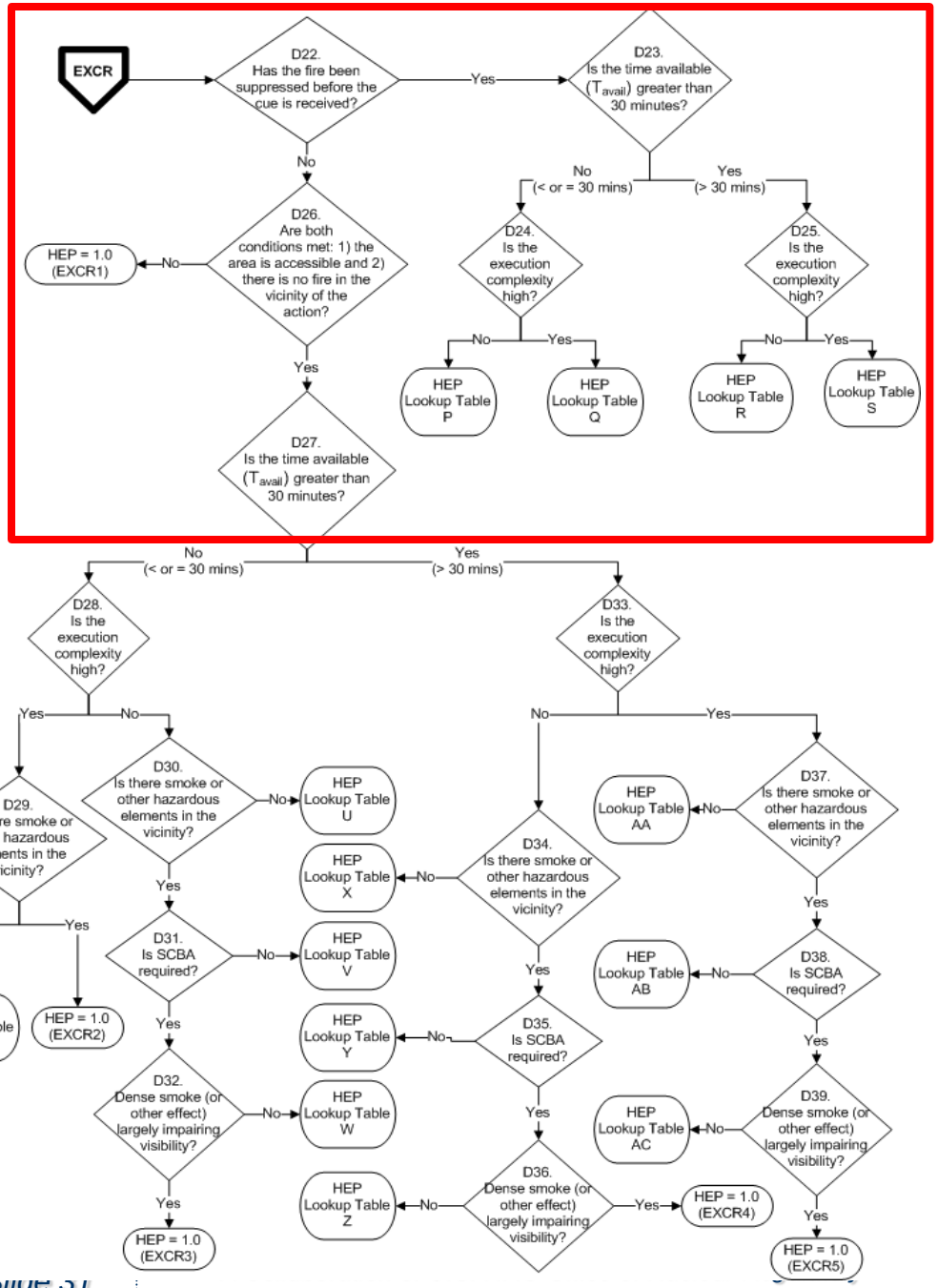


EXCR – Ex-MCR Actions

- Used for the following HFEs:
  - New HFEs identified outside the Internal Events PRA
  - Existing HFEs from the Internal Events that survive quantitative screening
- Addresses diagnosis and execution of the action(s)
  - Diagnosis within the MCR
  - Execution locally (i.e., ex-MCR)
    - If action is require both in the MCR and locally, this tree should be used

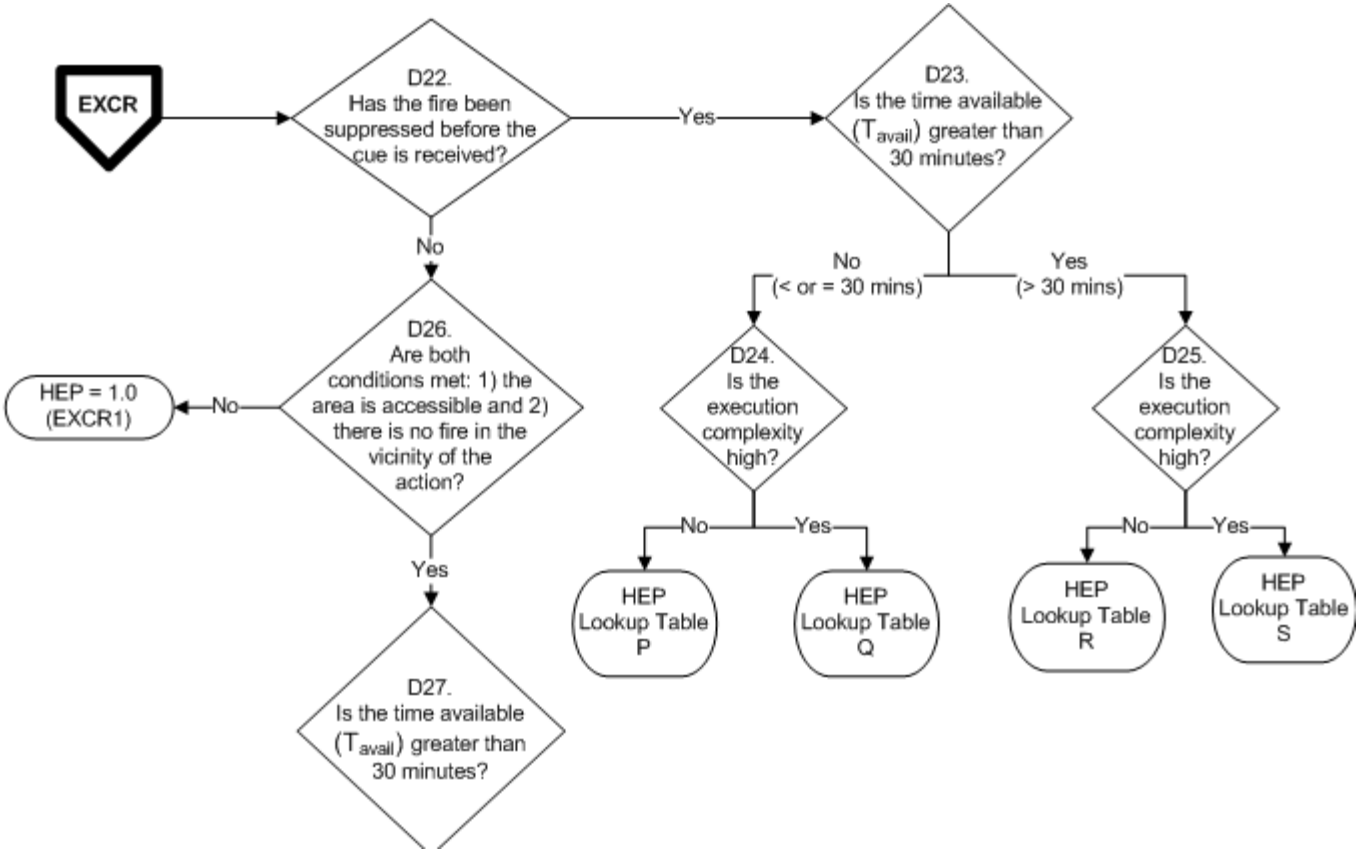
EXCR

- Scoping HRA for ex-MCR Actions



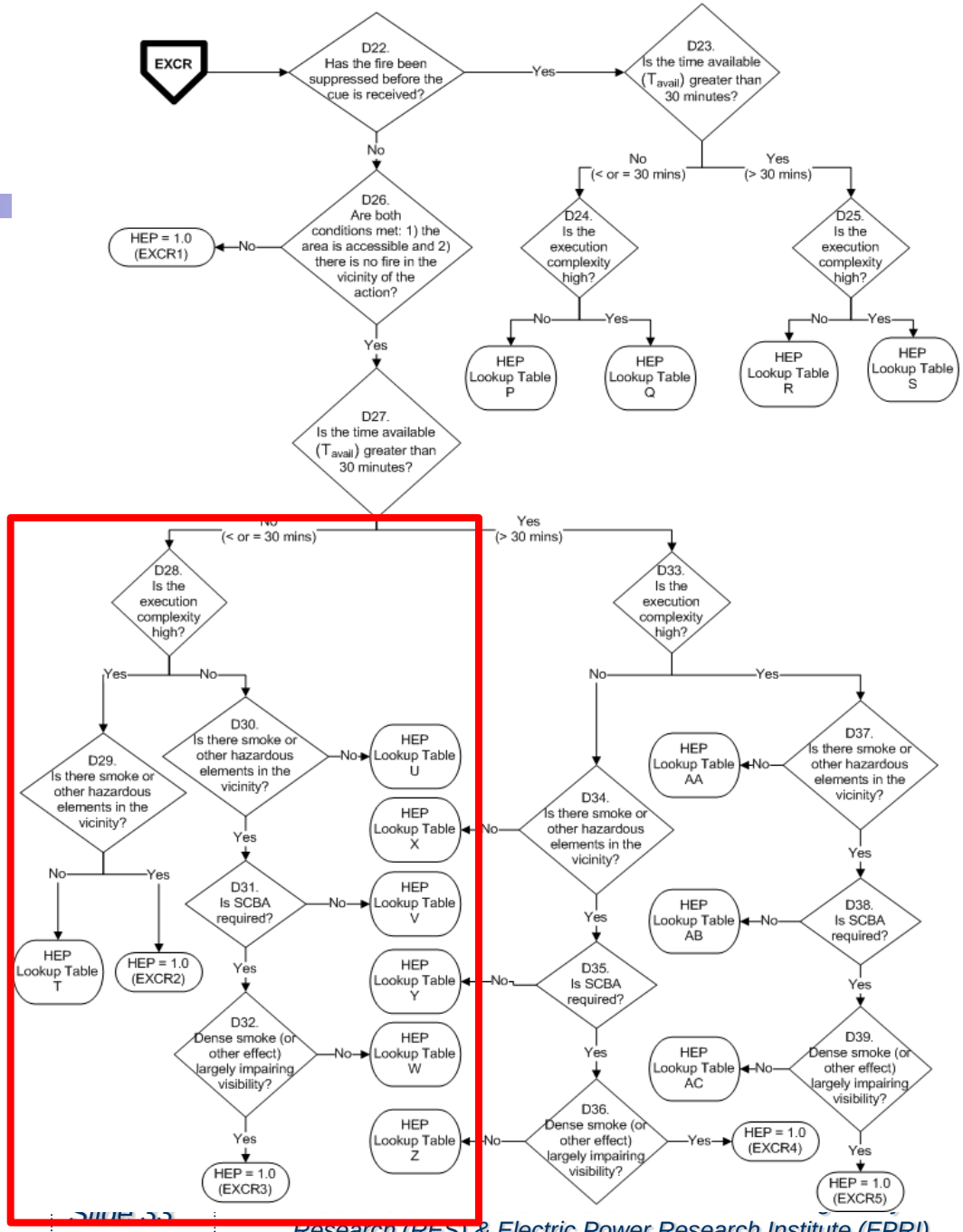
EXCR

- Fire Suppressed?
  - 70 minutes from reactor trip
  - Fire specific timing [FAQ-08-0050]
  - Challenging fires (e.g., turbine generator fires) assume fire has not been suppressed.



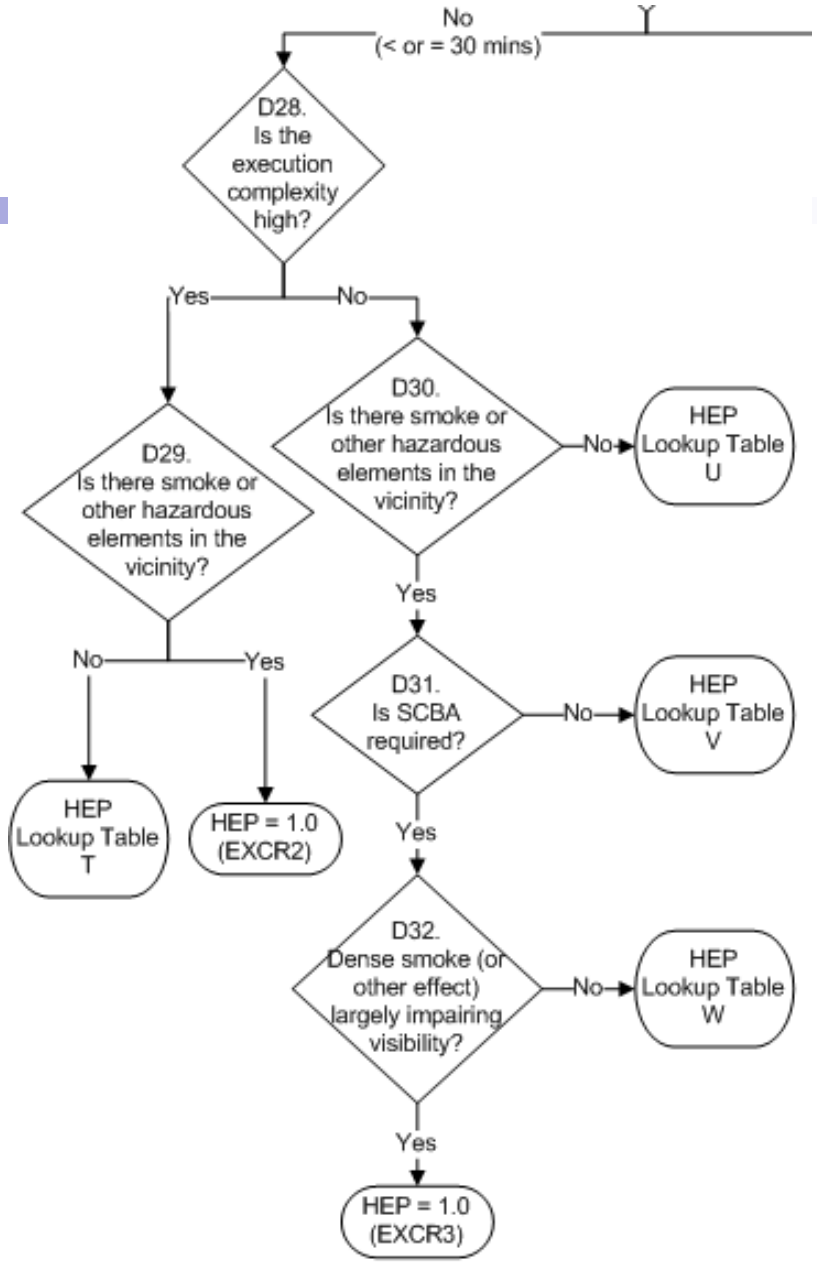
EXCR

- Scoping HRA for ex-MCR Actions



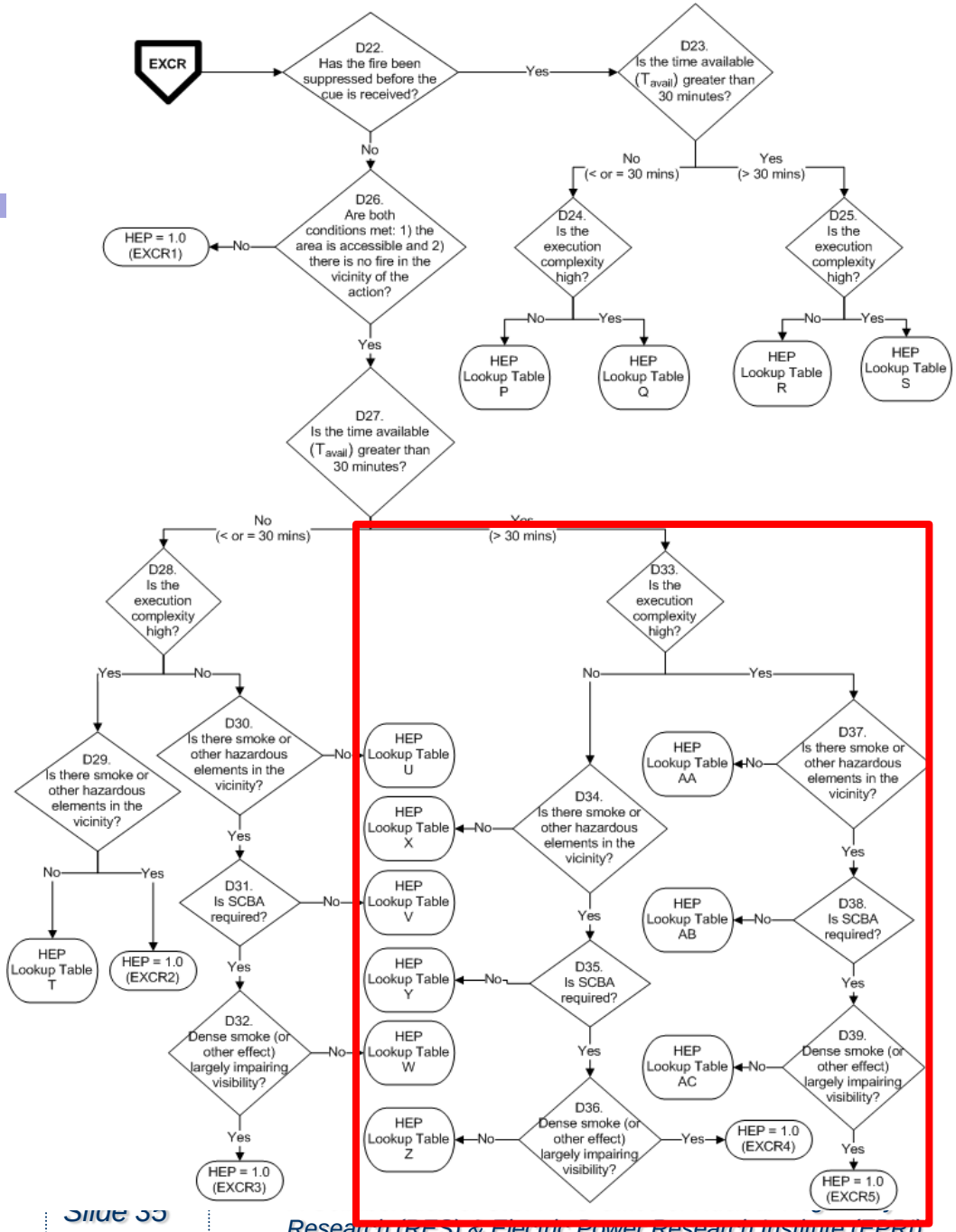
EXCR

- Fire on-going
- Short time window (< 30 min)



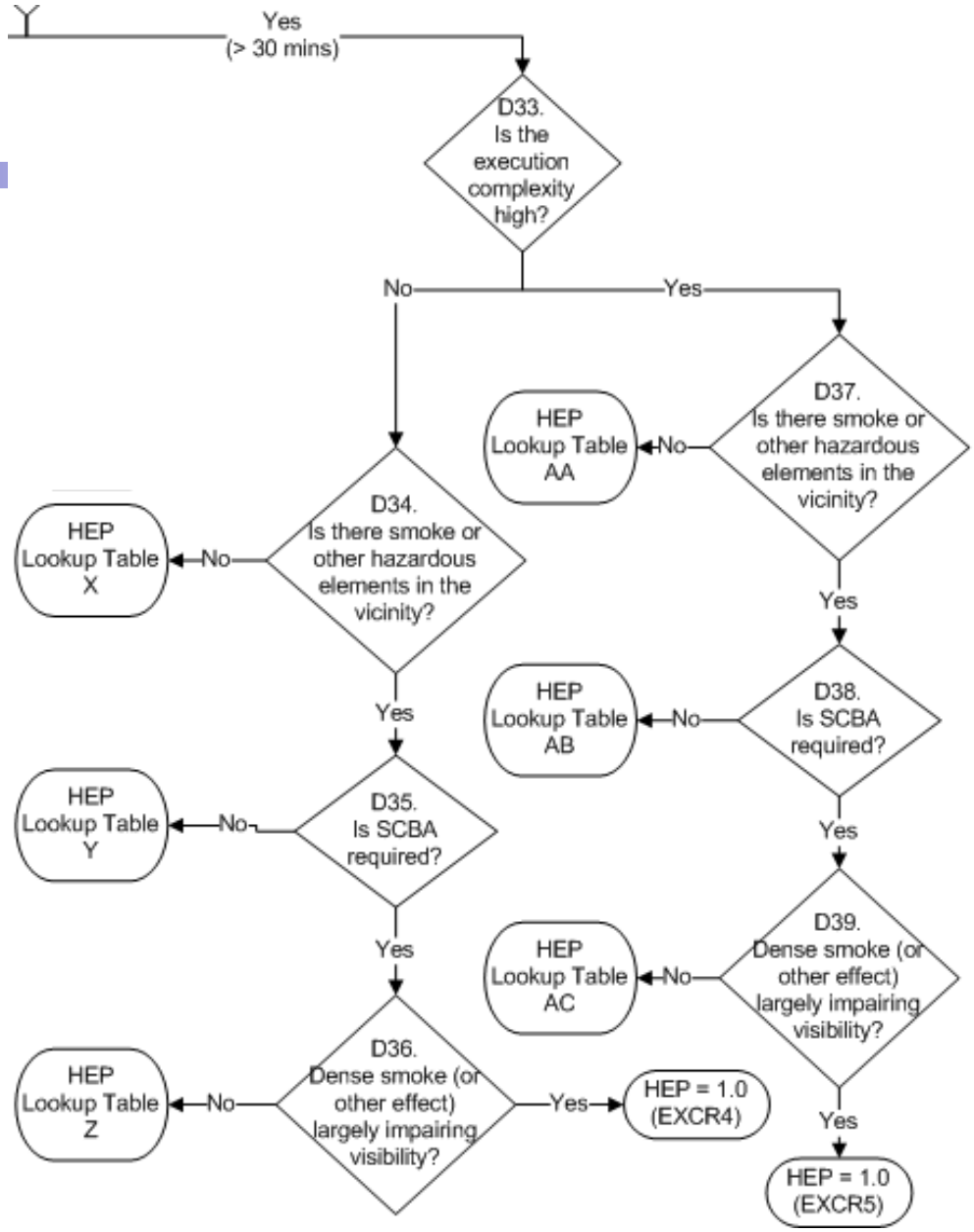
EXCR

- Scoping HRA for ex-MCR Actions



EXCR

- Fire on-going
- Long time window (> 30 min)

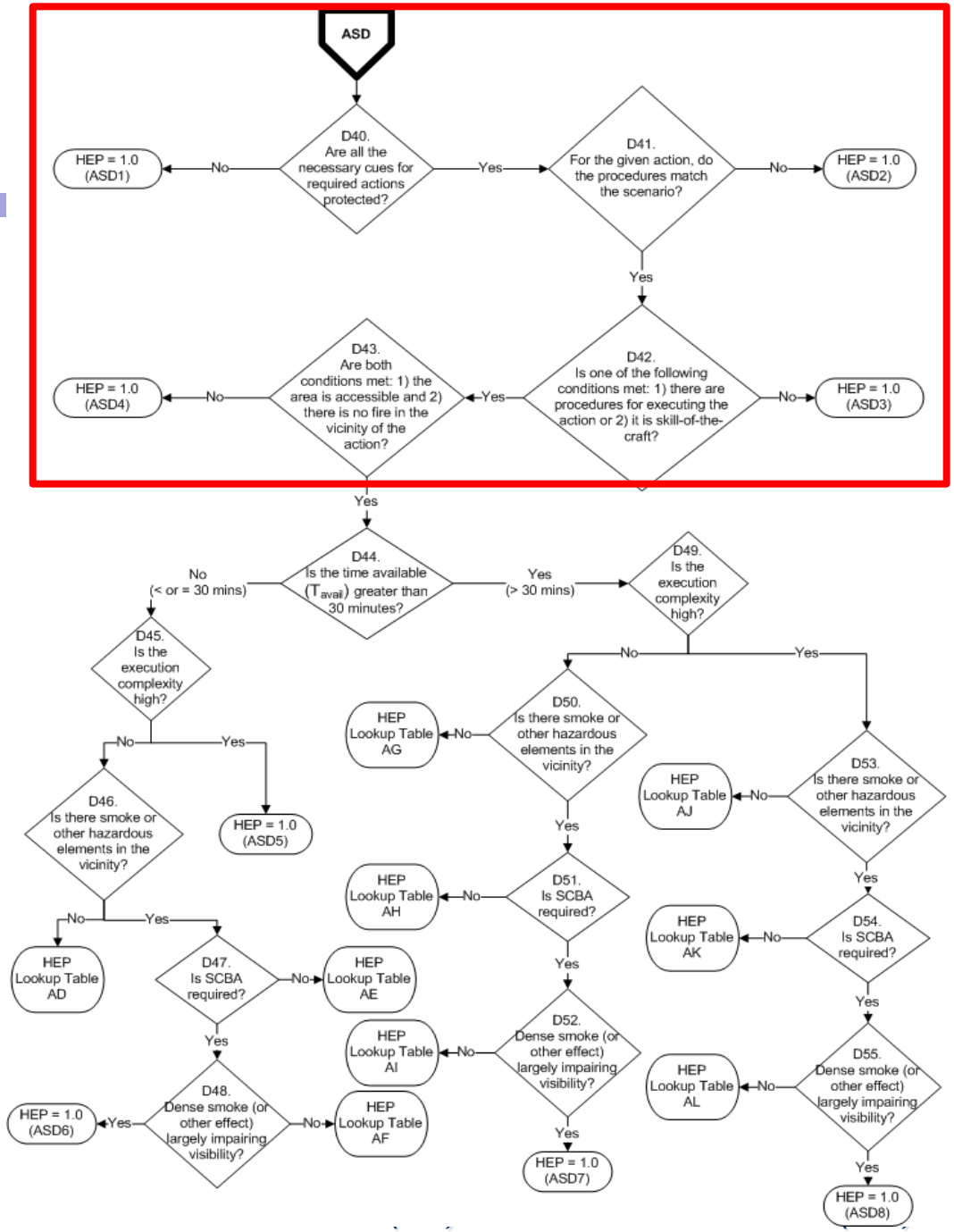


ASD – Alternate Shutdown

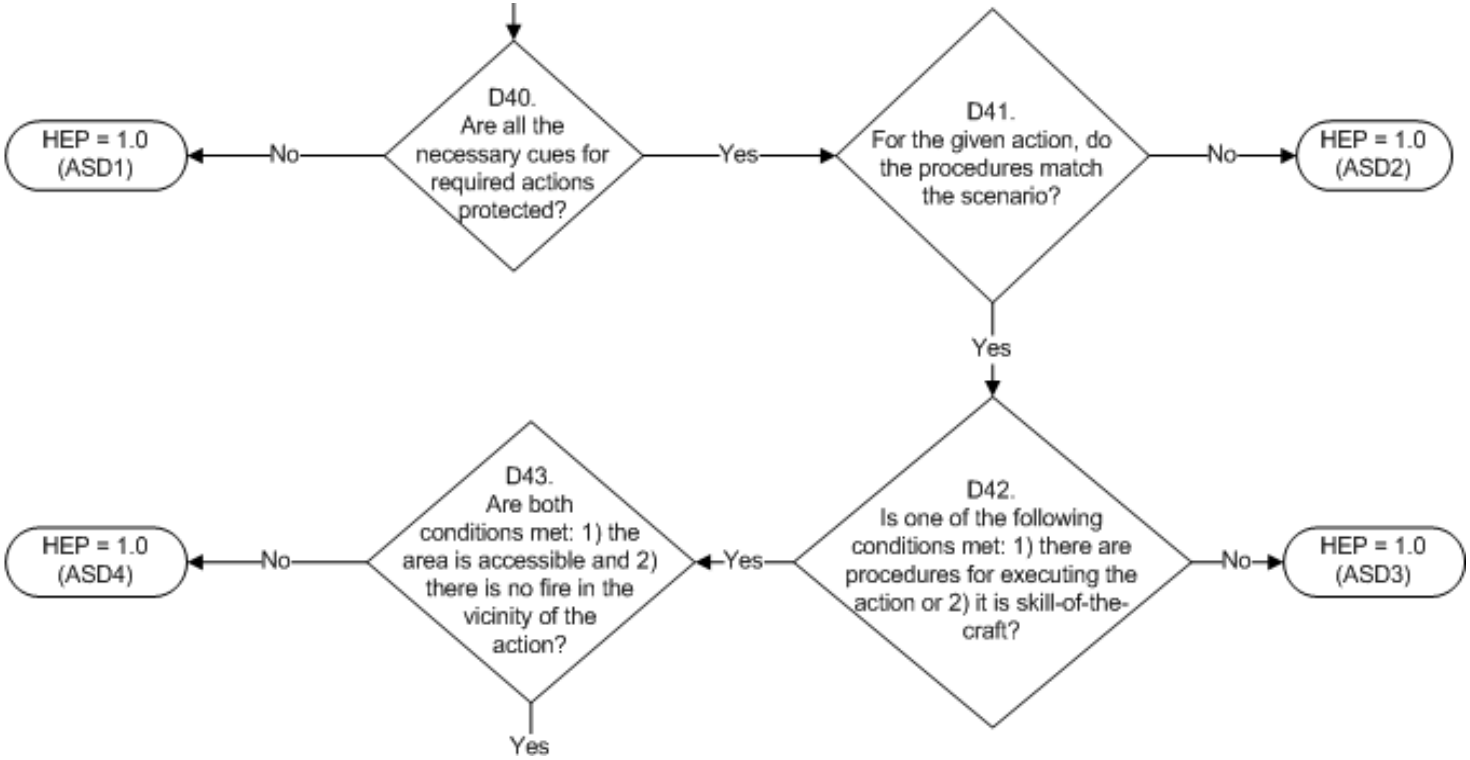
- Application to 2 situations:
  - Uninhabitable environment in MCR
  - Transfer of command and control to outside the MCR due to an inability to control the plant (loss of MCR functionality)
    - If the crew decides to stay in the MCR (i.e., direct the crew response and perform actions from the MCR to the extent possible), but collect some information or take some actions outside the MCR as necessary to reach safe shutdown (referred to as *remote shutdown*), actions should be quantified as ex-MCR actions and the EXCR flowchart should be used
- Additional information needed:
  - Identification of the cues necessary for diagnosis and verification that the instruments supporting these cues are protected from the fire effects
  - Determination of whether the action must take place in the direct vicinity of the fire.
  - Estimated level of smoke in the area

ASD

- Scoping HRA for Alternate Shutdown Actions



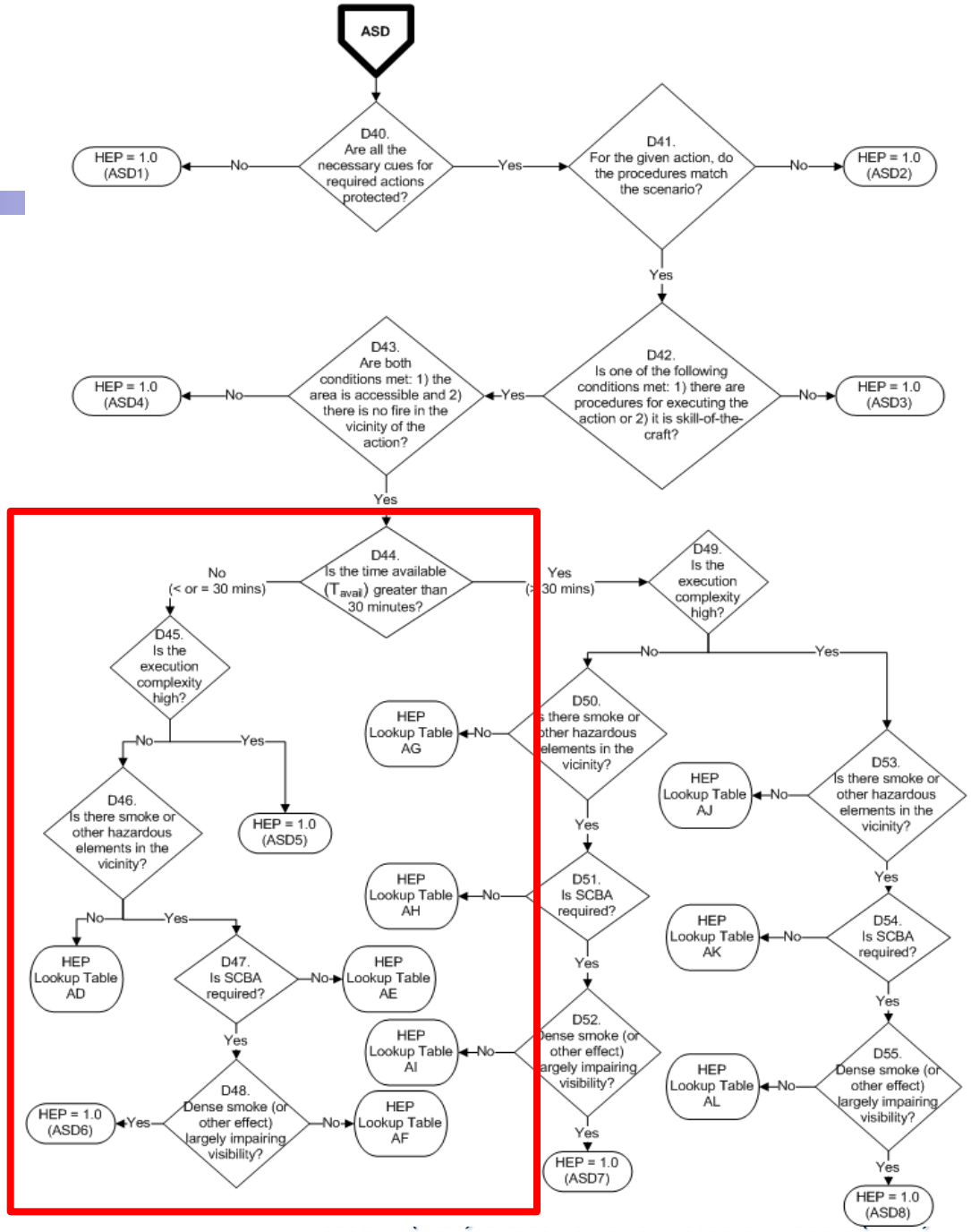
ASD



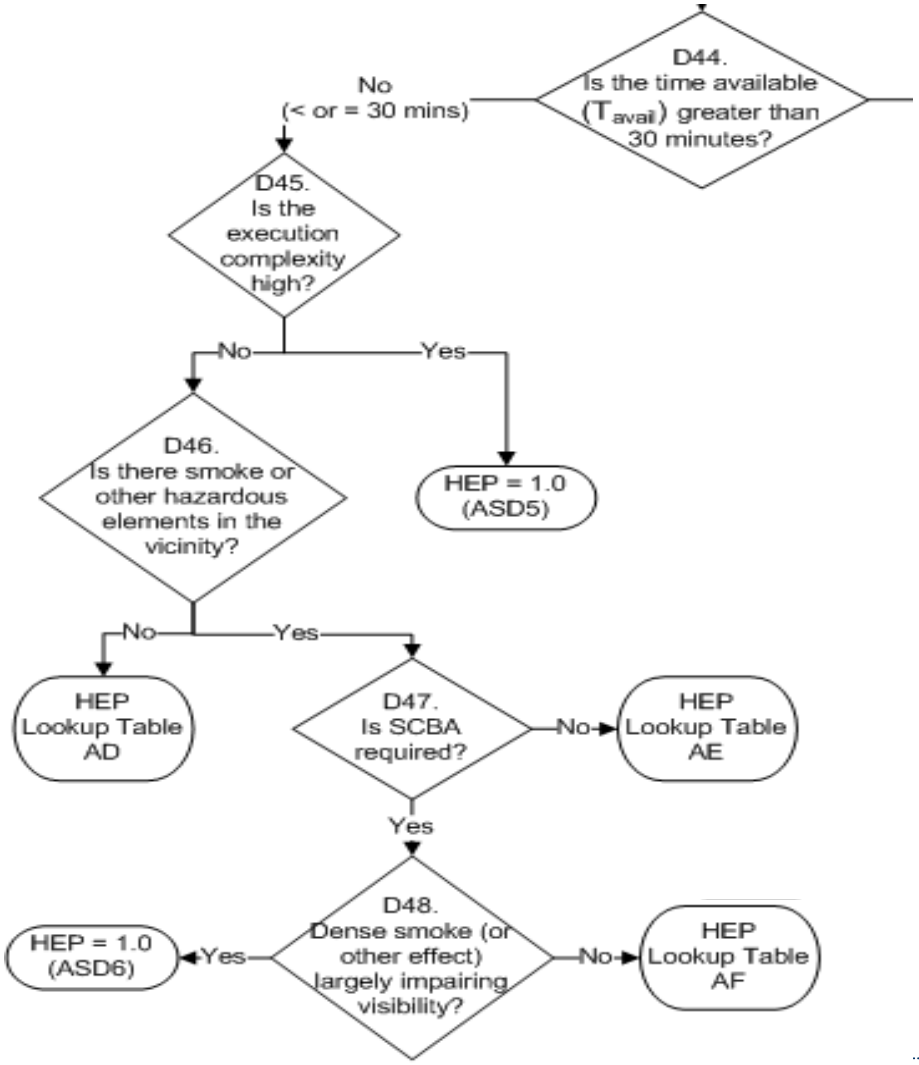
- D41 refers to diagnosis
- D42 refers to execution

ASD

- Scoping HRA for Alternate Shutdown Actions



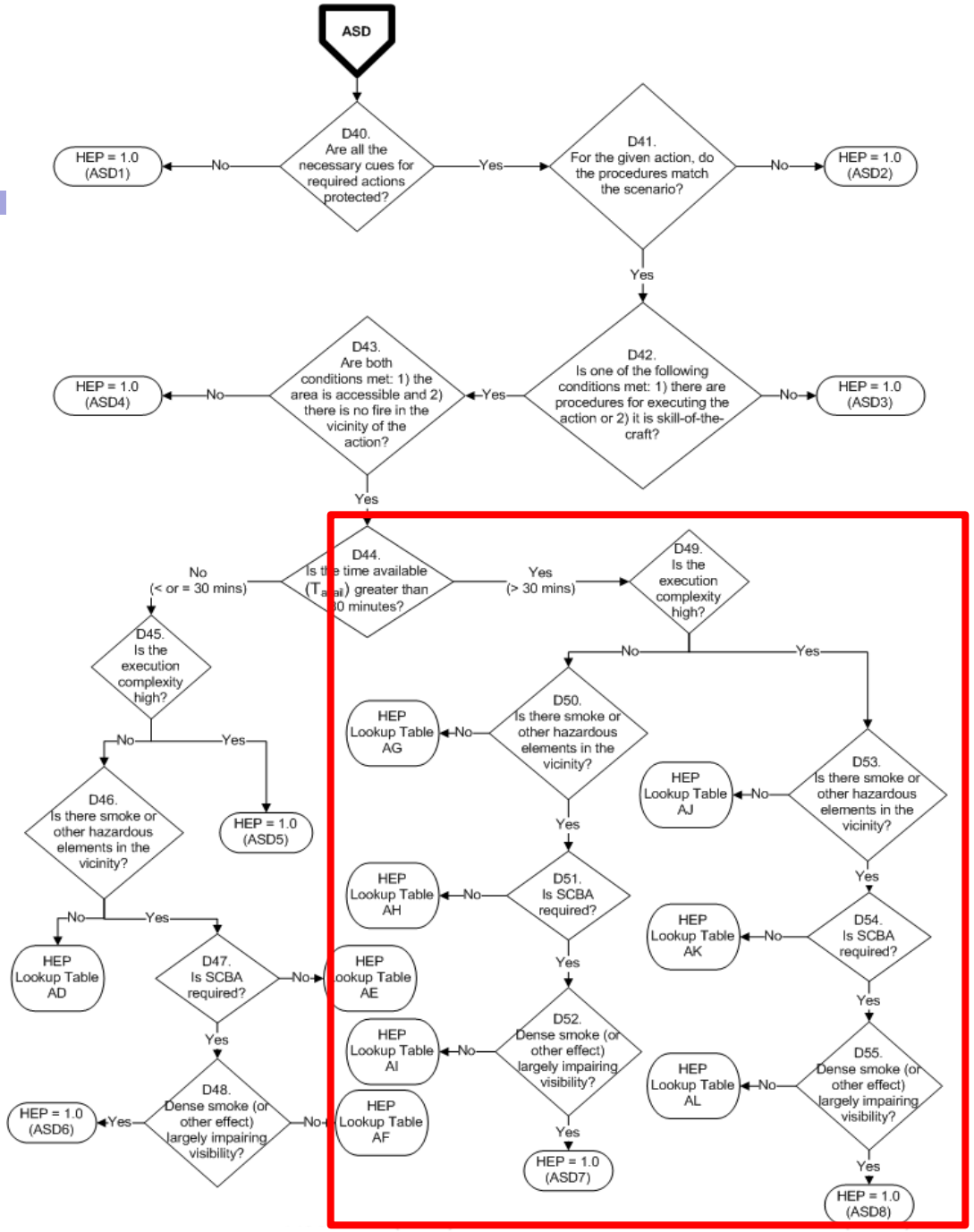
ASD



- Short time window (< 30 min)

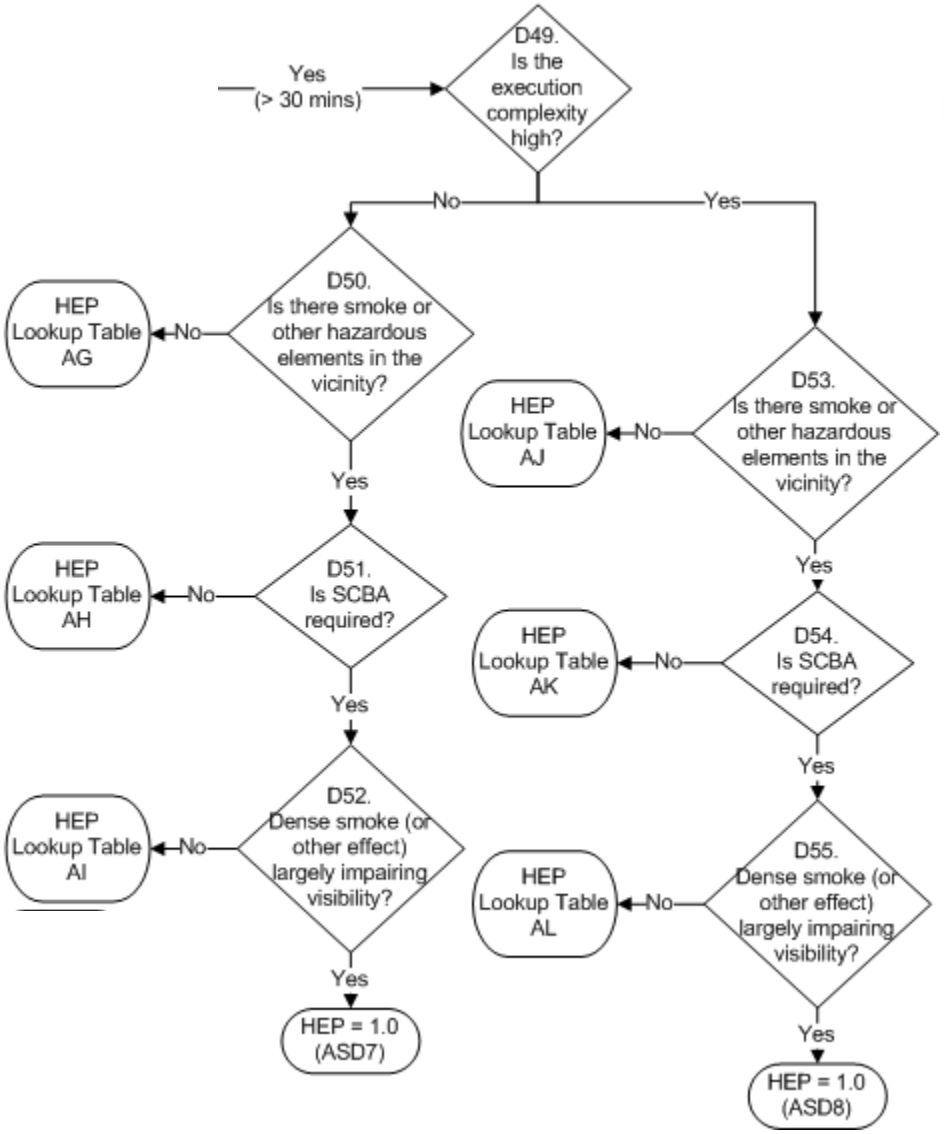
ASD

- Scoping HRA for Alternate Shutdown Actions



ASD

- Long time window (> 30 min)



SPI – EOC or EOO Due to Spurious Instrumentation

- Assumes the EOC or EOO has been committed & quantifies the probability that the error would remain uncorrected
- Assume an EOC or EOO if:
  - The instrumentation is not protected:
    - The cables are routed through the fire area (known routing)
      - Includes cables with unknown routing (exclusion approach)
      - Need cable routing information!
    - For example, instrumentation is not required for an Appendix R action, such that it cannot be assumed to be protected by a fire barrier wrap
  - A single affected instrument can lead to the action
- Do not assume an EOC or EOO if:
  - Operator is suspicious of the equipment or instrument because it may be “suspect” due to location of fire
  - Demonstrated redundancy and diversity

SPI – Spurious Instrumentation

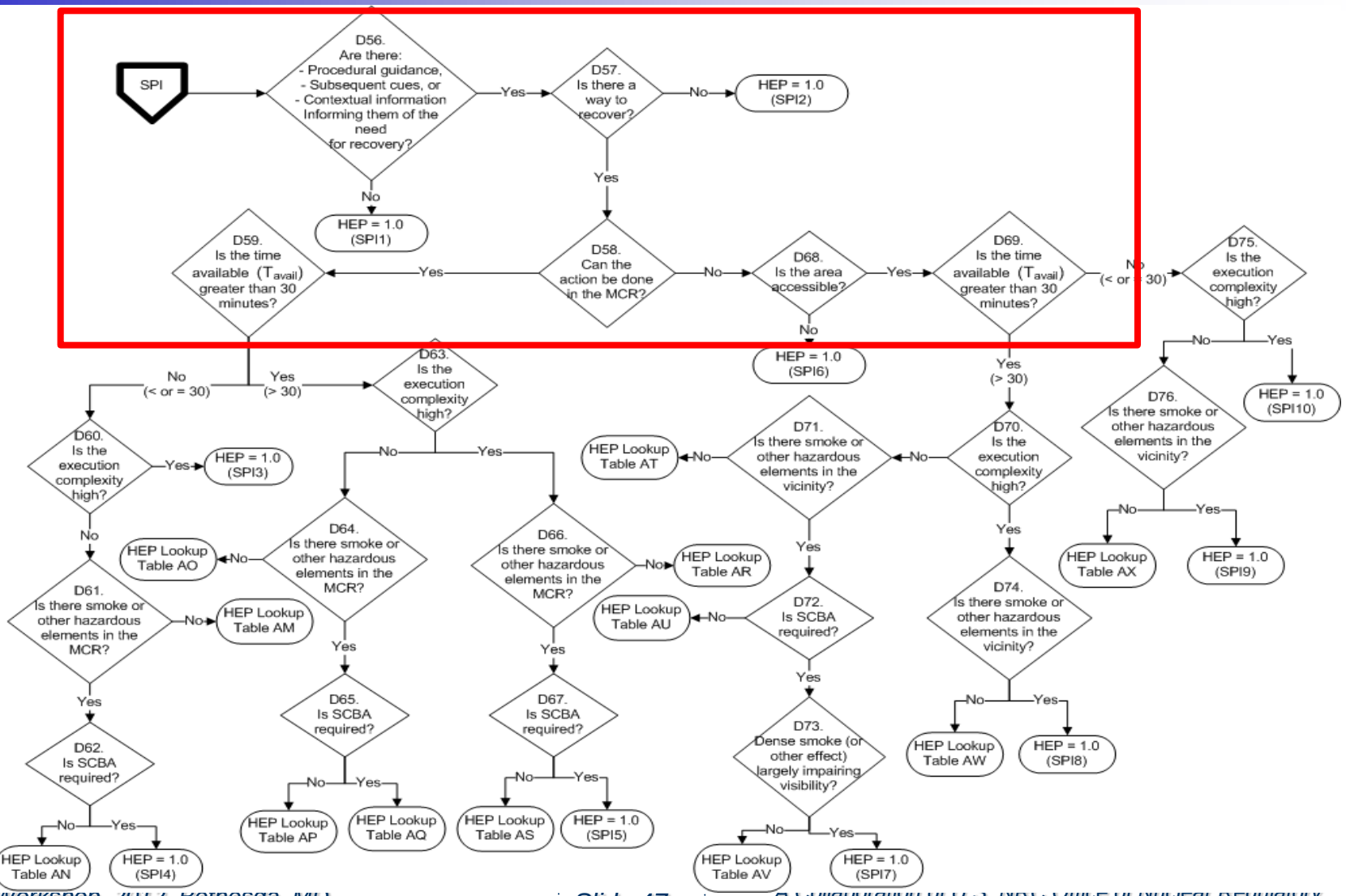
- Spurious instrumentation refers to the instrumentation necessary for the operator to diagnose the action (e.g., expected cues from the procedure)
- Analyst judgment required in cases of partial spurious indication (e.g., 2 out of 4 instruments fail vs. 2 out of 10 instruments fail). In these cases the analyst should consider:
  - How do the instruments fail?
  - Is it likely to cause the operator to fail to diagnose the problem?

SPI – Recovery of an EOC or EOO

- Recovery prompted by either:
  - Procedural guidance
  - Contextual information or subsequent cues in conjunction with existing procedures
- Recognition for need to recover may be either through:
  - Recognition of an error
  - Recognition of the need for the function
- Recovery possible by:
  - Reversal of the action (EOC)
  - Use of alternate system (EOC)
  - Performance of the necessary action (EOO)

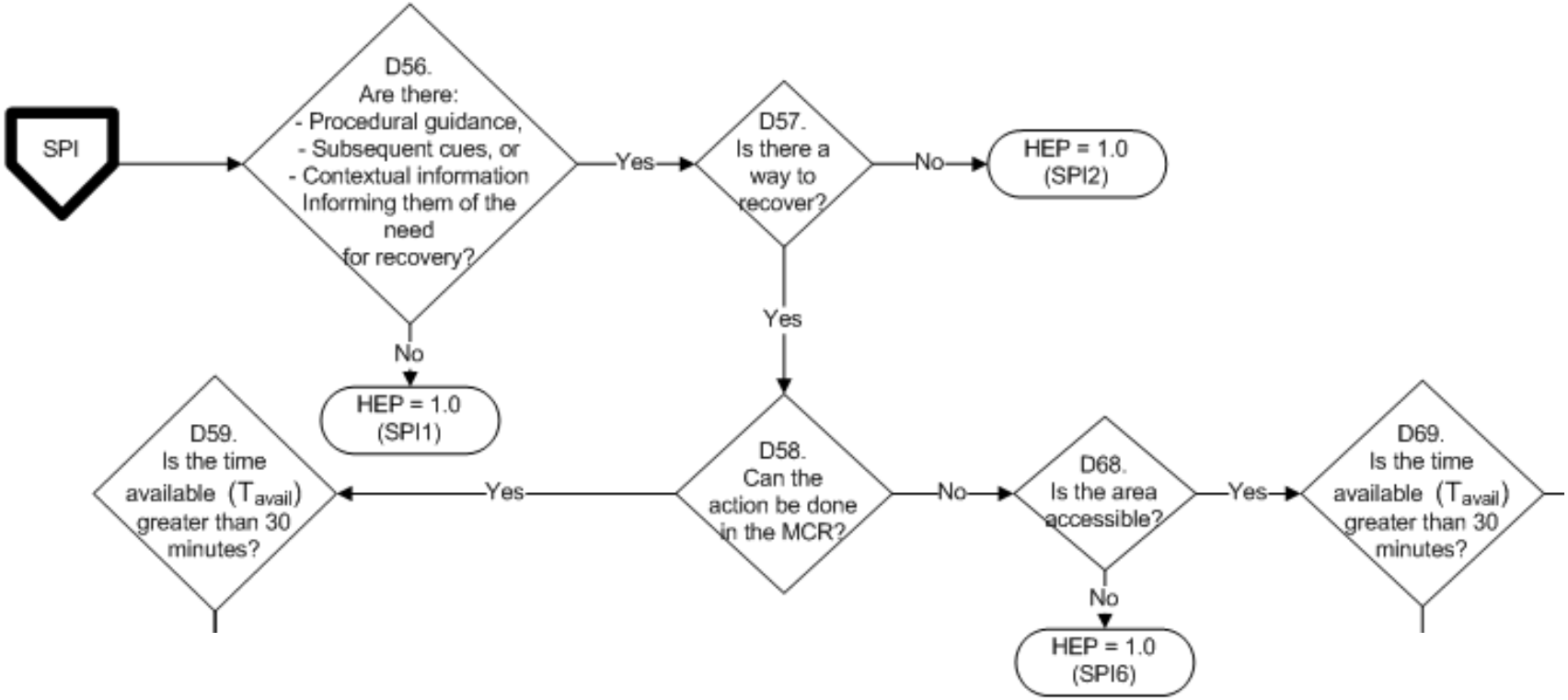
SPI

Scoping HRA for EOC or EOO due to spurious instrumentation



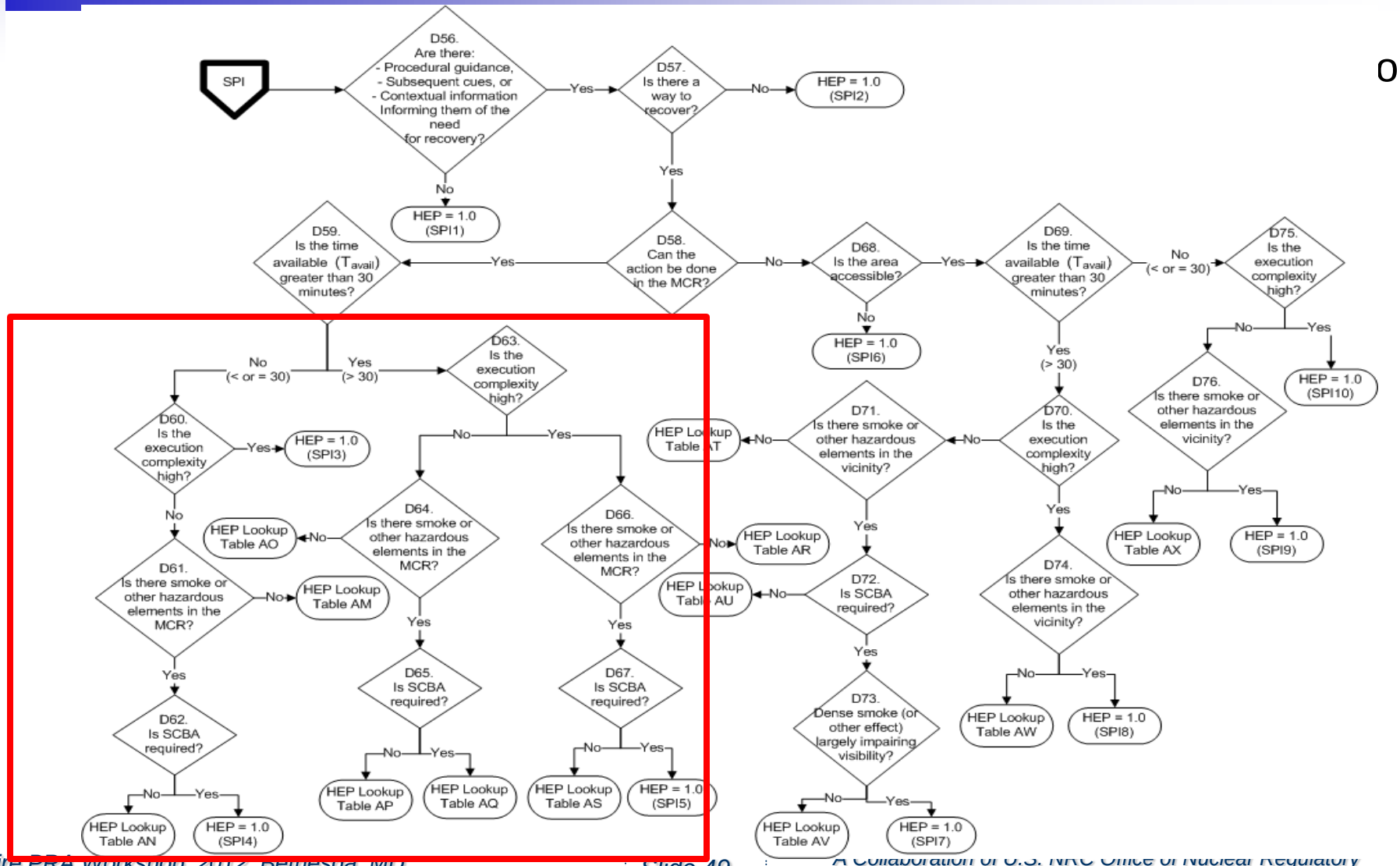
SPI

Initial questions

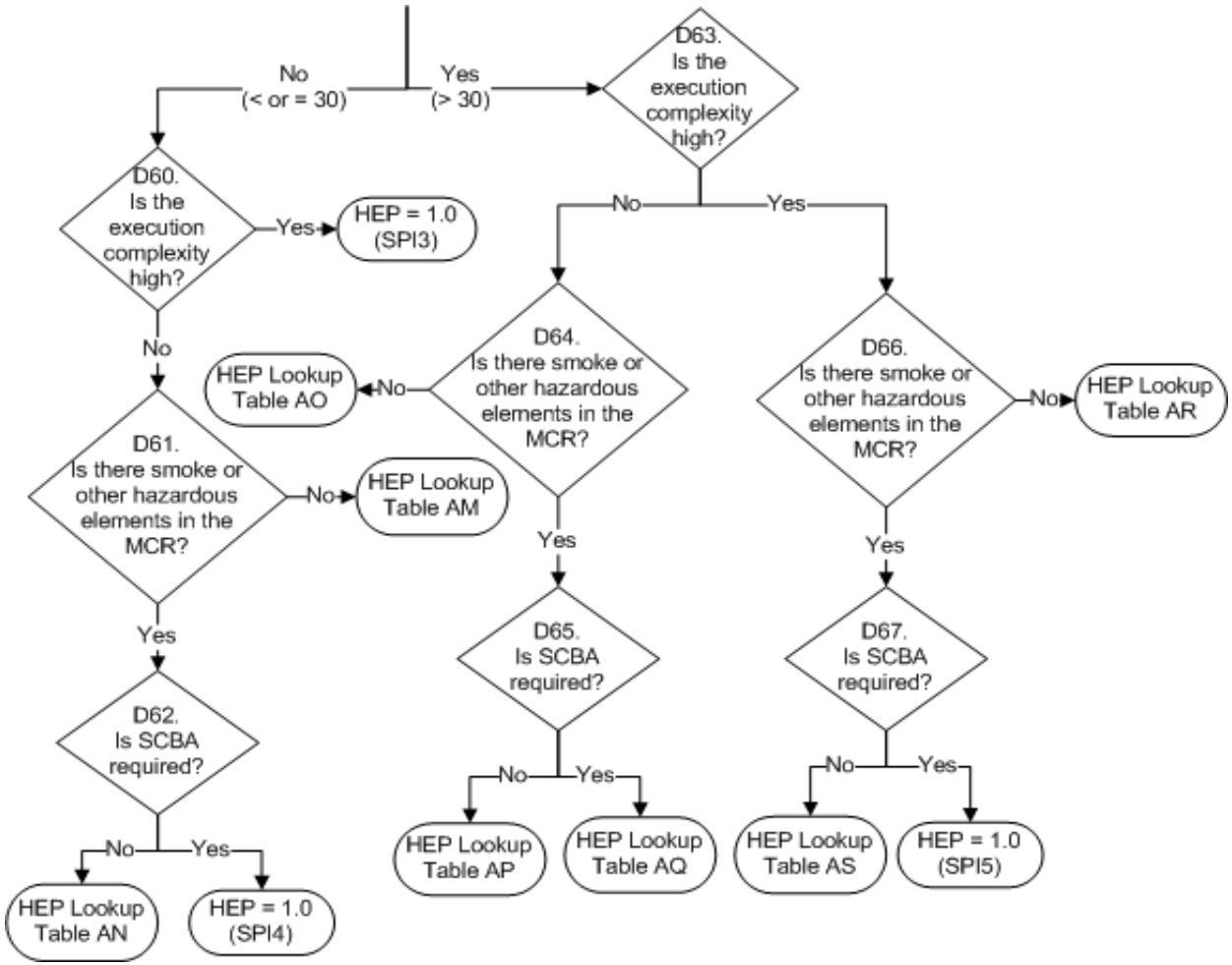


SPI

or

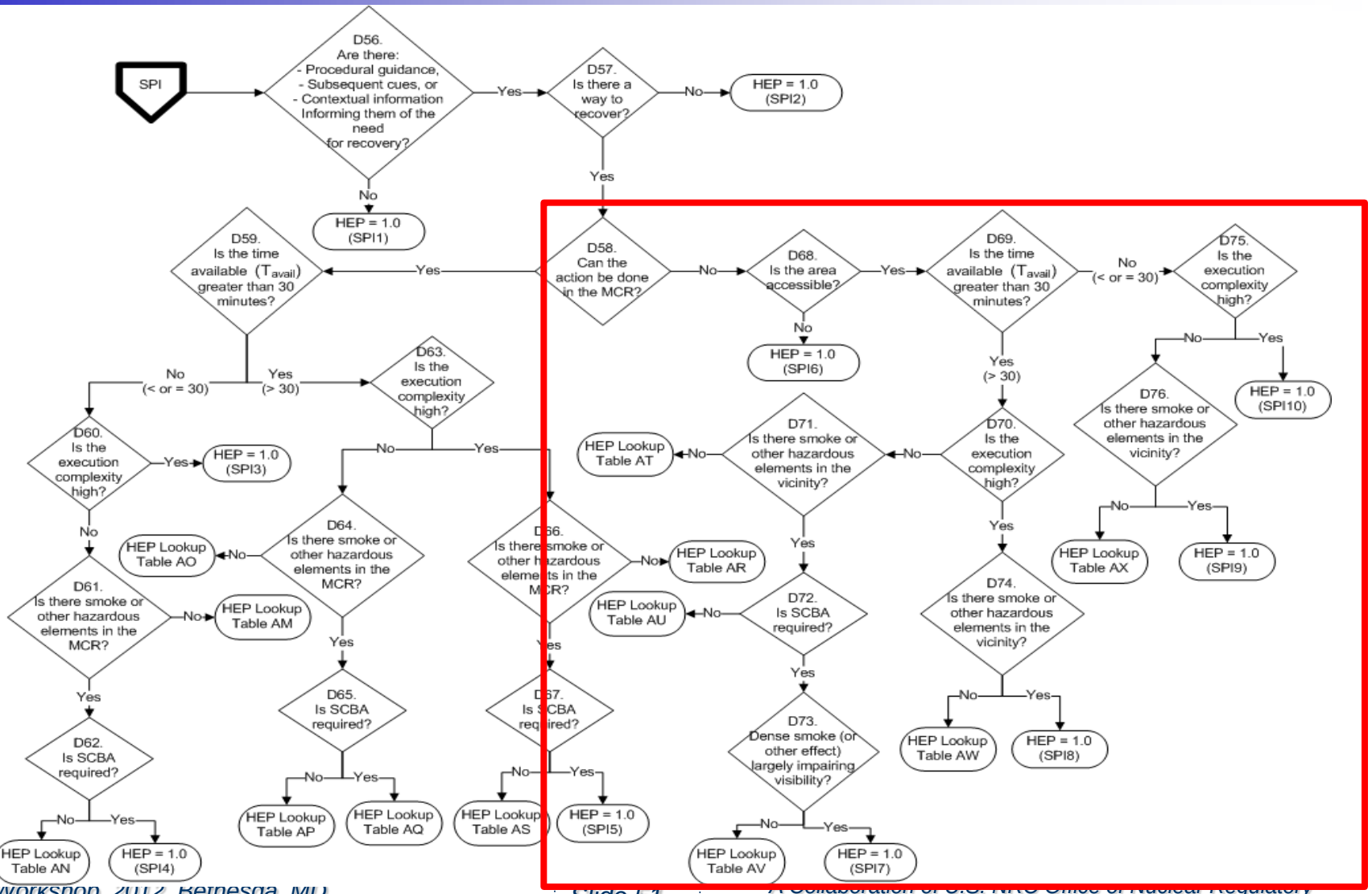

SPI
D56. Are there: - Procedural guidance, - Subsequent cues, or - Contextual information Informing them of the need for recovery?
Yes
No
HEP = 1.0 (SPI1)
D57. Is there a way to recover?
No
HEP = 1.0 (SPI2)
Yes
D58. Can the action be done in the MCR?
Yes
D59. Is the time available (T_{avail}) greater than 30 minutes?
No
D68. Is the area accessible?
No
HEP = 1.0 (SPI6)
Yes
D69. Is the time available (T_{avail}) greater than 30 minutes?
No (< or = 30)
D75. Is the execution complexity high?
No
Yes
HEP = 1.0 (SPI10)
D76. Is there smoke or other hazardous elements in the vicinity?
No
Yes
HEP Lookup Table AX
HEP = 1.0 (SPI9)
Yes (> 30)
D70. Is the execution complexity high?
No
D71. Is there smoke or other hazardous elements in the vicinity?
No
HEP Lookup Table AT
Yes
D72. Is SCBA required?
No
HEP Lookup Table AU
Yes
D73. Dense smoke (or other effect) largely impairing visibility?
No
HEP Lookup Table AV
Yes
HEP = 1.0 (SPI7)
Yes
D74. Is there smoke or other hazardous elements in the vicinity?
No
HEP Lookup Table AW
Yes
HEP = 1.0 (SPI8)
No (< or = 30)
Yes (> 30)
D60. Is the execution complexity high?
Yes
HEP = 1.0 (SPI3)
No
D61. Is there smoke or other hazardous elements in the MCR?
No
HEP Lookup Table AM
Yes
D62. Is SCBA required?
No
HEP Lookup Table AN
Yes
HEP = 1.0 (SPI4)
D63. Is the execution complexity high?
No
D64. Is there smoke or other hazardous elements in the MCR?
No
HEP Lookup Table AO
Yes
D65. Is SCBA required?
No
HEP Lookup Table AP
Yes
HEP Lookup Table AQ
Yes
D66. Is there smoke or other hazardous elements in the MCR?
No
HEP Lookup Table AR
Yes
D67. Is SCBA required?
No
HEP Lookup Table AS
Yes
HEP = 1.0 (SPI5)

SPI



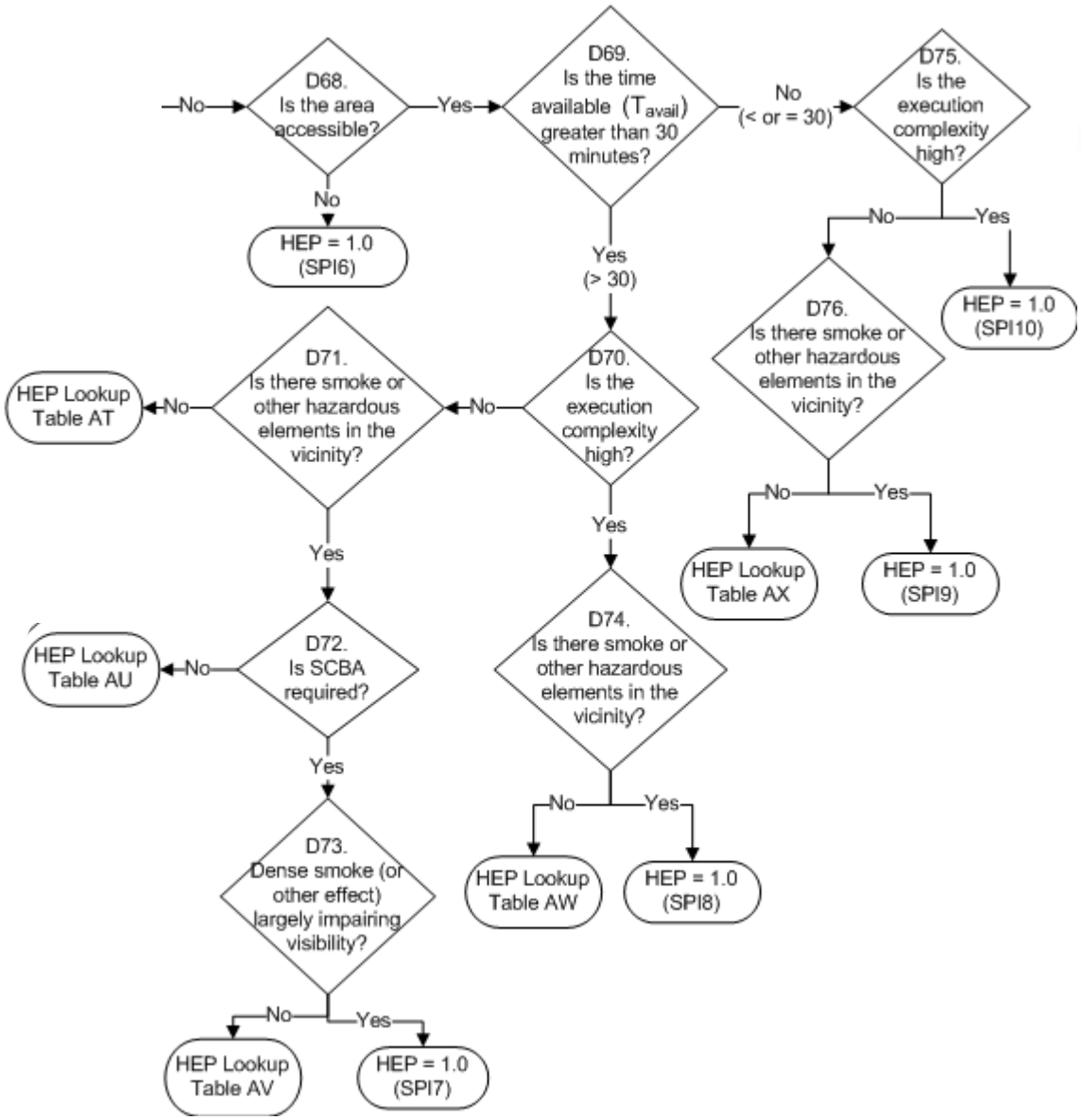
Action completed within the MCR

SPI


SPI
D56. Are there: - Procedural guidance, - Subsequent cues, or - Contextual information Informing them of the need for recovery?
Yes
No
HEP = 1.0 (SPI1)
D57. Is there a way to recover?
No
HEP = 1.0 (SPI2)
Yes
D58. Can the action be done in the MCR?
Yes
D59. Is the time available (T_{avail}) greater than 30 minutes?
No (< or = 30)
Yes (> 30)
D60. Is the execution complexity high?
Yes
HEP = 1.0 (SPI3)
No
D61. Is there smoke or other hazardous elements in the MCR?
No
HEP Lookup Table AM
Yes
D62. Is SCBA required?
No
Yes
HEP Lookup Table AN
HEP = 1.0 (SPI4)
D63. Is the execution complexity high?
No
Yes
D64. Is there smoke or other hazardous elements in the MCR?
No
HEP Lookup Table AO
Yes
D65. Is SCBA required?
No
Yes
HEP Lookup Table AP
HEP Lookup Table AQ
D66. Is there smoke or other hazardous elements in the MCR?
No
HEP Lookup Table AR
Yes
D67. Is SCBA required?
No
Yes
HEP Lookup Table AS
HEP = 1.0 (SPI5)
D68. Is the area accessible?
No
HEP = 1.0 (SPI6)
Yes
D69. Is the time available (T_{avail}) greater than 30 minutes?
No (< or = 30)
Yes (> 30)
D70. Is the execution complexity high?
No
D71. Is there smoke or other hazardous elements in the vicinity?
No
HEP Lookup Table AT
Yes
D72. Is SCBA required?
No
HEP Lookup Table AU
Yes
D73. Dense smoke (or other effect) largely impairing visibility?
No
Yes
HEP Lookup Table AV
HEP = 1.0 (SPI7)
Yes
D74. Is there smoke or other hazardous elements in the vicinity?
No
Yes
HEP Lookup Table AW
HEP = 1.0 (SPI8)
D75. Is the execution complexity high?
No
Yes
HEP = 1.0 (SPI10)
D76. Is there smoke or other hazardous elements in the vicinity?
No
Yes
HEP Lookup Table AX
HEP = 1.0 (SPI9)

SPI

Action completed locally (ex-MCR)



HEP Values

- Base HEP = 1E-3 (minimally attainable value)
- Within a flowchart, HEP values are based on:
  - Timing of the cue for an action relative to start of fire
  - Length of action time window
  - Level of execution complexity
  - Level of smoke (area of action & travel path)
  - Accessibility of action site (area of action & travel path)

Multipliers Applied to HEPs Within Flowchart

- HEPs adjusted within a flowchart
  - Fire effects ongoing – significant increase
  - Action time window ≤ 30 minutes – moderate increase
  - High execution complexity – moderate increase
  - Increases in smoke level – slight increase
  - Decrease in time margin – moderate increase
- HEPs is a function of the time margin (TM)
  - TM < 50%
  - 50% < TM < 100%
  - TM ≥ 100%

Multipliers Applied to HEPs Across Flowcharts

HEP in Base Flowchart	Adjustment Value	HEP in Scoping Flowchart
INCR	2	EXCR
EXCR	2	ASD
INCR for in-MCR actions; EXCR for ex-MCR actions	5	SPI

Change in PSF	Scoping Approach Multipliers
Fire effects ongoing (i.e., < 70 minutes from the start of the fire)	10
Action time window ≤ 30 minutes	5
High execution complexity	5
Increases in smoke level	2
Decreases in time margin: from ≥ 100% to 50%-99% from ≥ 50% to < 50%	 5 Set HEP = 1.0

Summary of Scoping Quantification

- Purpose:
  - Offers less conservative and more realistic HEPs compared to the screening approach
  - More conservative but less resource intensive than more detailed HRA methods
- Categories:
  - In-MCR or local (ex-MCR) actions
  - Alternate shutdown
  - Recovery of errors due to spurious instrumentation
- Quantification:
  - Relies on assessment of feasibility of actions, time margin, and simple judgments about a few PSFs
  - Quantification is through the use of flowcharts

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BACKUP SLIDES

INCR Look-up Table

HEP Lookup Table	Time Margin	HEP	HEP Label
A	≥ 100%	0.005	INCR2
	50 – 99%	0.025	INCR3
	< 50%	1.0	INCR4
B	≥ 100%	0.025	INCR5
	50 – 99%	0.125	INCR6
	< 50%	1.0	INCR7
C	≥ 100%	0.001	INCR8
	50 – 99%	0.005	INCR9
	< 50%	1.0	INCR10
D	≥ 100%	0.005	INCR11
	50 – 99%	0.025	INCR12
	< 50%	1.0	INCR13
E	≥ 100%	0.05	INCR14
	50 – 99%	0.25	INCR15
	< 50%	1.0	INCR16
F	≥ 100%	0.1	INCR17
	50 – 99%	0.5	INCR18
	< 50%	1.0	INCR19
G	≥ 100%	0.2	INCR20
	< 100%	1.0	INCR21
H	≥ 100%	0.25	INCR22
	< 100%	1.0	INCR23
I	≥ 100%	0.5	INCR24
	< 100%	1.0	INCR25
J	≥ 100%	0.01	INCR26
	50 – 99%	0.05	INCR27
	< 50%	1.0	INCR28
K	≥ 100%	0.02	INCR29
	50 – 99%	0.1	INCR30
	< 50%	1.0	INCR31
L	≥ 100%	0.04	INCR32
	50 – 99%	0.2	INCR33
	< 50%	1.0	INCR34
M	≥ 100%	0.05	INCR35
	50 – 99%	0.25	INCR36
	< 50%	1.0	INCR37
N	≥ 100%	0.1	INCR38
	50 – 99%	0.5	INCR39
	< 50%	1.0	INCR40
O	≥ 100%	0.2	INCR41
	< 100%	1.0	INCR42

Note that some tables (e.g., G) “absorb” the 50-99% TM into one <100% because multiplying the >100% TM by 5 already causes HEP=1

EXCR Look-up Table

HEP Lookup Table	Time Margin	HEP	HEP Label
P	≥ 100%	0.01	EXCR6
	50 – 99%	0.05	EXCR7
	< 50%	1.0	EXCR8
Q	≥ 100%	0.05	EXCR9
	50 – 99%	0.25	EXCR10
	< 50%	1.0	EXCR11
R	≥ 100%	0.002	EXCR12
	50 – 99%	0.01	EXCR13
	< 50%	1.0	EXCR14
S	≥ 100%	0.01	EXCR15
	50 – 99%	0.05	EXCR16
	< 50%	1.0	EXCR17
T	≥ 100%	0.5	EXCR18
	< 100%	1.0	EXCR19
U	≥ 100%	0.1	EXCR20
	50 – 99%	0.5	EXCR21
	< 50%	1.0	EXCR22
V	≥ 100%	0.2	EXCR23
	< 100%	1.0	EXCR24
W	≥ 100%	0.4	EXCR25
	< 100%	1.0	EXCR26
X	≥ 100%	0.02	EXCR27
	50 – 99%	0.1	EXCR28
	< 50%	1.0	EXCR29
Y	≥ 100%	0.04	EXCR30
	50 – 99%	0.2	EXCR31
	< 50%	1.0	EXCR32
Z	≥ 100%	0.08	EXCR33
	50 – 99%	0.4	EXCR34
	< 50%	1.0	EXCR35
AA	≥ 100%	0.1	EXCR36
	50 – 99%	0.5	EXCR37
	< 50%	1.0	EXCR38
AB	≥ 100%	0.2	EXCR39
	< 100%	1.0	EXCR40
AC	≥ 100%	0.4	EXCR41
	< 100%	1.0	EXCR42

ASD Look-up Table

HEP Lookup Table	Time Margin	HEP*	HEP Label
AD	≥ 100%	0.2	ASD9
	< 100%	1.0	ASD10
AE	≥ 100%	0.4	ASD11
	< 100%	1.0	ASD12
AF	≥ 100%	0.8	ASD13
	< 100%	1.0	ASD14
AG	≥ 100%	0.04	ASD15
	50 – 99%	0.2	ASD16
	< 50%	1.0	ASD17
AH	≥ 100%	0.08	ASD18
	50 – 99%	0.4	ASD19
	< 50%	1.0	ASD20
AI	≥ 100%	0.16	ASD21
	50 – 99%	0.8	ASD22
	< 50%	1.0	ASD23
AJ	≥ 100%	0.2	ASD24
	< 100%	1.0	ASD25
AK	≥ 100%	0.4	ASD26
	< 100%	1.0	ASD27
AL	≥ 100%	0.8	ASD28
	< 100%	1.0	ASD29

SPI Look-up Table

AM	≥ 100%	0.25	SPI11
	< 100%	1.0	SPI12
AN	≥ 100%	0.5	SPI13
	< 100%	1.0	SPI14
AO	≥ 100%	0.05	SPI15
	50 – 99%	0.25	SPI16
	< 50%	1.0	SPI17
AP	≥ 100%	0.1	SPI18
	50 – 99%	0.5	SPI19
	< 50%	1.0	SPI20
AQ	≥ 100%	0.2	SPI21
	< 100%	1.0	SPI22
AR	≥ 100%	0.25	SPI23
	< 100%	1.0	SPI24
AS	≥ 100%	0.5	SPI25
	< 100%	1.0	SPI26
AT	≥ 100%	0.1	SPI27
	50 – 99%	0.5	SPI28
	< 50%	1.0	SPI29
AU	≥ 100%	0.2	SPI30
	< 100%	1.0	SPI31
AV	≥ 100%	0.4	SPI32
	< 100%	1.0	SPI33
AW	≥ 100%	0.5	SPI34
	< 100%	1.0	SPI35
AX	≥ 100%	0.5	SPI36
	< 100%	1.0	SPI37

Conclusions on Scoping Analysis

- Useful to address actions for which
  - Screening analysis is inadequate
  - Additional resources required for detailed analysis may be unwarranted
- More detailed analyses should be pursued when
  - Conditions are beyond those addressed by scoping approach
  - Resulting HFEs continue to be significant contributors to risk
- Examples via Handouts