SDP AND MANUAL ACTIONS

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Credit for Manual Actions In SDP

- Typical recovery actions (for a train)
- Alternate Shutdown
  - Operators may evacuate or remain in the control room
  - Manual actions more complicated in control room evacuation than for recovery of a single train

Variations of Shutdown Scheme Between App R and Scenario Approach

- App R approach assumes failure of all safe shutdown trains within fire area or zone
- Scenario approach typically assumes failure of only a subset of trains failed in App R approach
- Scenario approach may have trains of safe shutdown available which are failed in App R approach
  - Alternate shutdown area in App R may not be so for scenario approach
  - A risk significant area under App R assumptions may not be so under scenario approach
  - Difference in timeline between App R and scenario approach due to different equipment availability

Control Room Evacuation

- Operator decision for control room evacuation depends upon fire scenarios which force abandonment
  - Cable spreading room fire forces evacuation when ability to shutdown lost due to cable damage or spurious actuations
  - Control room fire forces evacuation due to smoke obscuring panels (SNL studies support evacuation due to a single cabinet fire)

Basis for Credit for Manual Actions

- Functionality (e.g. physical accessibility restricted or prevented, tool available to manipulate equipment, lighting, noise)
- Impact of fire/smoke
- Procedures, training

Tool Currently Available for Evaluating Human Actions

- SPAR HRA model (ASP Human Error Worksheets)
  - Developed for event assessment, approved and in public domain
  - Address response time, stress, complexity, experience/training, quality of procedures, environment, dependencies between actions.
  - Fire/smoke affects not addressed directly. Must judge effect on environment and stress.
- Qualitative judgement on factors related to human actions made to support quantification
- Used to characterize each human action of the sequence separately
- SRAs very familiar with this tool

SPAR Model Human Error Worksheet (Page 1 of 3)

Plant: ANO Unit 2 **Event Name:** SWS-XHE-XM-STRT

Task Error Description: Operator fails to align/start spare service water pump

Does this task contain a significant amount of diagnosis activity? YES ___ NO ✔

If Yes, Use Table 1 below to evaluate the PSFs for the Diagnosis portion of the task before going to Table 2. If No, go directly to Table 2.

Table 1. Diagnosis worksheet.

PSFs	PSF Levels	Multiplier for Diagnosis	If non-nominal PSF levels are selected, please note specific reasons in this column
1. Available Time	Inadequate	1.0[a]	
	Barely adequate < 20 m	10	
	Nominal ≈ 30 m	1	
	Extra > 60 m	0.1	
	Expansive > 24 h	0.01	
2. Stress	Extreme	5	
	High	2	
	Nominal	1	
3. Complexity	Highly	5	
	Moderately	2	
	Nominal	1	
4. Experience/ Training	Low	10	
	Nominal	1	
	High	0.5	
5. Procedures	Not available	50	
	Available, but poor	5	
	Nominal	1	
	Diagnostic/symptom oriented	0.5	
6. Ergonomics	Missing/Misleading	50	
	Poor	10	
	Nominal	1	
	Good	0.5	
7. Fitness for Duty	Unfit	1.0[a]	
	Degraded Fitness	5	
	Nominal	1	
8. Work Processes	Poor	2	
	Nominal	1	
	Good	0.8	

a. Task failure probability is 1.0 regardless of other PSFs.

Table 2. Action worksheet.

PSFs	PSF Levels	Multiplier for Action	If non-nominal PSF levels are selected, please note specific reasons in this column
1. Available Time	Inadequate	1.0[a]	
	Time available ≈ time required	10	
	Nominal	1✔	
	Available > 50x time required	0.01	
2. Stress	Extreme	5	
	High	2	
	Nominal	1✔	
3. Complexity	Highly	5	
	Moderately	2	
	Nominal	1✔	
4. Experience/ Training	Low	3	
	Nominal	1✔	
	High	0.5	
5. Procedures	Not available	50	
	Available, but poor	5	
	Nominal	1✔	
6. Ergonomics	Missing/Misleading	50	
	Poor	10	
	Nominal	1✔	
	Good	0.5	
7. Fitness for Duty	Unfit	1.0[a]	
	Degraded Fitness	5	
	Nominal	1✔	
8. Work Processes	Poor	2	
	Nominal	1✔	
	Good	0.8	

a. Task failure probability is 1.0 regardless of other PSFs.

Table 3. Task failure probability without formal dependence worksheet.

Task Portion	Nom. Prob.	Time	Stress	Compl.	Exper./ Train.	Proced.	Ergon.	Fitness	Work Process	Prob.
Diag.	1.0E-2									N/A
tion	1.0E-3	x 1.0	x 1.0	x 1.0	x 1.0	x 1.0	x 1.0	x 1.0	x 1.0	1.0E-3
al										1.0E-3

For all tasks, except the first task in the sequence, use the table and formulae below to calculate the Task Failure Probability With Formal Dependence.

Table 4. Dependency condition worksheet.

Condition Number	Crew (same or different)	Location (same or different)	Time (close in time or not close in time)	Cues (additional or not additional)	Dependency	Number of Human Action Failures Rule
1	s	s	c	–	complete	If this error is the 3rd error in the sequence, then the dependency is at least moderate. If this error is the 4th error in the sequence, then the dependency is at least high. This rule may be ignored only if there is compelling evidence for less dependence with the previous tasks.
2	s	s	nc	na	high	
3	s	s	nc	a	moderate	
4	s	d	c	–	high	
5	s	d	nc	na	moderate	
6	s	d	nc	a	low	
7	d	s	c	–	moderate	
8	d	s	nc	na	low	
9	d	s	nc	a	low	
10	d	d	c	–	moderate	
11	d	d	nc	na	low	
12	d	d	nc	a	low	
13 ✔					zero	

Using P = Task Failure Probability Without Formal Dependence (calculated on page 2):

For Complete Dependence the probability of failure = 1.0
For High Dependence the probability of failure = (1 + P)/2
For Moderate Dependence the probability of failure = (1 +6P)/7
For Low Dependence the probability of failure = (1 + 19P)/20
✔ For Zero Dependence the probability of failure = P

Task Failure Probability With Formal Dependence = (1 + (____ * _____)) / ____ = 1.0E-3

Additional Notes:

RES-Developed Tool for Alternate Shutdown

- Realistic to conservative tool; depends on specific plant
- Can characterize recovery due to complicated set of human actions, or a single human action also.
- Addresses impact of spurious actuation due to incomplete electrical separation in addition to impact of fire/smoke and functionality, other environmental considerations.
- Combines all impact into an evaluation of shutdown capability. Judgement still required.
- Recovery of systems or components from spurious actuation treated from human reliability point of view
- Assumes full procedure is necessary for shutdown
    - Tool can be modified to remove this shortcoming

Further Discussion of Alternate Shutdown Tool

- Originally, a one step better approach for remote shutdown due to CR evacuation
  - Baseline in SDP was 0.1 failure probability due to a set of human actions
  - Produces either a baseline probability for alternate shutdown, more reliable probability for alternate shutdown, or a lesser reliable shutdown
- Extended to alternate shutdown since human actions are required for successful alternate shutdown

Alternate Shutdown Evaluation Table					
Category	**Plant Inspectable**	**Human Inspectable**	**Secondary Human Inspectable**	**Additional Considerations**	**Evaluation**
Environmental Considerations	No or only one fire barrier with potential leakage points between fire and RSO areas	Activities required in smoke-filled or exceedingly high temperature or CO2 significantly impacted environments			α
	Fire and RSO areas well separated	No activities required in smoke-impacted or high temperature or CO2 environments, and no requirement to pass through those environments			γ
		Must pass through areas affected by fire environment; i.e., sufficient smoke or heat to threaten personal physical danger or impede progress			2 β
Electrical Separation Considerations	Electrical isolation is incomplete	Existing procedures provide alternative means to prevent spurious operation and damage (not necessarily from spurious actuation)	Procedures are clear and straightforward	Training: regular training (or very simple operations) and all actions have been tested or demonstrated	β
				Training: no training or electrical operations never actually tested or demonstrated	α
			Procedures do not clearly and unambiguously spell out some actions to be taken	Training: regular training, all actions have been tested or demonstrated	β

Alternate Shutdown Evaluation Table					
Category	**Plant Inspectable**	**Human Inspectable**	**Secondary Human Inspectable**	**Additional Considerations**	**Evaluation**
			(e.g. required actions not in EOP or Safe Shutdown Procedure)	Training is irregular, or not all actions have been tested or demonstrated	α
		Existing procedures do not provide alternative means to prevent spurious operation and damage, and, as a result, safe shutdown is prevented (e.g. actions beyond simple actions required which are supported by skill of trade)			α
	Electrical isolation is complete				γ
Functional Considerations		Physical accessibility restricted in some area where operators are required carry out RSOs, including the RSP area (by security, radiation, maintenance, high temperature, etc.)			β
		Complexity: multiple location RSOs	Operators must perform manual actions in < 4 locations to set up RSOs		γ
			Operators must perform manual actions in ≥ 4 locations to set up RSOs		β

Alternate Shutdown Evaluation Table					
Category	**Plant Inspectable**	**Human Inspectable**	**Secondary Human Inspectable**	**Additional Considerations**	**Evaluation**
		Complexity: procedural	Fire procedure requires multiple local actions to disconnect offsite power and repower selected equipment		β
	Some of the equipment required to carry out the fire EOPs is not available in the the RSOs areas	Operators know where to find alternative equipment and it is in close proximity and is available			γ
		Operators do not know where to find alternative equipment or equipment is not in close proximity and readily available			α
	RSO areas are too noisy to permit needed remote communications with provided devices, but effective communications can be established from an adjacent area				β
	RSO areas and adjacent areas are too noisy to permit needed remote communications with provided devices				2 β
	RSO areas are dark (but portable lighting is available and is demonstrated to be functional)				β
	Power failures have eliminated all lighting in RSO areas; no portable lighting available or is not demonstrated to be functional				α
	Unable to perform remote shutdown operations				α

Alternate Shutdown Evaluation Table					
Category	**Plant Inspectable**	**Human Inspectable**	**Secondary Human Inspectable**	**Additional Considerations**	**Evaluation**

Notes on application of RSO Evaluation Table:

1. Apply table to specific plant fire scenario.
2. Select column in Fire SDP "Risk Significance Estimation Matrix" based on the following rules:
   - If any row is α, then use column "0" in Matrix
   - If the sum of rows evaluated as β or 2 β is ≥ 3 β, then assume equivalent to α and use column "0" in Matrix
   - If all categories are γ, then use column "-2" in Matrix
   - Otherwise (i.e., if the sum of rows evaluated as β or 2 β is β or 2 β), then use column "-1" in Matrix

Use of RES-Developed Tool for Alternate Shutdown

- Must put in public domain before using it, even on a trial basis.
- Draft form in Spring 2001, have comment period for industry, and resolve comments with an industry meeting

Current Plans

- Review inspection findings related to alternate shutdown
- Assess their significance
  - Use SPAR HRA product to quantify HEP
  - If significant, develop the basis for risk-informed decision making