Attachment B

MCR Abandonment Screening HRA Examples

1.0 Industry Examples

The purpose of this section to provide actual industry examples that follow the process outlined the FAQ. These examples are in order of least complicated to most complicated. Each example is assessed against the PIF criteria matrix that was presented in the main paper (the material that will be placed in section 2.2 of the FAQ. The matrix uses a color coding scheme to provide an ease of understanding of the results of each assessment. Each matrix is interpreted as follows.

Column 1: The list of PIFs considered.

Columns 2-7: The six potential tasks that are considered as part of the abandonment process. These columns are the primary focus of the assessment.

- Task 1 is always cross hatched out for loss of habitability scenarios, since even though the task is required, it does not need to be assessed because it has been agreed that failure of this task does not contribute to overall failure of the abandonment process.
- If a task column is completely blacked out, it means that this task is not required to be successful for the scenario that is being assessed.
- A color in a cell indicates the assessment of a particular PIF with regard to the task in the column. The colors are interpreted as follows"
    - GREEN means that the PIF in that row for that task meets the criterion associated with a screening HEP of 0.1 for abandonment.
    - YELLOW means that the PIF in that row for that task is degraded versus the 0.1 criterion, and instead is consistent with the criterion of a value greater than 0.1 (but less than 1.0)
    - RED means that the PIF in that row for that task fails the go/no-go criterion for success of that task
    - BLUE means that the PIF in that row is optimal versus the 0.1 criterion, and instead is consistent with the criterion of a value less than 0.1.
    - WHITE means that the PIF is not evaluated individually, but provides information used in the assessment of another PIF.

Column 8: This lists the go/no-go criteria for a PIF. It is highlighted RED if a red cell appears anywhere in columns 2-7 in that row.

Column 9: This lists the criteria for a PIF that suggest a value of greater than 0.1 may be appropriate. It is highlighted YELLOW if a yellow cell appears anywhere in columns 2-7 in that row.

Column 10: This lists the criteria for a PIF that suggest a value of less than 0.1 may be appropriate. It is highlighted BLUE if a blue cell appears anywhere in columns 2-7 in that row.

A "Green Board" is a case where the PIFs are such that the criteria for use of a 0.1 screening HEP are met exactly, so 0.1 is justified. However, it is unlikely that this would be the case. One would expect that there will be individual entries where the conditions are better or worse than this, and thus some interpretation would be required as to what screening HEP would be justified. One of the key purposes of these examples, in addition to showing how one would perform an assessment, is to show how such cases could be interpreted to justify the use of a particular screening value.

The following background information and assumptions apply to each example

1.1 Plant Background and initial plant conditions:

- Westinghouse PWR
- At the time of the fire the plant is operating at full power steady state.
- Following the detection of a fire, the MCR will activate the fire brigade and performs the first 4 steps of EOP-0. While in the MCR the operators will be working in both the EOPs and the fire procedures. Following the decision to abandon the EOP procedures are suspended.
- Plant trains biannually on the MCR abandonment procedure.

1.2 Assumptions:

- T = 0 is considered to be the start of the fire as well as reactor trip. There no considerable time between the start of the fire and when reactor trip occurs.
- Once the decision to abandon the MCR is made there will be no hesitation of the crew to implement all steps in the MCR abandonment procedure.

1.3 Example 1

1.3.1 Plant Background Information Specific to Example

Plant has a remote shutdown panel.

1.3.2 MCR Abandonment Scenario Description

A fire occurs in one of the back panels of the MCR. At the start of the fire a reactor trip/turbine trip occurs and there are no fire induced spurious operations of equipment. Following the reactor trip, the plant response is as expected for a transient with reactor trip until smoke fills the MCR causing the MCR to be uninhabitable. Electrical power, AFW and charging are available until they are switched off by the operators in the first few steps of the MCR abandonment procedure just before the crew abandons the MCR due to high smoke levels. There are no fire induced spurious operations of equipment after the operators abandon the MCR.

Table 2: Identification of Operator Actions Required For Success For Example 1						
	Task 1 Decide to Abandon	**Task 2 Isolation of MCR control circuits**	**Task 3 Establish Remote Control/ Instrumentation**	**Task 4 Restore/Ensure Decay Heat Removal**	**Task 5 Restore/ Ensure Injection**	**Task 6 Recovery of spurious operations**
High level task(s)	Assumed successful due to loss of habitability	Isolation of the MCR is not required because there are no spurious impacts that would result in core damage if not mitigated both before and after abandonment occurs.	Reestablish instrumentation at RSP by placing switches in local.	Restore AFW at RSP	Restore power to CCW and CCP by closing breaker then start CCW and CCP pumps locally.	Not required because there are no spurious operations

1.3.3 Definition and Qualitative Analysis

The fire and the reactor trip to occur at the same time. Upon receiving a reactor trip the control room crew will enter E-0 and perform the first 4 steps of E-0 and transfer to ES-01 within the first 5 minutes of the scenario. All AC power is initially available, reactor trip and turbine trip are successful, and AFW successfully starts and runs. Reactor Coolant System (RCS) pressure stabilizes following reactor trip and the operators are maintaining successful control over the plant before they leave the MCR.

When the crew enters EOP ES-0.1 they will also open MCR abandonment procedure. The fire is spreading within the panel and suppression measures are not successful. Because the fire is spreading, and the smoke levels are increasing the operators start performing steps 1-8 of the abandonment procedure at about 15 minutes. As the scenario progresses, smoke levels continue to build and force the operators out of the MCR at 18 minutes. (This time is determined by CFAST)

The fire PRA context for this scenario is that after the fire causes a reactor trip, charging, AFW, CCPs, and CCW will remain running until the operators switch them off at 15 minutes (before leaving the MCR.)

Once outside the MCR, the MRC abandonment procedure directs a single RO to perform all actions at the RSP and then directs additional local actions via standalone attachments. The PSFs associated with each Task are shown in Table 2.

Table 2: Qualitative Analysis Summary For Example 1				
PSF	**Task 1**	**Task 3**	**Task 4**	**Task 5**
	Decide to Abandon	**Task 3 Establish RSD Control & Instrumentation**	**Restore/Ensure Decay Heat Removal**	**Restore/ Ensure Injection**
Complexity	Nominal	Nominal	Nominal	Nominal
Procedure	EOP-MCR-ABANDONMENT The purpose of this procedure is to provide actions for achieving safe shutdown when control room evacuation is required.	Steps 11 and 12 of the MCR abandonment procedure direct provide the execution steps for this action.	Steps 13- 21 direct the crew to restore AFW from the remote shutdown panel.	Steps 23 – 28 direct the crew to maintain CCW and charging and associated cooling systems from the remote shutdown panel.
Training (Input to complexity assignment)	Yes – Bi-annually as part of the class room discussion.	Yes – Bi-annually No JPM exists	Yes – Bi-annually JPM exists for this Attachment B	Yes – Bi-annually JPM exists for this Attachment C
Cues/Indications	Smoke forces operators to leave.	Following steps in the procedure to establish instrumentation.	Following steps in the procedure. No additional instrumentation is required.	Following steps in the procedure. No additional instrumentation is required.
Staffing	Decision to abandon is made by Unit Supervisor	Reactor Operator # 1	Reactor Operator # 1	Balance of Plant Operator and Aux Building Operator
Lighting	Normal	Normal	Normal	Normal
Tools/Parts	N/A	None required	None required	None required
Accessibility	Control room is un inhabitable	Remote shutdown panel	Remote shutdown panel	Remote shutdown panel and various plant locations

Table 2: Qualitative Analysis Summary For Example 1				
PSF	**Task 1**	**Task 3**	**Task 4**	**Task 5**
	Decide to Abandon	**Task 3 Establish RSD Control & Instrumentation**	**Restore/Ensure Decay Heat Removal**	**Restore/ Ensure Injection**
Communications (Input to complexity assignment)	N/A	Available- Operators can communicate via phone lines. The evacuation phone numbers are provided in the MCR abandonment procedure as notes when communication is required.	Available- Operators can communicate via phone lines. The evacuation phone numbers are provided in the MCR abandonment procedure as notes when communication is required.	Available- Operators can communicate via phone lines. The evacuation phone numbers are provided in the MCR abandonment procedure as notes when communication is required.
Critical Tasks	1 Critical Task	2 Critical Tasks	3 Critical Tasks	3 Critical Task
Details about critical tasks	Critical task but the HEP is negligible in this simplified case.	1. Place Ctrl Room isolation switches in LOCAL Hand switch – 1-X Hand switch -2 –X 2. Place the following system switches in local Hand switch – 3-AL Hand switch -4 – CCW Hand switch – 5-FC	1. Align AFW suction from the CST. (CST-XX-1) 2. START AFW pump A. 3. Open AFW Valve –XX All actions are performed at the remote shutdown panel.	1. Restore power to both CCW pumps and charging pumps by closing breaker in south electrical room. 2. Start CCW in CCW pump room 3. Start CCP from north piping penetration room. Critical task 1 is

Table 2: Qualitative Analysis Summary For Example 1				
PSF	**Task 1**	**Task 3**	**Task 4**	**Task 5**
	Decide to Abandon	**Task 3 Establish RSD Control & Instrumentation**	**Restore/Ensure Decay Heat Removal**	**Restore/ Ensure Injection**
		Hand switch -6 –PW All actions are performed at the remote shutdown panel.		performed by BOP. Critical task 2 and 3 are performed by Aux Tour operator
Timing	See next sections for intergraded timeline and individual timing components			

Table 3: Integrated Timeline For Example 1	
T =0	Start of fire.
T =0	Reactor trip
T =0	Control room is aware of a fire in the control room.
T=0	Fire brigade summoned.
T = 5 minutes	Operators enter E-0 and complete first 4 steps within 5 minutes. No SSD equipment is damaged by the fire.
T = 5 minutes	Fire brigade continues to fight fire unsuccessfully. Operators open MCR abandonment procedure, but fire has not yet progressed sufficiently to enter procedure.
T = 5-18 minutes	Operators work in ES-01 and try and assess damage caused by fire. The fire brigade continues unsuccessfully to suppress fire.
T=15	Operators will have seen the smoke building, and at the 15 minute point will decide to implement the MCR Abandonment procedure. The 15 minute point was modeled based on the following: • CFAST calculations showing the evacuation criteria are met at 18 minutes • Operators have stated that they will remain in the MCR as long as possible. • Operators see smoke building, respond to the reactor trip using EOPs until the point where abandonment is imminent AFW, CVCS and Reactor Coolant Pumps (RCPs) are all stopped as directed by MCR abandonment procedure.
T =15-17 minutes	Operators perform the first 8 steps of MCR abandonment procedure. Most of the actions associated with these procedure steps will have already been performed since the plant has been shutting down since the start of the fire. Although the fire is causing smoke and hot gas, it has damaged only components associated with the panel where the fire has started. Upon completion of the first 8 steps of the MCR Abandonment procedure, AFW and Reactor Coolant Pumps (RCPs) are all stopped as directed by the procedure and the electrical power feed from offsite power is tripped.
T =18 minutes	For this fire, CFAST calculations show the evacuation criteria have been met and force the operators out of the control room. At the same time one RO goes the RPS and Aux Building Operator starts to align breaker to restore power to CVCS and CCW.
T=20 minutes	Operators arrive at RSP
T = 22 minutes	RSP instrumentation is established.
T = 27 minutes	AFW is established at RSP
T = 38 minutes	Charging and CCW are re-established.

Timing For Task 3: Establish Instrumentation at RPS

T_{SW} = 18+36.6 minutes = 54.6 minutes.

Per NSCA analysis the allowed completion time is 36.57 minutes. This is the time from when abandon is required and abandonment occurs at 18 minutes.

T_{delay} = 20 minutes. This is the time to abandonment is required plus 2 minutes to travel to the RPS.

T_{cog} = 0. There is expected to be no hesitation in further deciding whether instrumentation is needed or not.

T_{Exe} = 2.0 minutes. This is the manipulation time to control at the RPS from the feasibility study. The Alignment of instrumentation is complete at 22.0 minutes after the start of the fire.

Timing for Task 4 Establish Restore/Ensure Decay Heat Removal

T_{SW} = 65 minutes. For establishing the AFW the system time window is based on the time to SG dryout. Per MAAP run (PRA-RUN –XXX) the time to SG dryout given a loss of AFW with reactor trip on normal level is 50 minutes. AFW successfully runs for the first 15 minutes after reactor trip, so T_{SW} is conservatively modeled as (15 + 50) = 65 minutes.

T_{delay} = 22 minutes -Time at which the MCR abandonment procedure directs that AFW be restored, which is the cue for this action. AFW is turned off just before abandonment occurs (15 minutes) and is directed to be restored at step 13 in the MCR abandonment procedure.

T_{cog} = 0 minutes. Given that the decision to abandon has already been made, there is expected to be no hesitation in further deciding whether the restoration of AFW is needed or not.

T_{exe} = 5 minutes to restore AFW. This is the manipulation time from the feasibility study.

The time to complete the Auxiliary Feedwater restoration is 27 minutes after the start of the fire.

Timing for Task 5: Restore/ Ensure Injection

TSW = 18+36.6 minutes = 54.6 minutes.

Per NSCA analysis the allowed completion time is 36.57 minutes. This is the time from when abandon is required and abandonment occurs at 18 minutes.

T_{delay} = 18 minutes. -Time at which the MCR abandonment occurs at this time abandonment occurs an operator in given the attachment to align breaker.

T_{cog} = 0 minutes. Given that the decision to abandon has already been made, there is expected to be no hesitation in further deciding whether the restoration of CVCS is needed or not.

T_{EXE}= 20 minutes. This is the manipulation time to re-establish CCP and CCW, from the feasibility study.

1.3.4 Justification for Screening HEP

All of the PSFs identified in Table 1 are compared against the general criteria for screening and shown below.

Table 4: Assessment of Screening Criteria For Example 1	
Complexity	Nominal ISG criteria • Are there many alarms or indications to which the crew or operator must identify, evaluate, and respond? - NO • Will communication between several individuals at different locations be necessary? Yes – Available- Operators can communicate via phone lines. The evacuation phone numbers are provided in the MCR abandonment procedure as notes when communication is required. • Will plant symptoms be difficult to ascertain because of instrumentation failures and spurious indications? No – Once the crew leaves the MCR all instrumentation is available. • Will component failures have multiple or propagated effects on systems, equipment, or other components? NO • Will the action sequence include concurrent tasks that require specific timing to be successful? – No. The actions performed away from the RSDP do not require coordination with other sctions, other than notification on completion. • Will the situation include many distractions, crowds of people, or other factors that could divert attention from the required tasks? No
Procedure	Procedure explicitly documents all required tasks.
Training	Bi-annual training on all tasks. (Subsumed in complexity.)
Cues/ Indications	All cues and indications are available for all tasks
Staffing	No staffing limitations.
Tools/Parts	No task requires special tools and parts.
Accessibility	The travel routes were clearly documented in the feasibly study. There are no locked doors which the operators must obtain keys for.
Communications	Phone lines are the preferred method of communication and they are available and are not impacted by the fire. (Subsumed in complexity)
Lighting	The fire does not cause a loss of power therefore all lighting conditions are normal.
Timing	See next table

Table 5: Time Margins Assessment For Example 1 (five minute intervals)			
Timing input	**Task 3**	**Task 4**	**Task 5**
Tsw	55 minutes	65 minutes	55 minutes
Tdelay	20 minutes	25 minutes	20 minutes
Tcog	0 minutes	0 minutes	0 minutes
Texe	5 minutes	5 minutes	20 minutes
Time Available – Time Required	30 minutes	35 minutes	15 minutes

The overall assessment is shown in below. Note that it is not necessary to provide an assessment result for the decision to abandon, even though the task is required, because it has been agreed that the decision is highly reliable.

It can be seen that most of the PSFs are green, indicating they support the use of the value of 0.1. There is one task that is yellow for time margin, because the margin is 15 minutes. However, there is also one task that has an extremely favorable time margin. In addition, there are no special tools needed and there will be normal lighting because there is no loss of power. Taken as a whole, the conditions are such that a screening value of 0.1 is applicable, but the limitations are such that a screening value of less than 0.1 could not be justified.

Table 6 – Summary of Assessment for Example 1							
Performance Influence Factor	**Conditions Supporting Use of 0.1 Screening Value**				**"Go/No-Go" Conditions (If Any of These Conditions Exists, 1.0 HEP is Used)**	**Considerations That Suggest Use of Screening HEP > 0.1**	**Considerations That Support Use of Screening HEP < 0.1**
	Task 1 Decide to Abandon	**Task 3 Establish RSD Control & Instrumen-tation**	**Task 4 Restore/ Ensure Decay Heat Removal**	**Task 5 Restore/ Ensure Injection**			
Complexity		Nominal	Nominal	Nominal	See training and communications.	Degraded	Nominal
Procedure		Available and complete	Available and complete	Available and complete	Procedure not available or completion will not result in success.	Procedure is potentially confusing, unclear, or overly subject to interpretation.	Procedure very straightforward, easy to implement, minimal or no steps not directly required for Tasks 1-5.
Training		Subsumed by Complexity	Subsumed by Complexity	Subsumed by Complexity	No training	Subsumed by Complexity.	Subsumed by Complexity.
Cues/ Indications		Yes	Yes	Yes	Cues are in error for given fire scenario.	Cues are provided, but are not clear.	Cues clear and well trained.
Staffing		Adequate	Adequate	Adequate	Insufficient staff to perform all required actions.	Expect staff limitations to result in a longer time required to complete each task.	Extra staff available for checking.
Tools/Parts		Not needed	Not needed	Not needed	Not available	Need or location unclear. Difficult to obtain.	No special tools or parts required for any execution activities.
Accessibility		Accessible	Accessible	Accessible	Not accessible	Limited accessibility (e.g., tight quarters, long access path)	Highly accessible, no impairments, short direct access paths.
Communications		Subsumed by Complexity	Subsumed by Complexity	Subsumed by Complexity	Not available or highly questionable reliability.	Subsumed by Complexity	Subsumed by Complexity
Lighting		Normal	Normal	Normal	None in one or more areas where actions take place.	Portable in one or more locations where actions take place	Normal in all areas where actions take place.

Table 6 – Summary of Assessment for Example 1							
Performance Influence Factor	**Conditions Supporting Use of 0.1 Screening Value**					**"Go/No-Go" Conditions (If Any of These Conditions Exists, 1.0 HEP is Used)**	**Considerations That Suggest Use of Screening HEP > 0.1**	**Considerations That Support Use of Screening HEP < 0.1**
	Task 1 Decide to Abandon		**Task 3 Establish RSD Control & Instrumen-tation**	**Task 4 Restore/ Ensure Decay Heat Removal**	**Task 5 Restore/ Ensure Injection**			
Timing			5 timing elements for each task	5 timing elements for each task	5 timing elements for each task	See below	See below	See below
1) System Time window			System time window is 55 minutes Time Margin (Time Available – Time Required) is 20 to 30 minutes	System time window is 65 minutes Time Margin (Time Available – Time Required) is 20 to 30 minutes	System time window is 55 minutes. Time Margin (Time Available - Time Required) is 5 to 15 minutes.	Time Required is equal to or greater than Time Available.	Time Margin (Time Available - Time Required) is 5 to 15 minutes.	Time Margin (Time Available – Time Required) is at least 35 minutes.
2) Time of the decision to abandon			15	15	15	n/a	n/a	n/a
3) Time of Cue			20	25	20	See Time Available	See Time Available	See Time Available
4) Diagnosis Time			0	0	0	See Time Available	See Time Available	See Time Available
5) Time to Execute			5	5	20	See Time Available	See Time Available	See Time Available

1.3.5 Variation 1 For Example 1

The same scenario as Example 1 but the phone lines are damaged by the fire. In this case screening assessment is shown below.

Table 7: Assessment of Screening Criteria For Example 1 Variation 1

Complexity	Degraded ISG criteria • Are there many alarms or indications to which the crew or operator must identify, evaluate, and respond? - NO • Will communication between several individuals at different locations be necessary? Yes without phone communication this task could be challenging and the crew may need to send runners to address communication issues. • Will plant symptoms be difficult to ascertain because of instrumentation failures and spurious indications? No – Once the crew leaves the MCR all instrumentation is available. • Will component failures have multiple or propagated effects on systems, equipment, or other components? NO – MCR is isolated just before leaving to prevent additional spurious indications. • Will the action sequence include concurrent tasks that require specific timing to be successful? – No. The actions performed away from the RSDP do not require coordination with other actions, other than notification on completion. However, this can be significant when credited communications are not available. • Will the situation include many distractions, crowds of people, or other factors that could divert attention from the required tasks? No
Procedure	Procedure explicitly documents all required tasks.
Training	Bi-annual training on all tasks.
Cues/ Indications	All cues and indications are available for all tasks
Staffing	No staffing limitations.
Tools/Parts	No task requires special tools and parts.
Accessibility	The travel routes were clearly documented in the feasibly study. There are no locked doors which the operators must obtain keys for.
Communications	The phone lines are impacted by the fire and runners are need for communication. The timing parameters would need to be adjusted to account for these runners.
Lighting	The fire does not cause a loss of DC power therefore all lighting conditions are nominal.

Table 7: Assessment of Screening Criteria For Example 1 Variation 1	
Timing	See next table

Table 8: Time Margins Assessment For Example 1 Variation 1 (five minute intervals)

Timing input	**Task 3**	**Task 4**	**Task 5**
Tsw	55 minutes	65 minutes	55 minutes
Tdelay	20 minutes	25 minutes	20 minutes
Tcog	0 minutes	0 minutes	0 minutes
Texe	5 minutes	5 minutes + 5 minutes = 10 minutes	20 minutes + 5 minutes = 25 minutes
Time Available – Time Required	30 minutes	30 minutes	10 minutes

Task 4 and 5 would need additional execution time for the runners to report to the RSP once their tasks are complete. T_{exe} has been increased by 5 minutes to account for this time.

The overall assessment is shown below. Note that it is not necessary to provide an assessment result for the decision to abandon, even though the task is required, because it has been agreed that the decision is highly reliable.

It can be seen that many of the PSFs are green, indicating they support the use of the value of 0.1. However, the complexity in this case is degraded, and there is one task that is yellow for time margin, because the margin is 15 minutes. Of most significance is that the unavailability of communications of any kind other then runners violates a go/no-go criterion. While again there are no special tools needed and there will be normal lighting because there is no loss of power, the lack of communications overrides other considerations. Taken as a whole, the conditions are such that a screening value of 0.1 is not applicable, and a screening value of 1.0 should be applied, even though the actions are considered feasible.

Table 9 – Summary of Assessment for Variation 1 of Example 1							
Performance Influence Factor	**Conditions Supporting Use of 0.1 Screening Value**				**"Go/No-Go" Conditions (If Any of These Conditions Exists, 1.0 HEP is Used)**	**Considerations That Suggest Use of Screening HEP > 0.1**	**Considerations That Support Use of Screening HEP < 0.1**
	Task 1 Decide to Abandon	**Task 3 Establish RSD Control & Instrumen-tation**	**Task 4 Restore/ Ensure Decay Heat Removal**	**Task 5 Restore/ Ensure Injection**			
Complexity		Degraded	Degraded	Degraded	See training and communications.	Degraded	Nominal
Procedure		Available and complete	Available and complete	Available and complete	Procedure not available or completion will not result in success.	Procedure is potentially confusing, unclear, or overly subject to interpretation.	Procedure very straightforward, easy to implement, minimal or no steps not directly required for Tasks 1-5.
Training		Subsumed by Complexity	Subsumed by Complexity	Subsumed by Complexity	No training	Subsumed by Complexity.	Subsumed by Complexity.
Cues/ Indications		Yes	Yes	Yes	Cues are in error for given fire scenario.	Cues are provided, but are not clear.	Cues clear and well trained.
Staffing		Adequate	Adequate	Adequate	Insufficient staff to perform all required actions.	Expect staff limitations to result in a longer time required to complete each task.	Extra staff available for checking.
Tools/Parts		Not needed	Not needed	Not needed	Not available	Need or location unclear. Difficult to obtain.	No special tools or parts required for any execution activities.
Accessibility		Accessible	Accessible	Accessible	Not accessible	Limited accessibility (e.g., tight quarters, long access path)	Highly accessible, no impairments, short direct access paths.
Communications		Not available	Not available	Not available	Not available or highly questionable reliability.	Subsumed by Complexity	Subsumed by Complexity
Lighting		Normal	Normal	Normal	None in one or more areas where actions take place.	Portable in one or more locations where actions take place	Normal in all areas where actions take place.

Table 9 – Summary of Assessment for Variation 1 of Example 1							
Performance Influence Factor	**Conditions Supporting Use of 0.1 Screening Value**					**"Go/No-Go" Conditions (If Any of These Conditions Exists, 1.0 HEP is Used)**	**Considerations That Suggest Use of Screening HEP > 0.1**	**Considerations That Support Use of Screening HEP < 0.1**
	Task 1 Decide to Abandon		**Task 3 Establish RSD Control & Instrumen-tation**	**Task 4 Restore/ Ensure Decay Heat Removal**	**Task 5 Restore/ Ensure Injection**			
Timing			5 timing elements for each task	5 timing elements for each task	5 timing elements for each task	See below	See below	See below
1) System Time window			System time window is 55 mins Time Margin (Time Available – Time Required) is 20 to 30 minutes	System time window is 65 mins Time Margin (Time Available – Time Required) is 20 to 30 minutes	System time window is 55 mins Time Margin (Time Available - Time Required) is 5 to 15 minutes.	Time Required is equal to or greater than Time Available.	Time Margin (Time Available - Time Required) is 5 to 15 minutes.	Time Margin (Time Available – Time Required) is at least 35 minutes.
2) Time of the decision to abandon			15	15	15	n/a	n/a	n/a
3) Time of Cue			20	25	20	See Time Available	See Time Available	See Time Available
4) Diagnosis Time			0	0	0	See Time Available	See Time Available	See Time Available
5) Time to Execute			5	10	25	See Time Available	See Time Available	See Time Available

1.3.6 Variation 2 for Example 1

This is the same scenario as Example 1 with a slight variation in that AFW fails to start at T= 0 and AFW cannot be started from the MCR due to the fire damage. A local operator must be sent to start AFW locally.

The crew would diagnose a loss of AFW on loss of AFW flow and SG level indications based on a red path on the critical safety function status trees. FRH-1 will be entered within the first 6 minutes of the scenario. SG level indications are not impacted by the fire.

Before abandonment occurs the MCR will send a local operator to start AFW. Locally starting AFW takes 10 minutes to complete and this action could be completed before abandonment is required.

This action is complicated by the fact that the MCR abandonment procedure directs the crew to switch off AFW just before leaving the MCR. There could be some hesitation among the crew to switch off AFW since they will have either just re-established AFW or a field operator will still be working the restoration when abandonment occurs.

The TSW for Task 4 would need to changed as follow:

T_{SW} = 50 minutes. For establishing the AFW the system time window is based on the time to SG dryout. Per MAAP run (PRA-RUN –XXX) the time to SG dryout given a loss of AFW with reactor trip on normal level is 50 minutes.

T_{delay} = 6 minutes – Time to reach entry criteria for FRH-1

T_{cog} = 1 minutes – Time for diagnosis for loss of AFW.

T_{exe} = 10 minutes to restore AFW locally. This is the timing from the internal events PRA.

The time to complete the Auxiliary Feed water restoration is 17 minutes after the start of the fire and abandonment occurs at 18 minutes.
If the operator were to switch off AFW at T=18 minute then AFW could be re-start it at the RSP.

Tsw = 50 minutes – Assume was running for less than a minutes before it is turned off at 18 minutes
Tdelay = 22 minutes – See base case Example 1

Tcog = 0 see base case Example 1

T_{exe} = 5 see base case Example 1

The screening assessment for this variation is shown below.

Table 10: Screening Criteria Assessment For Example 1 Variation 1	
Complexity	Degraded ISG criteria • Are there many alarms or indications to which the crew or operator must identify, evaluate, and respond? - NO • Will communication between several individuals at different locations be necessary? Yes – However, when communication is required a phone number is listed in the procedure for who to call. The phone lines are not impacted by the fire. This type of communication is no different than any local action directed by the MCR. • Will plant symptoms be difficult to ascertain because of instrumentation failures and spurious indications? No – SG level indication in the MCR is not impacted by the fire. Once the crew leaves the MCR all instrumentation is available. • Will component failures have multiple or propagated effects on systems, equipment, or other components? NO • Will the action sequence include concurrent tasks that require specific timing to be successful? – No. The actions performed away from the RSDP do not require coordination with other actions, other than notification on completion. • Will the situation include many distractions, crowds of people, or other factors that could divert attention from the required tasks? The diagnosis for the loss of AFW before MCR abandonment is required could complicate the situation. The loss of AFW could lead to potential confusion on the decision to switch off AFW just before leaving the MCR.
Procedure	The MCR abandonment procedure will work if implemented as directed. However there maybe some hesitation among the crew to switch off AFW just before leaving the MCR after they just restored the system.
Training	Bi-annual training on all tasks. (Subsumed in complexity)
Cues/ Indications	All cues and indications are available for all tasks
Staffing	No staffing limitations.
Tools/Parts	No task requires special tools and parts.
Accessibility	The travel routes were clearly documented in the feasibly study. There are no locked doors which the operators must obtain keys for.
Communications	Phone lines are the preferred method of communication and they are available and are not impacted by the fire. (Subsumed in complexity)
Lighting	The fire does not cause a loss of DC power therefore all lighting conditions are normal.
Timing	See next table

Table 11: Time Margins Assessment For Example 1 Variation 2 (five minute intervals			
Timing input	**Task 3**	**Task 4**	**Task 5**
Tsw	55 minutes	50 minutes	55 minutes
Tdelay	20 minutes	25 minutes	20 minutes
Tcog	0 minutes	0 minutes	0 minutes
Texe	5 minutes	5 minutes	20 minutes
Time Available – Time Required	30 minutes	20 minutes	15 minutes

Based on this timing change for Task 5 the time available – time required still barely meets the meets the 0.1 screening criteria. However, the complexity in this case is degraded, and there is a procedural deficiency where the procedure is somewhat counter-intuitive in calling for AFW to be terminated then it may have just been started. Therefore, the complexity criteria and procedure criteria are not met to support a 0.1 screening value. This variation is a good example of where a screening value between 0.1 and 1 could be used. This scenario is clearly feasible but the 0.1 criteria are not sufficiently met or compensated for.

Table 12 – Summary of Assessment for Variation 2 of Example 1							
Performance Influence Factor	**Conditions Supporting Use of 0.1 Screening Value**				**"Go/No-Go" Conditions (If Any of These Conditions Exists, 1.0 HEP is Used)**	**Considerations That Suggest Use of Screening HEP > 0.1**	**Considerations That Support Use of Screening HEP < 0.1**
	Task 1 Decide to Abandon	**Task 3 Establish RSD Control & Instrumen-tation**	**Task 4 Restore/ Ensure Decay Heat Removal**	**Task 5 Restore/ Ensure Injection**			
Complexity		Degraded	Degraded	Degraded	See training and communications.	Degraded	Nominal
Procedure		Available and complete	Procedure is potentially confusing.	Available and complete	Procedure not available or completion will not result in success.	Procedure is potentially confusing, unclear, or overly subject to interpretation.	Procedure very straightforward, easy to implement, minimal or no steps not directly required for Tasks 1-5.
Training		Subsumed by Complexity	Subsumed by Complexity	Subsumed by Complexity	No training	Subsumed by Complexity.	Subsumed by Complexity.
Cues/ Indications		Yes	Yes	Yes	Cues are in error for given fire scenario.	Cues are provided, but are not clear.	Cues clear and well trained.
Staffing		Adequate	Adequate	Adequate	Insufficient staff to perform all required actions.	Expect staff limitations to result in a longer time required to complete each task.	Extra staff available for checking.
Tools/Parts		Not needed	Not needed	Not needed	Not available	Need or location unclear. Difficult to obtain.	No special tools or parts required for any execution activities.
Accessibility		Accessible	Accessible	Accessible	Not accessible	Limited accessibility (e.g., tight quarters, long access path)	Highly accessible, no impairments, short direct access paths.
Communications		Subsumed by Complexity	Subsumed by Complexity	Subsumed by Complexity	Not available or highly questionable reliability.	Subsumed by Complexity	Subsumed by Complexity
Lighting		Normal	Normal	Normal	None in one or more areas where actions take place.	Portable in one or more locations where actions take place	Normal in all areas where actions take place.

Table 12 – Summary of Assessment for Variation 2 of Example 1								
Performance Influence Factor	**Conditions Supporting Use of 0.1 Screening Value**					**"Go/No-Go" Conditions (If Any of These Conditions Exists, 1.0 HEP is Used)**	**Considerations That Suggest Use of Screening HEP > 0.1**	**Considerations That Support Use of Screening HEP < 0.1**
	Task 1 Decide to Abandon		**Task 3 Establish RSD Control & Instrumen-tation**	**Task 4 Restore/ Ensure Decay Heat Removal**	**Task 5 Restore/ Ensure Injection**			
Timing			5 timing elements for each task	5 timing elements for each task	5 timing elements for each task	See below	See below	See below
1) System Time window			System time window is 55 minutes Time Margin (Time Available – Time Required) is 20 to 30 minutes	System time window is 50 minutes Time Margin (Time Available – Time Required) is 20 to 30 minutes	System time window is 55 minutes . Time Margin (Time Available - Time Required) is 5 to 15 minutes.	Time Required is equal to or greater than Time Available.	Time Margin (Time Available - Time Required) is 5 to 15 minutes.	Time Margin (Time Available – Time Required) is at least 35 minutes.
2) Time of the decision to abandon			15	15	15	n/a	n/a	n/a
3) Time of Cue			20	25	20	See Time Available	See Time Available	See Time Available
4) Diagnosis Time			0	0	0	See Time Available	See Time Available	See Time Available
5) Time to Execute			5	5	20	See Time Available	See Time Available	See Time Available

1.4 Example 2

1.4.1 Plant Background Information Specific to Example

- Fire is in the Unit 1 control room and remote shutdown strategy is to cross-tie to other unit.
- Plant has a local control stations instead of a remote shutdown panel. This is the key difference between Example 1 and Example 2.

1.4.2 MCR Abandonment Scenario Description

A fire occurs in one of the back panels of the MCR. At the start of the fire a reactor trip/turbine trip occurs and there are no fire induced spurious operations of equipment. Following the reactor trip, the plant response is as expected for a transient with reactor trip until smoke fills the MCR causing the MCR to be uninhabitable. Electrical power, AFW and charging are available until they are switched off by the operators in the first few steps of the MCR abandonment procedure just before the crew abandons the MCR due to high smoke levels. There are no fire induced spurious operations of equipment after the operators abandon the MCR.

Table 13: Identification of Operator Actions Required For Success For Example 2

	Task 1 Decide to Abandon	Task 2 Isolate of MCR control circuits	Task 3 Establish RSD Control & Instrumentation	Task 4 Restore/Ensure Decay Heat Removal	Task 5 Restore/ Ensure Injection	Task 6 Recovery of spurious operations
High level task(s)	Assumed successful due to loss of habitability	Isolation of the MCR is not required because there are no spurious impacts that would result in core damage if not mitigated.	Local instrumentation is required to be established.	AFW pumps are shut off just before the crew leaves the MCR and the crew needs to Restore AFW by cross-ting to other unit in order to maintain SG cooling	CVCS is shut off just before the crew leaves the MCR and the crew needs to restore CVCS by cross-ting to other unit	Not required

1.4.3 Definition and Qualitative Analysis

The fire and the reactor trip to occur at the same time. Upon receiving a reactor trip the control room crew will enter E-0 and perform the first 4 steps of E-0 and transfer to ES-01 within the first 5 minutes of the scenario. All AC power is initially available, reactor trip and turbine trip are successful, and AFW successfully starts and runs. Reactor Coolant System (RCS) pressure is stabilizes following reactor trip and the operators are maintain successful control over the plant before they leave the MCR.

When the crew entered EOP ES-0.1 they will also open MCR abandonment procedure. The fire is spreading within the panel and suppression measures are not successful. Because the fire is spreading, and the smoke levels are increasing the operators start performing steps 1-16 of the abandonment procedure at about 15 minutes. As the scenario progresses, smoke levels continue to build and force the operators out of the MCR at 18 minutes. (This time is determined by CFAST)

The fire PRA context for this scenario is that after the fire causes a reactor trip, charging, AFW, and the RCPs will remain running until the operators switch them off at 15 minutes (before leaving the MCR.)

Once outside the MCR, the MRC abandonment procedure directs individual operators to perform individual tasks. Each critical task has a standalone procedures. The PSFs associated with each task are shown in Table 14.

Table 14: Qualitative Analysis Summary For Example 2				
PSF	**Task 1**	**Task 3**	**Task 4**	**Task 5**
	Decide to Abandon	**Task 3 Establish RSD Control & Instrumentation**	**Restore/Ensure Decay Heat Removal**	**Restore/ Ensure Injection**
Complexity	Nominal	Nominal	Nominal	Nominal
Procedure	EOP-MCR-ABANDONMENT The purpose of this procedure is to provide actions for achieving safe shutdown when control room evacuation is required.	The procedure steps for these actions are in a standalone attachment A of the MCR abandonment procedure. Attachment A is directed from step 17 of the MCR abandonment procedure.	The procedure steps for these actions are in a standalone attachment B of the MCR abandonment procedure. Attachment B is directed from step 19 of the MCR abandonment procedure.	The procedure steps for these actions are in a standalone attachment C of the MCR abandonment procedure. Attachment C is directed from step 17 of the MCR abandonment procedure.
Training (Input to complexity assignment)	Yes – Bi-annually as part of the class room discussion.	Yes – Bi-annually No JPM exists	Yes – Bi-annually JPM exists for this Attachment B	Yes – Bi-annually JPM exists for this Attachment C
Cues/Indications	Smoke forces operators to leave.	Following steps in the procedure to establish instrumentation. No additional instrumentation is required.	Following steps in the procedure. No additional instrumentation is required.	Following steps in the procedure. No additional instrumentation is required.
Staffing	Decision to abandon is made by Unit Supervisor	Reactor Operator	Turbine Operator	Aux Operator
Lighting	Normal	Normal	Normal	Normal
Tools/Parts	N/A	None required	None required	None required

Table 14: Qualitative Analysis Summary For Example 2				
PSF	**Task 1**	**Task 3**	**Task 4**	**Task 5**
Accessibility	Control room is un inhabitable	Auxiliary Building on 612'	Auxiliary Building on 591'	Auxiliary Building on 633'
Communications (Input to complexity assignment)	N/A	Available. Operators will communicate via headsets.	Available Operators will communicate via headsets.	Available Operators will communicate via headsets.
Critical Tasks	1 Critical Task	4 Critical Tasks	4 Critical Tasks	7 Critical Task
Details about critical tasks	Critical task but the HEP is negligible in this simplified case.	1. Align SG wide range level indications by placing switches in local. 2. Align the power supply indications for AFW. 3. Align charging pump indications by placing switches in local. 4. Align PZR level indications switches in local. All actions take place at 612' Auxiliary Building location.	1. Confirm with other Unit MDAFP valves are closed. 2. Open Motor Driven Auxiliary Feedwater Pump Discharge to Unit 2 Crosstie Shutoff Valve. VALVE AFW-1-XX Location: Auxiliary Building on 591' 3 .Open Breakers Breaker A Breaker B Location: Turbine Building on 613' Elevation 4.0 Ensure local SG Level Indication is available.	1. Deenergize BIT Injection Valve Motors by opening breakers. Breaker C Breaker D Breaker E Breaker F Location: 4 kv Room Mezzanine Area 2. Align BIT for Injection - Open VALVE BIT-1-XX Location: 633' Auxiliary Building 3.Align BIT for Injection

Table 14: Qualitative Analysis Summary For Example 2				
PSF	**Task 1**	**Task 3**	**Task 4**	**Task 5**
			Location: Auxiliary Building on 612 This step will require coordination with Task 3.	VALVE BIT-2-XX Location: 612' Auxiliary Building 4.0 Isolate Seal Injection Flow Path. CLOSE Valve CS-1-XX Location Auxiliary Building Hallway 587' 5.0 Slowly Open CS-2-XX Location Auxiliary Building Hallway 587' 6.0 Slowly Throttle Open CS-3-XX Location Auxiliary Building Hallway 587' 7.0 Throttle open CS-3-XX to maintain PRZ level within- 20% to 50% ACTUAL Location Auxiliary Building Hallway 587'
Timing	See next sections for intergraded timeline and individual timing components			

Table 15: Integrated Timeline For Example 2	
T =0	Start of fire.
T =0	Reactor trip
T =0	Control room is aware of a fire in the control room.
T=0	Fire brigade summoned.
T = 5 minutes	Operators enter E-0 and complete first 4 steps within 5 minutes. No SSD equipment is damaged by the fire.
T = 5 minutes	Fire brigade continues to fight fire unsuccessfully. Operators open MCR abandonment procedure, but fire has not yet progressed sufficiently to enter procedure.
T = 5-18 minutes	Operators work in ES-01 and try and assess damage caused by fire. The fire brigade continues unsuccessfully to suppress fire.
T=15	Operators will have seen the smoke building, and at the 15 minute point will decide to implement the MCR Abandonment procedure. The 15 minute point was modeled based on the following: • CFAST calculations showing the evacuation criteria are met at 18 minutes • It takes about 2 minutes to complete the first 15 steps of the MCR abandonment procedure. • Operators have stated that they will remain in the MCR as long as possible. • Operators see smoke building, respond to the reactor trip using EOPs until the point where abandonment is imminent AFW, CVCS and Reactor Coolant Pumps (RCPs) are all stopped as directed by MCR abandonment procedure.
T =15-17 minutes	Operators perform the first 15 steps of MCR abandonment procedure. Most of the actions associated with these procedure steps will have already been performed since the plant has been shutting down since the start of the fire. Although the fire is causing smoke and hot gas, it has damaged only components associated with the panel where the fire has started. Upon completion of the first 15 steps of the MCR Abandonment procedure, AFW, CVCS and Reactor Coolant Pumps (RCPs) are all stopped as directed by the procedure and the electrical power feed from offsite power is tripped.
T =18 minutes	For this fire, CFAST calculations show the evacuation criteria have been met and force the operators out of the control room.
T= 19 minutes	Crew musters in Shift Supervisor (SS) office
T= 20 minutes	RO is handed Attachment and is directed to establish local instrumentation monitoring.
T= 22 minutes	Aux operator is handed the Attachment C and is directed to cross tie CVCS.
T=23 minutes	Turbine operator is handed Attachment B and instructed to cross-tie AFW
T=31 minutes	AFW cross-tie is complete
T=33 minutes	Local instrumentation monitoring is complete
T= 39 minutes	CVCS cross-tie is complete

Timing For Task 3: Establish Local Instrumentation

Tsw = 88 minutes. T_{SW} is based on the limiting time for all HFEs credited in this MCR abandonment scenario. See Task 5 for justification of the 88 minutes.

T_{delay} = 20 minutes. This is the time to reach the MCR abandonment procedure step which directs the use of Attachment A to establish local instrumentation. 20 minutes is estimated based on MCR abandonment starting at 18 minutes plus 2 minutes to reach step 17.

Tcog = 0. There is expected to be no hesitation in further deciding whether instrumentation is needed or not.

Tm = 13 minutes. This is the manipulation time to establish local instrumentation, from the feasibility study.

Alignment of local instrumentation monitoring is completed 33 minutes after the start of the fire (20+0+13) = (time delay plus median response plus manipulation).

Timing for Task 4 Establish Restore/Ensure Decay Heat Removal

T_{SW} = 100 minutes. For establishing the AFW cross-tie the system time window is based on the onset of core damage. Per MAAP run (PRA-RUN –XXX) the time to core damage given a loss of AFW is 85 minutes. AFW successfully runs for the first 15 minutes after reactor trip, so T_{SW} is conservatively modeled as (15 + 85) = 100 minutes.

T_{delay} = 23 minutes -Time at which the MCR abandonment procedure directs that AFW be restored, which is the cue for this action. AFW is turned off just before abandonment occurs (15 minutes) and is directed to be restored at step 19 in the MCR abandonment procedure. Tdelay = 23 minutes which is estimated based on MCR abandonment starting at 18 minutes plus 5 minutes to reach step 19.

T_{cog} = 0 minutes. Given that the decision to abandon has already been made, there is expected to be no hesitation in further deciding whether the restoration of CVCS is needed or not.
T_{exe} = 7 minutes and 30 seconds for AFW cross-tie. This is the manipulation time to establish the AFW cross-tie, from the feasibility study.

The action to complete the Auxiliary Feedwater cross-tie (via the MDAFW) is completed approximately 31 minutes = (23+8 =31) after the start of the fire.

Timing for Task 5: Restore/ Ensure Injection

T_{SW} = 88 minutes. For establishing the CVCS cross-tie the system time window is based on re-establishing injection flow in time to mitigate a LOCA. For this fire modeled, an RCP seal LOCA is possible as operators turn off all RCP seal cooling upon abandoning the MCR. The system time window in this calculation is calculated as follows.

- CVCS continues to run for the first 15 minutes after reactor trip, and then it is turned off by the operators.
- 13 minutes after the pumps are turned off a 1 gpm per pump seal leakage occurs conservatively, the HRA has used the timing of 60 minutes until core uncovery given a 76 gpm leak per pump.
- T_{SW} = 15 + 13 + 60 = 88 minutes

T_{delay} = 22 minutes. -Time at which the MCR abandonment procedure directs that CVCS be restored, which is the cue for this action. 22 minutes is estimated based on MCR abandonment starting at 18 minutes (per CFAST calculation) plus 4 minutes to reach step 18.

T_{cog} = 0 minutes. Given that the decision to abandon has already been made, there is expected to be no hesitation in further deciding whether the restoration of CVCS is needed or not.

T_{EXE}= 16.5 minutes. This is the manipulation time to establish the CVCS cross-tie, from the feasibility study.

The CVCS cross-tie is completed approximately 41 minutes (15+9+16.5) after the start of the fire.

1.4.4 Justification for screening HEP

All of the PSFs identified is Table 14 are compared against the general criteria for screening

Table 16: Screening Criteria Assessment For Example 2	
Complexity	Nominal ISG criteria • Are there many alarms or indications to which the crew or operator must identify, evaluate, and respond? - NO • Will communication between several individuals at different locations be necessary? Yes – However, all operators are given headsets for communication once the leave the MCR. Communication is considered to nominal. • Will plant symptoms be difficult to ascertain because of instrumentation failures and spurious indications? No – Once the crew leaves the MCR all instrumentation is available. Establishing local instrumentation is considered to be a nominal task. • Will component failures have multiple or propagated effects on systems, equipment, or other components? NO • Will the action sequence include concurrent tasks that require specific timing to be successful? – No. Each operator is handed a standalone attachment once the decision to abandon is made. • Will the situation include many distractions, crowds of people, or other factors that could divert attention from the required tasks? No
Procedure	Procedure explicitly documents all required tasks.
Training	Bi-annual training on all tasks. (Subsumed by complexity.)
Cues/ Indications	All cues and indications are available for all tasks
Staffing	No staffing limitations.
Tools/Parts	No task requires special tools and parts.
Accessibility	The travel routes were clearly documented in the feasibly study. There are no locked doors which the operators must obtain keys for.
Communications	Operators will communicate via headsets. (Subsumed by complexity.)
Lighting	The fire does not cause a loss of DC power therefore all lighting conditions are nominal.
Timing	See next table

Table 17: Time Margins Assessment For Example 2 (five minute intervals)			
Timing input	**Task 3**	**Task 4**	**Task 5**
Tsw	90 minutes	100 minutes	90 minutes
Tdelay	20 minutes	25 minutes	25 minutes
Tcog	0 minutes	0	0
Texe	15 minutes	10 minutes	15 minutes
Time Available – Time Required	55 minutes	65 minutes	50 minutes

The overall assessment is shown below. Note that it is not necessary to provide an assessment result for the decision to abandon, even though the task is required, because it has been agreed that the decision is highly reliable.

It can be seen that all of the PSFs are at least green, indicating they support the use of the value of 0.1. However, it is also noteworthy that all of the time margins are very favorable (supporting a lower screening value), complexity is not degraded, lighting is favorable, and no tools are required. All of these things taken together provide a weight of evidence that a value lower than 0.1 could also be justified.

Table 18 – Summary of Assessment Example 2

Performance Influence Factor	Conditions Supporting Use of 0.1 Screening Value				"Go/No-Go" Conditions (If Any of These Conditions Exists, 1.0 HEP is Used)	Considerations That Suggest Use of Screening HEP > 0.1	Considerations That Support Use of Screening HEP < 0.1
	Task 1 Decide to Abandon	Task 3 Establish RSD Control & Instrumen-tation	Task 4 Restore/ Ensure Decay Heat Removal	Task 5 Restore/ Ensure Injection			
Complexity		Nominal	Nominal	Nominal	See training and communications.	Degraded	Nominal
Procedure		Available and complete	Available and complete	Available and complete	Procedure not available or completion will not result in success.	Procedure is potentially confusing, unclear, or overly subject to interpretation.	Procedure very straightforward, easy to implement, minimal or no steps not directly required for Tasks 1-5.
Training		Subsumed by Complexity	Subsumed by Complexity	Subsumed by Complexity	No training	Subsumed by Complexity.	Subsumed by Complexity.
Cues/ Indications		Yes	Yes	Yes	Cues are in error for given fire scenario.	Cues are provided, but are not clear.	Cues clear and well trained.
Staffing		Adequate	Adequate	Adequate	Insufficient staff to perform all required actions.	Expect staff limitations to result in a longer time required to complete each task.	Extra staff available for checking.
Tools/Parts		Not needed	Not needed	Not needed	Not available	Need or location unclear. Difficult to obtain.	No special tools or parts required for any execution activities.
Accessibility		Accessible	Accessible	Accessible	Not accessible	Limited accessibility (e.g., tight quarters, long access path)	Highly accessible, no impairments, short direct access paths.
Communications		Subsumed by Complexity	Subsumed by Complexity	Subsumed by Complexity	Not available or highly questionable reliability.	Subsumed by Complexity	Subsumed by Complexity
Lighting		Normal	Normal	Normal	None in one or more areas where actions take place.	Portable in one or more locations where actions take place	Normal in all areas where actions take place.
Timing		5 timing elements for each task	5 timing elements for each task	5 timing elements for each task	See below	See below	See below

Table 18 – Summary of Assessment Example 2

Performance Influence Factor	Conditions Supporting Use of 0.1 Screening Value					"Go/No-Go" Conditions (If Any of These Conditions Exists, 1.0 HEP is Used)	Considerations That Suggest Use of Screening HEP > 0.1	Considerations That Support Use of Screening HEP < 0.1
	Task 1 Decide to Abandon	[redacted]	Task 3 Establish RSD Control & Instrumen-tation	Task 4 Restore/ Ensure Decay Heat Removal	Task 5 Restore/ Ensure Injection	[redacted]		
6) System time window	[redacted]	[redacted]	System time window is 90 minutes Time Margin (Time Available – Time Required) is 55 minutes	System time window is 100 minutes Time Margin (Time Available – Time Required) is is 65 minutes	System time window is 88 minutes Time Margin (Time Available - Time Required) is 50 minutes	[redacted]	Time Required is equal to or greater than Time Available.	Time Margin (Time Available - Time Required) is 5 to 15 minutes.	Time Margin (Time Available – Time Required) is at least 35 minutes.
7) Time of the decision to abandon	[redacted]	[redacted]	15	15	15	[redacted]	n/a	n/a	n/a
8) Time of Cue	[redacted]	[redacted]	20	25	25	[redacted]	See Time Available	See Time Available	See Time Available
9) Diagnosis Time	[redacted]	[redacted]	0	0	0	[redacted]	See Time Available	See Time Available	See Time Available
10) Time to Execute	[redacted]	[redacted]	5	10	15	[redacted]	See Time Available	See Time Available	See Time Available

1.4.5 Variation 1 For Example 2

Once outside the MCR the plant must communicate face-to-face. There are multiple actions taking place is multiple locations that require communication. (No headsets are available in this variation.)

In this case screening criteria is shown in the Table below.

Table 19: Screening Criteria Assessment For Example 2 Variation 1

Complexity	Degraded ISG criteria • Are there many alarms or indications to which the crew or operator must identify, evaluate, and respond? - NO • Will communication between several individuals at different locations be necessary? Yes – The headsets required for communication are not available and instead face-to-face communication is required. • Will plant symptoms be difficult to ascertain because of instrumentation failures and spurious indications? No – Once the crew leaves the MCR all instrumentation is available. • Will component failures have multiple or propagated effects on systems, equipment, or other components? NO • Will the action sequence include concurrent tasks that require specific timing to be successful? – No. Each operator is handed a standalone attachment once the decision to abandon is made. • Will the situation include many distractions, crowds of people, or other factors that could divert attention from the required tasks? No
Procedure	Procedure explicitly documents all required tasks.
Training	Bi-annual training on all tasks.
Cues/ Indications	All cues and indications are available for all tasks. (Subsumed by complexity.)
Staffing	No staffing limitations.
Tools/Parts	No task requires special tools and parts.
Accessibility	The travel routes were clearly documented in the feasibly study. There are no locked doors which the operators must obtain keys for.
Communications	The timing parameters need to be adjusted to account for communication impacts since headsets are not available. (Subsumed by complexity.)
Lighting	The fire does not cause a loss of DC power therefore all lighting conditions are nominal.
Timing	See next table

Table 20: Time Margins Assessment For Example 2 Variation 1 (five minute intervals)

Timing input	Task 3	Task 4	Task 5

EXAMPLE 2

Tsw	90 minutes	100 minutes	90 minutes
Tdelay	20 minutes	25 minutes	25 minutes
Tcog	0 minutes	0	0
Texe	5 minutes+10 minutes	10 minutes +10 minutes	15 minutes +10 minutes
Time Available – Time Required	55 minutes	55 minutes	40 minutes

With a 10 minute increase in the manipulation time the time margin requirements are met. It can be seen that many of the PSFs are green, indicating they support the use of the value of 0.1. In addition, the time margin is extremely favorable. However, the complexity in this case is degraded,. Of most significance is that the unavailability of communications of any kind other than runners violates a go/no-go criterion. While again there are no special tools needed and there will be normal lighting because there is no loss of power, the lack of communications overrides other considerations. Taken as a whole, the conditions are such that a screening value of 0.1 is not applicable, and a screening value of 1.0 should be applied, even though the actions are considered feasible.

Table 21 – Summary of Assessment Example 2

Performance Influence Factor	Conditions Supporting Use of 0.1 Screening Value				"Go/No-Go" Conditions (If Any of These Conditions Exists, 1.0 HEP is Used)	Considerations That Suggest Use of Screening HEP > 0.1	Considerations That Support Use of Screening HEP < 0.1
	Task 1 Decide to Abandon	Task 3 Establish RSD Control & Instrumen-tation	Task 4 Restore/ Ensure Decay Heat Removal	Task 5 Restore/ Ensure Injection			
Complexity		Degraded	Degraded	Degraded	See training and communications.	Degraded	Nominal
Procedure		Available and complete	Available and complete	Available and complete	Procedure not available or completion will not result in success.	Procedure is potentially confusing, unclear, or overly subject to interpretation.	Procedure very straightforward, easy to implement, minimal or no steps not directly required for Tasks 1-5.
Training		Subsumed by Complexity	Subsumed by Complexity	Subsumed by Complexity	No training	Subsumed by Complexity.	Subsumed by Complexity.
Cues/ Indications		Yes	Yes	Yes	Cues are in error for given fire scenario.	Cues are provided, but are not clear.	Cues clear and well trained.
Staffing		Adequate	Adequate	Adequate	Insufficient staff to perform all required actions.	Expect staff limitations to result in a longer time required to complete each task.	Extra staff available for checking.
Tools/Parts		Not needed	Not needed	Not needed	Not available	Need or location unclear. Difficult to obtain.	No special tools or parts required for any execution activities.
Accessibility		Accessible	Accessible	Accessible	Not accessible	Limited accessibility (e.g., tight quarters, long access path)	Highly accessible, no impairments, short direct access paths.
Communications		Not available	Not available	Not available	Not available or highly questionable reliability.	Subsumed by Complexity	Subsumed by Complexity
Lighting		Normal	Normal	Normal	None in one or more areas where actions take place.	Portable in one or more locations where actions take place	Normal in all areas where actions take place.
Timing		5 timing elements for each task	5 timing elements for each task	5 timing elements for each task	See below	See below	See below
1) System Time window		System time window is 90 minutes Time Margin (Time Available – Time Required) is 55 minutes	System time window is 100 minutes Time Margin (Time Available – Time Required) is 55 minutes	System time window is 90 minutes Time Margin (Time Available - Time Required) is 40 minutes	Time Required is equal to or greater than Time Available.	Time Margin (Time Available - Time Required) is 5 to 15 minutes.	Time Margin (Time Available – Time Required) is at least 35 minutes.

Table 21 – Summary of Assessment Example 2								
Performance Influence Factor	Conditions Supporting Use of 0.1 Screening Value						"Go/No-Go" Conditions (If Any of These Conditions Exists, 1.0 HEP is Used)	Considerations That Suggest Use of Screening HEP > 0.1	Considerations That Support Use of Screening HEP < 0.1
	Task 1 Decide to Abandon		Task 3 Establish RSD Control & Instrumen-tation	Task 4 Restore/ Ensure Decay Heat Removal	Task 5 Restore/ Ensure Injection				
2) Time of the decision to abandon			15	15	15		n/a	n/a	n/a
3) Time of Cue			20	25	25		See Time Available	See Time Available	See Time Available
4) Diagnosis Time			0	0	0		See Time Available	See Time Available	See Time Available
5) Time to Execute			15	20	25		See Time Available	See Time Available	See Time Available

1.4.6 Variation 2 for Example 1: AFW fails to start and run at T=0.

In the case AFW fails to start at T= 0 and AFW cannot be started from the MCR due to the fire damage. A local operator must be sent to start AFW locally before the MCR is abandoned.

The crew would diagnose a loss of AFW on loss of AFW flow and SG level indications based on a red path on the critical safety function status trees. FRH-1 will be entered within the first 6 minutes of the scenario. SG level indications are not impacted by the fire.

Before abandonment occurs the MCR will send a local operator to start AFW. Locally starting AFW takes 10 minutes to complete and this action could be completed before abandonment is required.

This action is complicated by the fact that the MCR abandonment procedure directs the crew to switch off AFW just before leaving the MCR. There could be some hesitation among the crew to switch off AFW since they will have either just re-established AFW or a field operator will still be working the restoration when abandonment occurs.

The TSW for Task 4 would need changed as follow:
T_{SW} = 85 minutes. For establishing the AFW the system time window is based on the time to SG dryout. Per MAAP run (PRA-RUN –XXX) the time to core damage given a loss of AFW is 85 minutes

T_{delay} = 6 minutes – Time to reach entry criteria for FRH-1

T_{cog} = 1 minutes – Time for diagnosis for loss of AFW.

T_{exe} = 10 minutes to restore AFW locally. This is the timing from the internal events PRA.

The time to complete the Auxiliary Feed water restoration is 17 minutes after the start of the fire and abandonment occurs at 18 minutes.

If the operator were to switch off AFW at T=18 minute then AFW could still be aligned to the other unit in with sufficient time.

Tsw = 85 minutes – Assume AFW was running for less than a minutes before it is turned off at 18 minutes

T_{delay} = 23 minutes (see discussion on example 2 base case)

T_{cog} = 0 minutes. (see discussion on example 2 base case)

T_{exe} = 7 minutes (see discussion on example 2 base case)

In this case the screening assessment is shown below.

Table 22: Screening Criteria Assessment For Example 2 Variation 2	
Complexity	Complex ISG criteria • Are there many alarms or indications to which the crew or operator must identify, evaluate, and respond? - NO • Will communication between several individuals at different locations be necessary? Yes – • Will plant symptoms be difficult to ascertain because of instrumentation failures and spurious indications? No – SG level indication in the MCR is not impacted by the fire. Once the crew leaves the MCR all instrumentation is available. • Will component failures have multiple or propagated effects on systems, equipment, or other components? NO – MCR is isolated just before leaving to prevent additional spurious indications. • Will the action sequence include concurrent tasks that require specific timing to be successful? – See Timing margin analysis • Will the situation include many distractions, crowds of people, or other factors that could divert attention from the required tasks? The diagnosis for the loss of AFW before MCR abandonment is required could complicate the situation. The loss of AFW could lead to potential confusion on the decision to switch off AFW just before leaving the MCR.
Procedure	The MCR abandonment procedure will work if implemented as directed. However there maybe some hesitation among the crew to switch off AFW just before leaving the MCR after they just restored the system.
Training	Bi-annual training on all tasks. (Subsumed by complexity.)
Cues/ Indications	All cues and indications are available for all tasks
Staffing	No staffing limitations.
Tools/Parts	No task requires special tools and parts.
Accessibility	The travel routes were clearly documented in the feasibly study. There are no locked doors which the operators must obtain keys for.
Communications	Operators will communicate via headsets. (Subsumed by complexity.)
Lighting	The fire does not cause a loss of DC power therefore all lighting conditions are nominal.
Timing	See next table

Table 23: Time Margins Assessment For Example 2 Variation 2 (five minute intervals)			
Timing input	**Task 3**	**Task 4**	**Task 5**
Tsw	90 minutes	85 minutes	90 minutes
Tdelay	20 minutes	25 minutes	25 minutes
Tcog	0 minutes	0 minutes	0 minutes
Texe	5 minutes	10 minutes	15 minutes
Time Available – Time Required	65 minutes	50 minutes	50 minutes

Based on this timing change for Task 4 the time available – time required does meet the 0.1 screening criteria. However, the complexity in this case is degraded, and there is a procedural deficiency where the procedure is somewhat counter-intuitive in calling for AFW to be terminated then it may have just been started. Therefore, the complexity criteria and procedure criteria are not met to support a 0.1 screening value. However, in this case the time margin is extremely favorable (exceeds the range required of support 0.1). This variation is a good example of where two very important PIF criteria can "cancel each other out." The degraded complexity is a detriment, but the very large time margin provides sufficient recovery time to compensate. Therefore, a screening HEP of 0.1 is supported.

Table 24 – Summary of Assessment Example 2

Performance Influence Factor	Conditions Supporting Use of 0.1 Screening Value				"Go/No-Go" Conditions (If Any of These Conditions Exists, 1.0 HEP is Used)	Considerations That Suggest Use of Screening HEP > 0.1	Considerations That Support Use of Screening HEP < 0.1
	Task 1 Decide to Abandon	Task 3 Establish RSD Control & Instrumen-tation	Task 4 Restore/ Ensure Decay Heat Removal	Task 5 Restore/ Ensure Injection			
Complexity		Degraded	Degraded	Degraded	See training and communications.	Degraded	Nominal
Procedure		Available and complete	Unclear	Available and complete	Procedure not available or completion will not result in success.	Procedure is potentially confusing, unclear, or overly subject to interpretation.	Procedure very straightforward, easy to implement, minimal or no steps not directly required for Tasks 1-5.
Training		Subsumed by Complexity	Subsumed by Complexity	Subsumed by Complexity	No training	Subsumed by Complexity.	Subsumed by Complexity.
Cues/ Indications		Yes	Yes	Yes	Cues are in error for given fire scenario.	Cues are provided, but are not clear.	Cues clear and well trained.
Staffing		Adequate	Adequate	Adequate	Insufficient staff to perform all required actions.	Expect staff limitations to result in a longer time required to complete each task.	Extra staff available for checking.
Tools/Parts		Not needed	Not needed	Not needed	Not available	Need or location unclear. Difficult to obtain.	No special tools or parts required for any execution activities.
Accessibility		Accessible	Accessible	Accessible	Not accessible	Limited accessibility (e.g., tight quarters, long access path)	Highly accessible, no impairments, short direct access paths.
Communications		Subsumed by Complexity	Subsumed by Complexity	Subsumed by Complexity	Not available or highly questionable reliability.	Subsumed by Complexity	Subsumed by Complexity
Lighting		Normal	Normal	Normal	None in one or more areas where actions take place.	Portable in one or more locations where actions take place	Normal in all areas where actions take place.
Timing		5 timing elements for each task	5 timing elements for each task	5 timing elements for each task	See below	See below	See below

Table 24 – Summary of Assessment Example 2

Performance Influence Factor	Conditions Supporting Use of 0.1 Screening Value						"Go/No-Go" Conditions (If Any of These Conditions Exists, 1.0 HEP is Used)	Considerations That Suggest Use of Screening HEP > 0.1	Considerations That Support Use of Screening HEP < 0.1
	Task 1 Decide to Abandon	[redacted]	Task 3 Establish RSD Control & Instrumen-tation	Task 4 Restore/ Ensure Decay Heat Removal	Task 5 Restore/ Ensure Injection	[redacted]			
1. System Time window	[redacted]	[redacted]	System time window in 90 minutes. Time Margin (Time Available – Time Required) is 60 minutes	System time window in 85 minutes Time Margin (Time Available – Time Required) is 50 minutes	System time window in 90 minutes Time Margin (Time Available - Time Required) is 50 minutes	[redacted]	Time Required is equal to or greater than Time Available.	Time Margin (Time Available - Time Required) is 5 to 15 minutes.	Time Margin (Time Available – Time Required) is at least 35 minutes.
2. Time of the decision to abandon	[redacted]	[redacted]	15	15	15	[redacted]	n/a	n/a	n/a
3. Time of Cue	[redacted]	[redacted]	20	25	25	[redacted]	See Time Available	See Time Available	See Time Available
4. Diagnosis Time	[redacted]	[redacted]	0	0	0	[redacted]	See Time Available	See Time Available	See Time Available
5. Time to Execute	[redacted]	[redacted]	15	20	25	[redacted]	See Time Available	See Time Available	See Time Available

1.5 Example 3

1.5.1 Plant Background Information Specific to Example

Plant has a remote shutdown panel.

1.5.2 MCR Abandonment Scenario Description

A fire occurs in an electrical panel in the back of the MCR. At the start of the fire a reactor trip/turbine trip occurs and there are no fire induced spurious operations of equipment. The fire causes a LOSP and EDGs fail to start due to fire damage. Following the reactor trip, the plant response is as expected for a SBO until smoke fills the MCR causing the MCR to be uninhabitable. DC power remains available until the batteries deplete at 4 hours or the EDGs are recovered. The TDAFW pump starts and continues to run until the operators turn the pump off just before leaving the MCR. There are no fire induced spurious operations of equipment after the operators abandon the MCR.

Table 25: Identification of Operator Actions Required For Success For Example 3						
	Task 1 Decide to Abandon	**Task 2 Isolation of MCR control circuits**	**Task 3 Establish Remote Control/ Instrumentation**	**Task 4 Restore/Ensure Decay Heat Removal**	**Task 5 Restore/ Ensure Injection**	**Task 6 Recovery of spurious operations**
High level task(s)	Assumed successful due to loss of habitability	Isolation of the MCR is required.	Reestablish instrumentation at RSP by placing switches in local.	Restore AFW at RSP	1. Start and load EDGs locally 2. Restore power to CCW and CCP by closing breaker then start CCW and CCP pumps locally.	None

1.5.3 Definition and Qualitative Analysis

The fire and the reactor trip to occur at the same time. The fire causes LOSP and the EDGs fail to start. Upon receiving a reactor trip the control room crew will enter E-0 and perform the first 4 steps of E-0 and transfer to ECA 0.0 within the first 5 minutes of the scenario. Within the first 5 minutes a local operator will be sent to locally investigate the failure of the EDGs based on directions in ECA 0.0

When the crew enters ECA 0.0 they will also open the MCR abandonment procedure. The fire is spreading within the panel and suppression measures are not successful. Because the fire is spreading, and the smoke levels are increasing the operators start performing steps 1-8 of the abandonment procedure at about 15 minutes. As the scenario progresses, smoke levels continue to build and force the operators out of the MCR at 18 minutes. (This time is determined by CFAST). It will take a local operator about 5 minutes once dispatched to locally start and load the EDGs. Therefore the EDGs will be running and power will be restored before the operators leave the MCR.

The fire PRA context for this scenario is that after the fire causes a LOSP and the EDGs fail to start (SBO). The TDAFW pump will start and remain running until the operator secures it at 15 minutes (before leaving the MCR.)

Once outside the MCR, the MRC abandonment procedure directs a single RO to perform all actions at the RSP and then directs additional local actions via standalone attachments. The PSFs associated with each Task are shown in Table 26.

Table 26: Qualitative Analysis Summary For Example 3					
PSF	**Task 1**	**Task 2**	**Task 3**	**Task 4**	**Task 5**
	Decide to Abandon	**Task 2 Isolation of MCR control circuits**	**Establish Instrumentation at RSP**	**Restore/Ensure Decay Heat Removal**	**Restore/ Ensure Injection**
Complexity	Nominal	Nominal	Nominal	Nominal	Nominal By the time abandonment occurs the EDGs are running.
Procedure	EOP-MCR-ABANDONMENT The purpose of this procedure is to provide actions for achieving safe shutdown when control room evacuation is required.	Step 8 of the MCR abandonment procedure directs the crew to isolate the MCR by tripping 2 breakers in the MCR just before leaving.	Steps 11 and 12 of the MCR abandonment procedure direct provide the execution steps for this action.	Steps 13- 21 of the MCR abandonment procedure direct the crew to restore AFW from the remote shutdown panel.	ECA 0.0 Step 2 directs the operators to locally start the EDGs. Steps 23 – 28 MCR abandonment procedure direct the crew to maintain CCW and charging and associated cooling systems from the remote shutdown panel.
Training (Input to complexity assignment)	Yes – Bi-annually as part of the class room discussion.	Yes – Bi-annually	Yes – Bi-annually No JPM exists	Yes – Bi-annually JPM exists for this Attachment B	Yes – Bi-annually JPM exists for this Attachment C
Complexity	Nominal	Nominal	Nominal	Nominal	Nominal By the time abandonment occurs the EDGs are running.

Table 26: Qualitative Analysis Summary For Example 3					
PSF	**Task 1**	**Task 2**	**Task 3**	**Task 4**	**Task 5**
	Decide to Abandon	**Task 2 Isolation of MCR control circuits**	**Establish Instrumentation at RSP**	**Restore/Ensure Decay Heat Removal**	**Restore/ Ensure Injection**
Cues/Indications	Smoke forces operators to leave.	Following steps in the procedure	Following steps in the procedure to establish instrumentation. No additional instrumentation is required.	Following steps in the procedure. No additional instrumentation is required.	Following steps in the procedure. No additional instrumentation is required.
Staffing	Decision to abandon is made by Unit Supervisor	Reactor Operator # 1	Reactor Operator # 1	Reactor Operator # 1	Balance of Plant Operator and Aux Building
Lighting	Emergency until EDGs are restored.	Emergency until EDGs are restored.	Emergency until EDGs are restored.	Emergency until EDGs are restored.	Emergency until EDGs are restored.
Tools/Parts	N/A	None required	None required	None required	None required
Accessibility	Control room is un inhabitable	This MCR action is performed just before operators leave the MCR.	Remote shutdown panel	Remote shutdown panel	EDG room Electrical room CCP pump room CCW pump room
Communications (Input to complexity assignment)	N/A	None required.	Available- Operators can communicate via phone lines. The evacuation phone numbers are provided in the MCR abandonment procedure as notes when communication is required.	Available- Operators can communicate via phone lines. The evacuation phone numbers are provided in the MCR abandonment procedure as notes when communication is required.	Available- Operators can communicate via phone lines. The evacuation phone numbers are provided in the MCR abandonment procedure as notes when communication is required.

Table 26: Qualitative Analysis Summary For Example 3					
PSF	**Task 1**	**Task 2**	**Task 3**	**Task 4**	**Task 5**
	Decide to Abandon	**Task 2 Isolation of MCR control circuits**	**Establish Instrumentation at RSP**	**Restore/Ensure Decay Heat Removal**	**Restore/ Ensure Injection**
Critical Tasks	1 Critical Task	1 Critical task	2 Critical Tasks	3 Critical Tasks	4 Critical Task
Details about critical tasks	Critical task but the HEP is negligible in this simplified case.	1. Place isolation switch in pull to lock.	1. Place Ctrl Room isolation switches in LOCAL Hand switch – 1-X Hand switch -2 –X 2. Place the following system switches in local Hand switch – 3-AL Hand switch -4 –CCW Hand switch – 5-FC Hand switch -6 –PW All actions are performed at the remote shutdown panel	1. Align AFW suction from the CST. (CST-XX-1) 2. START AFW pump A 3. Open AFW Valve –XX All actions are performed at the remote shutdown panel.	1. Start EDG locally. 2. Restore power to CCW pumps and charging pump by closing breaker in south electrical room. 3. Start CCW in CCW pump room 4. Start CCP from north piping penetration room. Critical task 1 is performed by local operator before abandonment is required. Critical task 2 is

Table 26: Qualitative Analysis Summary For Example 3					
PSF	**Task 1**	**Task 2**	**Task 3**	**Task 4**	**Task 5**
	Decide to Abandon	**Task 2 Isolation of MCR control circuits**	**Establish Instrumentation at RSP**	**Restore/Ensure Decay Heat Removal**	**Restore/ Ensure Injection**
					performed by BOP. Critical task 2 and 3 are performed by Aux operator
Timing		See next sections for intergraded timeline and individual timing components			

Table 27: Integrated Timeline For Example 3	
T =0	Start of fire.
T =0	Reactor trip
T =0	Control room is aware of a fire in the control room.
T=0	Fire brigade summoned.
T = 5 minutes	Operators enter E-0 and ECA0.0 complete first 4 steps within 5 minutes.
T = 5 minutes	Fire brigade continues to fight fire unsuccessfully. Operators open MCR abandonment procedure, but fire has not yet progressed sufficiently to enter procedure.
T = 5 minutes	MCR dispatches local operator to start the EDGs
T = 5-18 minutes	Operators work in ECA 0.0 and try and assess damage caused by fire. The fire brigade continues unsuccessfully to suppress fire.
T = 10 minutes	EDGs are started.
T=15 minutes	Operators will have seen the smoke building, and at the 15 minute point will decide to implement the MCR Abandonment procedure. The 15 minute point was modeled based on the following: • CFAST calculations showing the evacuation criteria are met at 18 minutes • Operators have stated that they will remain in the MCR as long as possible. • Operators see smoke building, respond to the reactor trip using EOPs until the point where abandonment is imminent
T =15-17 minutes	Operators perform the first 8 steps of MCR abandonment procedure. Most of the actions associated with these procedure steps will have already been performed since the plant has been shutting down since the start of the fire. Although the fire is causing smoke and hot gas, it has damaged only components associated with the panel where the fire has started. Upon completion of the first 8 steps of the MCR Abandonment procedure, TDAFW are all stopped as directed by the procedure and the electrical power feed from offsite power is tripped.
T =18 minutes	For this fire, CFAST calculations show the evacuation criteria have been met and force the operators out of the control room. At the time one RO goes the RPS and the Aux building operator starts to align breaker NB02.
T=20 minutes	Operators arrive at RSP
T = 22 minutes	RSP instrumentation is established.
T = 27 minutes	AFW is established at RSP
T = 38 minutes	Charging and CCW are re-established.

Timing For Task 2: Isolation of the MCR

T_{SW} = 18 minutes – The isolation of the MCR must occur before the habitability criteria are met.

T_{delay} = 15 minutes – This is the time when the decision to abandon is made.

T_{exe} = 1 minutes – This is the time to put the isolation switches in pull to lock.

T_{cog} = 0 There is expected to be no hesitation in further deciding whether this action is required after the decision to abandon has been made.

This step is highlighted in training and is graphically district. The isolation task could be performed early and there would be no impact on actions required in Tasks 3, 4 and 5. Failure to perform this step would result in additional spurious actuation of components which cannot be mitigated outside the control room and core damage would occur.

Timing For Task 3: Establish Instrumentation at remote shutdown panel

TSW = 18+36.6 minutes = 54.6 minutes.

Per NSCA analysis the allowed completion time is 36.57 minutes. This is the time from when abandon is required and abandonment occurs at 18 minutes.

T_{delay} = 20 minutes. This is the time to abandonment is required plus 2 minutes to travel to the RPS.

T_{cog} = 0. There is expected to be no hesitation in further deciding whether instrumentation is needed or not.
T_{Exe} = 2.0 minutes. This is the manipulation time to control at the RPS from the feasibility study. The Alignment of instrumentation is complete at 22.0 minutes after the start of the fire.

Timing for Task 4 Establish Restore/Ensure Decay Heat Removal

T_{SW} = 65 minutes. For establishing the AFW the system time window is based on SG dryout. Per MAAP run (PRA-RUN –XXX) the time to SG dryout given a loss of AFW is 50 minutes. AFW successfully runs for the first 15 minutes after reactor trip, so T_{SW} is conservatively modeled as (15 + 50) = 65 minutes.

T_{delay} = 22 minutes -Time at which the MCR abandonment procedure directs that AFW be restored, which is the cue for this action. AFW is turned off just before abandonment occurs (15 minutes) and is directed to be restored at step 13 in the MCR abandonment procedure.

T_{cog} = 0 minutes. Given that the decision to abandon has already been made, there is expected to be no hesitation in further deciding whether the restoration of AFW is needed or not.

T_{exe} = 5 minutes to restore AFW. This is the manipulation time from the feasibility study.

The time to complete the Auxiliary Feedwater restoration is 27 minutes after the start of the fire.

Timing for Task 5: Restore/ Ensure Injection

There are two parts with two different timelines for Task 5
1) Locally start the EDGs

T_{SW} = 45 minutes - Per MAAP run (PRA-RUN –XXX) the time to SG dryout is 45 minutes with loss of TDAFW. Per MAAP run (PRA-RUN –XXX) the time to core damage given an SBO with stuck open PORV is 90 minutes. In this example 45 minutes is used as the most limiting case even though the TDAFW starts and runs successfully at T = 0.

T_{delay} = 5 minutes – This time before the MCR directs and operator to locally star the EDGs.

T_{cog} = 0 minutes – Diagnosis of an SBO should be obvious and no cognition is required to send operator to locally start the EDG. This is step directed by ECA 0.0.

T_{exe} = 5 minutes – The is the time to locally start the EDGs and includes travel time.

2) Re-establish Charging and CCW after abandonment occurs.

TSW = 18+36.6 minutes = 54.6 minutes.

Per NSCA analysis the allowed completion time is 36.57 minutes. This is the time from when abandon is required and abandonment occurs at 18 minutes.

T_{delay} = 18 minutes. -Time at which the MCR abandonment occurs at this time abandonment occurs and operator is given the attachment to close breaker.

T_{cog} = 0 minutes. Given that the decision to abandon has already been made, there is expected to be no hesitation in further deciding whether the restoration of CVCS is needed or not.

T_{EXE}= 20 minutes. This is the manipulation time to establish the CVCS, from the feasibility study.

1.5.4 Justification HEP screening value

All of the PSFs identified in Table 26 are considered to be nominal and are compared against the screening criteria.

Table 28: Screening Criteria Assessment For Example 3	
Complexity	Nominal ISG criteria • Are there many alarms or indications to which the crew or operator must identify, evaluate, and respond? - NO • Will communication between several individuals at different locations be necessary? Yes – However, all operators are given headsets for communication once the leave the MCR. Communication is considered to nominal. • Will plant symptoms be difficult to ascertain because of instrumentation failures and spurious indications? No – Once the crew leaves the MCR all instrumentation is available. Establishing local instrumentation is considered to be a nominal task. • Will component failures have multiple or propagated effects on systems, equipment, or other components? NO – MCR is isolated just before leaving to prevent additional spurious indications. • Will the action sequence include concurrent tasks that require specific timing to be successful? – See Timing margin analysis • Will the situation include many distractions, crowds of people, or other factors that could divert attention from the required tasks? No
Procedure	Procedure explicitly documents all required tasks.
Training	Bi-annual training on all tasks. (Subsumed by complexity.)
Cues/ Indications	All cues and indications are available for all tasks
Staffing	No staffing limitations.
Tools/Parts	No task requires special tools and parts.
Accessibility	The travel routes were clearly documented in the feasibly study. There are no locked doors which the operators must obtain keys for.
Communications	Headsets are available for communication. (Subsumed by complexity.)
Lighting	Emergency lighting until the EDGs are restored
Timing	See next table

Table 29: Time Margins Assessment For Example 3 (five minute intervals)				
Timing input	**Task 2**	**Task 3**	**Task 4**	**Task 5**
Tsw	20 minutes	55 minutes	65 minutes	45 minutes
Tdelay	15 minutes	20 minutes	20 minutes	5 minutes
Tcog	0 minutes	0 minutes	0 minutes	0 minutes
Texe	1 minutes (0)	2 minutes (5)	5 minutes	5 minutes
Time Available – Time Required	4 minutes (5)	33 minutes (30)	40 minutes	35 minutes

Task 2 has a very short time margin however, this task is extremely well trained on and the procedure step is graphically distinct. The task only involves placing one control room switch in local. Even with a 2 minutes time margin a detailed HRA analysis will show that the HEP for Task 2 will be in the low 1E-2 range. The example scenario is assessed to meet the 0.1 screening criteria.

Table 30 – Summary of Assessment Example 3									
Performance Influence Factor	**Conditions Supporting Use of 0.1 Screening Value**						**"Go/No-Go" Conditions (If Any of These Conditions Exists, 1.0 HEP is Used)**	**Considerations That Suggest Use of Screening HEP > 0.1**	**Considerations That Support Use of Screening HEP < 0.1**
	Task 1 Decide to Abandon		**Task 2 Isolation of the MCR**	**Task 3 Establish RSD Control & Instrumentation**	**Task 4 Restore/ Ensure Decay Heat Removal**	**Task 5 Restore/ Ensure Injection**			
Complexity			Nominal	Nominal	Nominal	Nominal	See training and communications.	Degraded	Nominal
Procedure			Available and complete	Available and complete	Available and complete	Available and complete	Procedure not available or completion will not result in success.	Procedure is potentially confusing, unclear, or overly subject to interpretation.	Procedure very straightforward, easy to implement, minimal or no steps not directly required for Tasks 1-5.
Training			Subsumed by Complexity	Subsumed by Complexity	Subsumed by Complexity	Subsumed by Complexity	No training	Subsumed by Complexity.	Subsumed by Complexity.
Cues/ Indications			Yes	Yes	Yes	Yes	Cues are in error for given fire scenario.	Cues are provided, but are not clear.	Cues clear and well trained.
Staffing			Adequate	Adequate	Adequate	Adequate	Insufficient staff to perform all required actions.	Expect staff limitations to result in a longer time required to complete each task.	Extra staff available for checking.
Tools/Parts			Not needed	Not needed	Not needed	Not needed	Not available	Need or location unclear. Difficult to obtain.	No special tools or parts required for any execution activities.
Accessibility			Accessible	Accessible	Accessible	Accessible	Not accessible	Limited accessibility (e.g., tight quarters, long access path)	Highly accessible, no impairments, short direct access paths.
Communications			Subsumed by Complexity	Subsumed by Complexity	Subsumed by Complexity	Subsumed by Complexity	Not available or highly questionable reliability.	Subsumed by Complexity	Subsumed by Complexity
Lighting			Normal	Normal	Normal	Normal	None in one or more areas where actions take place.	Portable in one or more locations where actions take place	Normal in all areas where actions take place.
Timing			5 timing elements for each task	5 timing elements for each task	5 timing elements for each task	5 timing elements for each task	See below	See below	See below

Table 30 – Summary of Assessment Example 3

Performance Influence Factor	Task 1 Decide to Abandon	Task 2 Isolation of the MCR	Task 3 Establish RSD Control & Instrumentation	Task 4 Restore/ Ensure Decay Heat Removal	Task 5 Restore/ Ensure Injection	"Go/No-Go" Conditions (If Any of These Conditions Exists, 1.0 HEP is Used)	Considerations That Suggest Use of Screening HEP > 0.1	Considerations That Support Use of Screening HEP < 0.1
		Conditions Supporting Use of 0.1 Screening Value						
1) System time window		System time window is 20 minutes Time Margin (Time Available – Time Required) is 5 minutes	System time window is 55 minutes Time Margin (Time Available – Time Required) is 30 minutes	System time window is 65 minutes Time Margin (Time Available – Time Required) is 40 minutes	System time window is 45 minutes Time Margin (Time Available - Time Required) is 35 minutes	Time Required is equal to or greater than Time Available.	Time Margin (Time Available - Time Required) is 5 to 15 minutes.	Time Margin (Time Available – Time Required) is at least 35 minutes.
2) Time of the decision to abandon		15	15	15	15	n/a	n/a	n/a
3) Time of Cue		15	20	20	5	See Time Available	See Time Available	See Time Available
4) Diagnosis Time		0	0	0	0	See Time Available	See Time Available	See Time Available
5) Time to Execute		Less than 1 minute (0)	2	5	5	See Time Available	See Time Available	See Time Available

1.5.5 Variation 1 for Example 3: EDGs are not restored until after MCR is abandoned.

In this case, it is assumed that the EDGS are not restored before abandonment occurs. With the EDGS failed, the plant is relying on DC power and the TDAFW pump. The MCR abandonment procedure is silent on what to do with TDAFW pump before leaving the MCR. MDAFW is directed to be switched off and then re-started at the RPS. In this case the MCR abandonment procedure does not match the scenario.

If the operators were to trip the TDAFW pump before leaving the MCR they could restore the pump and control it locally. However, this is not currently procedurlized and is not credited in the fire PRA. Given the challenges of this scenario the 0.1 screening criteria is not applicable.

Table 31: Screening Criteria Assessment For Example 3 Variation 1

Complexity	Degraded ISG criteria • Are there many alarms or indications to which the crew or operator must identify, evaluate, and respond? - NO • Will communication between several individuals at different locations be necessary? Yes – However, when communication is required a phone number is listed in the procedure for who to call. The phone lines are not impacted by the fire. This type of communication is no different than any local action directed by the MCR • Will plant symptoms be difficult to ascertain because of instrumentation failures and spurious indications? Yes without power local indications would be challenging. • Will component failures have multiple or propagated effects on systems, equipment, or other components? NO • Will the action sequence include concurrent tasks that require specific timing to be successful? – Yes. Power must be restored before cross-ties can be completed. • Will the situation include many distractions, crowds of people, or other factors that could divert attention from the required tasks? No
Procedure	Procedure explicitly documents all required tasks.
Training	Bi-annual training on all tasks.
Cues/ Indications	All cues and indications are available for all tasks. (Subsumed by complexity.)
Staffing	No staffing limitations.
Tools/Parts	No task requires special tools and parts.
Accessibility	The travel routes were clearly documented in the feasibly study. There are no locked doors which the operators must obtain keys for.
Communications	The timing parameters need to be adjusted to account for communication impacts since headsets are not available. (Subsumed by complexity.)
Lighting	Emergency lighting until EDGs are recovered.
Timing	See next table

Table 32: Time Margins Assessment For Example 3 Variation 1 (five minute intervals)

Timing input	Task 2	Task 3	Task 4	Task 5
Tsw	20 minutes	55 minutes	65 minutes	45 minutes
Tdelay	15 minutes	20 minutes	20 minutes	5 minutes
Tcog	0 minutes	0 minutes	0 minutes	0 minutes
Texe	1 minutes (0)	2 minutes (5)	5 minutes	Action takes longer than 18 minutes to complete. (assume 25)
Time Available – Time Required	4 minutes (5)	33 minutes (30)	40 minutes	15 minutes

In this case, with three tasks having degraded complexity and unfavorable time margins, the use of 0.1 cannot be supported. However, none of the conditions is such that it would forced the use of a value of 1.0. Therefore, a value greater than 0.1 would be applied for the screening HEP.

Table 33 – Summary of Assessment Example 3, Variation 1

Performance Influence Factor	Task 1 Decide to Abandon	Task 2 Isolation of the MCR	Task 3 Establish RSD Control & Instrumen-tation	Task 4 Restore/ Ensure Decay Heat Removal	Task 5 Restore/ Ensure Injection	"Go/No-Go" Conditions (If Any of These Conditions Exists, 1.0 HEP is Used)	Considerations That Suggest Use of Screening HEP > 0.1	Considerations That Support Use of Screening HEP < 0.1
		Conditions Supporting Use of 0.1 Screening Value						
Complexity		Nominal	Degraded			See training and communications.	Degraded	Nominal
Procedure		Available and complete	Available and complete	Available and complete	Available and complete	Procedure not available or completion will not result in success.	Procedure is potentially confusing, unclear, or overly subject to interpretation.	Procedure very straightforward, easy to implement, minimal or no steps not directly required for Tasks 1-5.
Training		Subsumed by Complexity	Subsumed by Complexity	Subsumed by Complexity	Subsumed by Complexity	No training	Subsumed by Complexity.	Subsumed by Complexity.
Cues/ Indications		Yes	Yes	Yes	Yes	Cues are in error for given fire scenario.	Cues are provided, but are not clear.	Cues clear and well trained.
Staffing		Adequate	Adequate	Adequate	Adequate	Insufficient staff to perform all required actions.	Expect staff limitations to result in a longer time required to complete each task.	Extra staff available for checking.
Tools/Parts		Not needed	Not needed	Not needed	Not needed	Not available	Need or location unclear. Difficult to obtain.	No special tools or parts required for any execution activities.
Accessibility		Accessible	Accessible	Accessible	Accessible	Not accessible	Limited accessibility (e.g., tight quarters, long access path)	Highly accessible, no impairments, short direct access paths.
Communications		Subsumed by Complexity	Subsumed by Complexity	Subsumed by Complexity	Subsumed by Complexity	Not available or highly questionable reliability.	Subsumed by Complexity	Subsumed by Complexity
Lighting		Normal	Emergency			None in one or more areas where actions take place.	Portable in one or more locations where actions take place	Normal in all areas where actions take place.
Timing		5 timing elements for each task	5 timing elements for each task	5 timing elements for each task	5 timing elements for each task	See below	See below	See below
1) System time window		System time window is 20 minutes Time Margin (Time Available – Time Required) is 5 minutes	The time margin for Tasks 3, 4, and 5 are dependent on when the EDGS are recovered. This example assumes EDGS are not recovered before abandonments occurs. Time margin for Tasks 3 and 4 are being reduced by the Task 5 execution time (assume Task 5 delays 3 and 4 until DGs recovered). This is bounding.			Time Required is equal to or greater than Time Available.	Time Margin (Time Available - Time Required) is 5 to 15 minutes.	Time Margin (Time Available – Time Required) is at least 35 minutes.

Table 33 – Summary of Assessment Example 3, Variation 1									
Performance Influence Factor	Conditions Supporting Use of 0.1 Screening Value						"Go/No-Go" Conditions (If Any of These Conditions Exists, 1.0 HEP is Used)	Considerations That Suggest Use of Screening HEP > 0.1	Considerations That Support Use of Screening HEP < 0.1
	Task 1 Decide to Abandon		Task 2 Isolation of the MCR	Task 3 Establish RSD Control & Instrumen-tation	Task 4 Restore/ Ensure Decay Heat Removal	Task 5 Restore/ Ensure Injection			
2) Time of the decision to abandon			15	15	15	15		n/a	n/a	n/a
3) Time of Cue			15	20	20	5		See Time Available	See Time Available	See Time Available
4) Diagnosis Time			0	0	0	0		See Time Available	See Time Available	See Time Available
5) Time to Execute			Less than 1 minute	2	5	5		See Time Available	See Time Available	See Time Available

1.6 Example 4

1.6.1 Plant Background Information Specific to Example

- Fire is in the Unit 1 control room and remote shutdown strategy is to cross-tie to other unit.
- Plant has a local control stations instead of a remote shutdown panel.

1.6.2 MCR Abandonment Scenario Description

A fire occurs in one of the horseshoe panels of the MCR. At the start of the fire a reactor trip/turbine trip occurs and there is a spuriously open PORV, and the PORV block valves are failed open by the fire. Following the reactor trip, the plant response is as expected for LOCA until smoke fills the MCR causing the MCR to be uninhabitable. Electrical power, AFW and SI are available until they are switched off by the operators in the first few steps of the MCR abandonment procedure just before the crew abandons the MCR due to high smoke levels. There are no additional fire induced spurious operations of equipment after the operators abandon the MCR.

Table 34: Identification of Operator Actions Required For Success For Example 4						
	Task 1 Decide to Abandon	**Task 2 Isolation of MCR control circuits**	**Task 3 Establish Remote Control/ Instrumentation**	**Task 4 Restore/Ensure Decay Heat Removal**	**Task 5 Restore/ Ensure Injection**	**Task 6 Recovery of spurious operations**
High level task(s)	Assumed successful due to loss of habitability	Not Required.	Local instrumentation is required to be established.	AFW pumps are shut off just before the crew leaves the MCR and the crew needs to Restore AFW by cross-ting to other unit in order to maintain SG cooling	CVCS is shut off just before the crew leaves the MCR and the crew needs to restore CVCS by cross-ting to other unit	Pull fuses locally on PORVs to ensure valves fail closed.

1.6.3 Definition and Qualitative Analysis

The fire and the reactor trip to occur at the same time. Upon receiving a reactor trip the control room crew will enter E-0 and perform the first 4 steps of E-0 and respond to the SI. All AC power is available, reactor trip and turbine trip are successful, and AFW successfully starts and runs, SI actuates successfully and continues to run.

When the crew enters EOP E-1 they will also open MCR abandonment procedure. The fire is spreading within the panel and suppression measures are not successful. Because the fire is spreading, and the smoke levels are increasing the operators start performing steps 1-16 of the abandonment procedure at about 15 minutes. As the scenario progresses, smoke levels continue to build and force the operators out of the MCR at 18 minutes. (This time is determined by CFAST). The PORV is not closed before MCR abandonment occurs.

The fire PRA context for this scenario is that after the fire causes a reactor trip, charging, AFW will remain running until the operators switch them off at 15 minutes (before leaving the MCR.)

Once outside the MCR, the MCR abandonment procedure directs individual operators to perform individual tasks. Each critical task has standalone procedures . The PSFs associated with each task are shown in Table 35.

Table 35: Qualitative Analysis Summary For Example 4					
PSF	**Task 1**	**Task 3**	**Task 4**	**Task 5**	**Task 6**
	Decide to Abandon	**Task 3 Establish RSD Control & Instrumentation**	**Restore/Ensure Decay Heat Removal**	**Restore/ Ensure Injection**	**Recovery of Spurious Operations**
Complexity	Nominal	Nominal	Nominal	Nominal	Nominal
Procedure	EOP-MCR-ABANDONMENT The purpose of this procedure is to provide actions for achieving safe shutdown when Control Room evacuation is required.	The procedure steps for this task are in a standalone attachment A of the MCR abandonment procedure. Attachment A is directed from step 17 of the MCR abandonment procedure.	The procedure step for this task is in a standalone attachment B of the MCR abandonment procedure. Attachment B is directed from step 19 of the MCR abandonment procedure.	The procedure step for this task is in a standalone attachment C of the MCR abandonment procedure. Attachment C is directed from step 17 of the MCR abandonment procedure.	The procedure step for this task is in a standalone attachment D of the MCR abandonment procedure. Attachment D is directed from step 16 of the MCR abandonment procedure.
Training	Yes – Bi-annually as part of the class room discussion.	Yes – Bi-annually No JPM exists	Yes – Bi-annually JPM exists for this Attachment B	Yes – Bi-annually JPM exists for this Attachment C	Yes – Bi-annually JPM exists for this Attachment D
Cues/Indications	Smoke forces operators to leave.	Following steps in the procedure to establish instrumentation. Only the procedure is required to diagnosis.	Following steps in the procedure. No additional instrumentation is required.	Following steps in the procedure. No additional instrumentation is required.	Following steps in the procedure. No additional instrumentation is required. Prior to MCR abandonment the crew will be aware that they have stuck open PORV. RCS pressure and

Table 35: Qualitative Analysis Summary For Example 4					
PSF	**Task 1**	**Task 3**	**Task 4**	**Task 5**	**Task 6**
	Decide to Abandon	**Task 3 Establish RSD Control & Instrumentation**	**Restore/Ensure Decay Heat Removal**	**Restore/ Ensure Injection**	**Recovery of Spurious Operations**
					temperature are not impacted by the fire before the operators leave the MCR.
Staffing	Decision to abandon is made by Unit Supervisor	Reactor Operator	Turbine Tour Operator	Aux Tour Operator	Reactor Operator
Tools/Parts	N/A	None required	None required	None required	None required
Accessibility	Control room is un inhabitable	Auxiliary Building on 612'	Auxiliary Building on 591'	Auxiliary Building on 633'	Battery Room
Communications	N/A	Available. Operators will communicate via headsets.	Available Operators will communicate via headsets.	Available Operators will communicate via headsets.	Available Operators will communicate via headsets.
Critical Tasks	1 Critical Task	4 Critical Tasks	4 Critical Tasks	7 Critical Task	1 Critical Task
Details about critical tasks	Critical task but the HEP is negligible in this simplified case.	1. Align SG wide range level indications by placing switches in local. 2. Align the power supply indications for AFW.	1. Confirm with other Unit MDAFP valves are closed. 2. Open Motor Driven Auxiliary Feedwater Pump Discharge to Unit 2 Crosstie Shutoff	1. Deenergize BIT Injection Valve Motors by opening breakers. Breaker C Breaker D	1. Pull fuses to PORV Location: Battery room.

Table 35: Qualitative Analysis Summary For Example 4					
PSF	**Task 1**	**Task 3**	**Task 4**	**Task 5**	**Task 6**
	Decide to Abandon	**Task 3 Establish RSD Control & Instrumentation**	**Restore/Ensure Decay Heat Removal**	**Restore/ Ensure Injection**	**Recovery of Spurious Operations**
		3. Align charging pump indications by placing switches in local. 4. Align PZR level indications switches in local. All actions take place at 612' Auxiliary Building location.	Valve. VALVE AFW-1-XX Location: Auxiliary Building on 591' 3 .Open Breakers Breaker A Breaker B Location: Turbine Building on 613' Elevation 4.0 Ensure local SG Level Indication is available. Location: Auxiliary Building on 612 This step will require coordination with Task 3.	Breaker E Breaker F Location: 4 kv Room Mezzanine Area 2. Align BIT for Injection - Open VALVE BIT-1-XX Location: 633' Auxiliary Building 3.Align BIT for Injection VALVE BIT-2-XX Location: 612' Auxiliary Building 4.0 Isolate Seal Injection Flow Path. CLOSE Valve CS-1-XX Location Auxiliary Building Hallway 587'	

Table 35: Qualitative Analysis Summary For Example 4					
PSF	**Task 1**	**Task 3**	**Task 4**	**Task 5**	**Task 6**
	Decide to Abandon	**Task 3 Establish RSD Control & Instrumentation**	**Restore/Ensure Decay Heat Removal**	**Restore/ Ensure Injection**	**Recovery of Spurious Operations**
				5.0 Slowly Open CS-2-XX Location Auxiliary Building Hallway 587' 6.0 Slowly Throttle Open CS-3-XX Location Auxiliary Building Hallway 587' 7.0 Throttle open CS-3-XX to maintain PRZ level within- 20% to 50% ACTUAL Location Auxiliary Building Hallway 587'	
Timing	See next sections for intergraded timeline and individual timing components				

Table 36: Integrated Timeline For Example 4	
T =0	Start of fire.
T =0	Reactor trip
T =0	Control room is aware of a fire in the control room.
T=0	Fire brigade summoned.
T = 5 minutes	Operators enter E-0 and complete first 4 steps within 5 minutes.
T = 5 minutes	Fire brigade continues to fight fire unsuccessfully. Operators open MCR abandonment procedure, but fire has not yet progressed sufficiently to enter procedure.
T = 5-18 minutes	Operators work in E-0 and E-1 and try and assess damage caused by fire. The fire brigade continues unsuccessfully to suppress fire.
T=15	Operators will have seen the smoke building, and at the 15 minute point will decide to implement the MCR Abandonment procedure. The 15 minute point was modeled based on the following: • CFAST calculations showing the evacuation criteria are met at 18 minutes • It takes about 2 minutes to complete the first 15 steps of the MCR abandonment procedure. • Operators have stated that they will remain in the MCR as long as possible. • Operators see smoke building, respond to the reactor trip using EOPs until the point where abandonment is imminent AFW and CVCS are all stopped as directed by MCR abandonment procedure. There will be a short time when SI is stopped and the PORVs are still open.
T =15-17 minutes	Operators perform the first 15 steps of MCR abandonment procedure. Most of the actions associated with these procedure steps will have already been performed since the plant has been shutting down since the start of the fire. Although the fire is causing smoke and hot gas, it has damaged only components associated with the panel where the fire has started. Upon completion of the first 15 steps of the MCR Abandonment procedure, AFW and CVCS are all stopped as directed by the procedure and the electrical power feed from offsite power is tripped.
T =18 minutes	For this fire, CFAST calculations show the evacuation criteria have been met and force the operators out of the control room.
T= 19 minutes	Crew musters in Shift Supervisor (SS) office
T = 19 minutes	RO is handed Attachment D and is directed to remove fuses to PORVs
T= 20 minutes	Second RO is handed Attachment A and is directed to establish local instrumentation monitoring.
T= 22 minutes	Aux Tour operator is handed the Attachment C and is directed to cross tie CVCS.
T=23 minutes	Turbine Tour operator is handed Attachment B and instructed to cross-tie AFW
T = 24 minutes	PORV is closed.
T=31 minutes	AFW cross-tie is complete
T=33 minutes	Local instrumentation monitoring is complete
T= 39 minutes	CVCS cross-tie is complete

Timing For Task 3: Establish Local Instrumentation

Tsw = 88 minutes. T_{SW} is based on the limiting time for all HFEs credited in this MCR abandonment scenario. See Task 5 for justification of the 88 minutes.

T_{delay} = 20 minutes. This is the time to reach the MCR abandonment procedure step which directs the use of Attachment A to establish local instrumentation. 20 minutes is estimated based on MCR abandonment starting at 18 minutes plus 2 minutes to reach step 17.

Tcog = 0. There is expected to be no hesitation in further deciding whether instrumentation is needed or not.

Tm = 13 minutes. This is the manipulation time to establish local instrumentation, from the feasibility study.

Alignment of local instrumentation monitoring is completed 33 minutes after the start of the fire (20+0+13) = (time delay plus median response plus manipulation).

Timing for Task 4 Establish Restore/Ensure Decay Heat Removal

T_{SW} = 100 minutes. For establishing the AFW cross-tie the system time window is based on the onset of core damage. Per MAAP run (PRA-RUN –XXX) the time to core damage given a loss of AFW is 85 minutes. AFW successfully runs for the first 15 minutes after reactor trip, so T_{SW} is conservatively modeled as (15 + 85) = 100 minutes.

T_{delay} = 23 minutes -Time at which the MCR abandonment procedure directs that AFW be restored, which is the cue for this action. AFW is turned off just before abandonment occurs (15 minutes) and is directed to be restored at step 19 in the MCR abandonment procedure. Tdelay = 23 minutes which is estimated based on MCR abandonment starting at 18 minutes plus 5 minutes to reach step 19.

T_{cog} = 0 minutes. Given that the decision to abandon has already been made, there is expected to be no hesitation in further deciding whether the restoration of CVCS is needed or not.

T_{exe} = 7 minutes and 30 seconds for AFW cross-tie. This is the manipulation time to establish the AFW cross-tie, from the feasibility study.

The action to complete the Auxiliary Feedwater cross-tie (via the MDAFW) is completed approximately 31 minutes = (23+8 =31) after the start of the fire.

Timing for Task 5: Restore/ Ensure Injection

T_{SW} = 88 minutes. For establishing the CVCS cross-tie the system time window is based on re-establishing injection flow in time to mitigate a LOCA. For this fire modeled, an RCP seal LOCA is possible as operators turn off all RCP seal cooling upon abandoning the MCR. The system time window in this calculation is calculated as follows.

- CVCS continues to run for the first 15 minutes after reactor trip, and then it is turned off by the operators.

- 13 minutes after the pumps are turned off a 1 gpm per pump seal leakage occurs conservatively, the HRA has used the timing of 60 minutes until core uncovery given a 76 gpm leak per pump.
- T_{SW} = 15 + 13 + 60 = 88 minutes

T_{delay} = 22 minutes. -Time at which the MCR abandonment procedure directs that CVCS be restored, which is the cue for this action. 22 minutes is estimated based on MCR abandonment starting at 18 minutes (per CFAST calculation) plus 4 minutes to reach step 18.

T_{cog} = 0 minutes. Given that the decision to abandon has already been made, there is expected to be no hesitation in further deciding whether the restoration of CVCS is needed or not.

T_{EXE}= 16.5 minutes. This is the manipulation time to establish the CVCS cross-tie, from the feasibility study.

The CVCS cross-tie is completed approximately 41 minutes (15+9+16.5) after the start of the fire.

Task 6: De-energize Pressurizer PORVs

Tsw:= 162 minutes. This is the time to the onset of core damage for a 2-in ID LOCA with SI running . From MAAP PRA-RUN-1234,

Tdelay = 20 minutes. This is the time to reach Step 17

$T_{1/2}$ = 0 as the cognition for this action is based on simply reading a step in the procedure.

Tm = 5 minutes. This is the time it takes to de-energize the PORVs. This is based on feasibility study.

1.6.4 Assessment of HEP screening value

All of the PSFs identified in Table 35 are compared against the general criteria for screening. .

Table 37: Screening Criteria Assessment For Example 4	
Complexity	Nominal ISG criteria • Are there many alarms or indications to which the crew or operator must identify, evaluate, and respond? - NO • Will communication between several individuals at different locations be necessary? Yes – However, all operators are given headsets for communication once they leave the MCR. Communication is considered to nominal. • Will plant symptoms be difficult to ascertain because of instrumentation failures and spurious indications? No – Once the crew leaves the MCR all instrumentation is available. Establishing local instrumentation is considered to be a nominal task. • Will component failures have multiple or propagated effects on systems, equipment, or other components? NO • Will the action sequence include concurrent tasks that require specific timing to be successful? – No. There ia some level of communication/coordination required during task 3 to check AFW valve positions at the other unit and to coordinate establishing local SG instrumentation, but the timing and sequencing is not specific. • Will the situation include many distractions, crowds of people, or other factors that could divert attention from the required tasks? No
Procedure	Procedure explicitly documents all required tasks.
Training	Bi-annual training on all tasks.
Cues/ Indications	All cues and indications are available for all tasks
Staffing	No staffing limitations.
Tools/Parts	No task requires special tools and parts.
Accessibility	The travel routes were clearly documented in the feasibly study. There are no locked doors which the operators must obtain keys for.
Communications	The crew will be communicating with headsets.
Lighting	Normal
Timing	See next table

Table 38: Time Margins Assessment For Example 4 (five minute intervals)

Timing input	Task 3	Task 4	Task 5	Task 6
Tsw	85 minutes	100 minutes	85 minutes	165 minutes
Tdelay	25 minutes	25 minutes	25 minutes	20 minutes
Tcog	0 minutes	0 minutes	0 minutes	0 minutes
Texe	15 minutes	10 minutes	20 minutes	5 minutes
Time Available – Time Required	45 minutes	65 minutes	40 minutes	140 minutes

The overall assessment is shown in Table 39. Note that it is not necessary to provide an assessment result for the decision to abandon, even though the task is required, because it has been agreed that the decision is highly reliable.

It can be seen that all of the criteria for all of the tasks are either green or blue, so it is clear that the application of a screening HEP of 0.1 would be valid. However, of particular note are the PSFs shown in blue, which would support the use of a screening value less than 0.1. The combination of a significant additional time margin with the nominal complexity would in itself most likely be sufficient to justify a value of less than 0.1. With the addition of favorable lighting and no need for special tools or parts, the is a clear weight of evidence to justify the lower value.

Table 39 – Summary of Assessment for Example 4									
Performance Influence Factor	**Conditions Supporting Use of 0.1 Screening Value**						**"Go/No-Go" Conditions (If Any of These Conditions Exists, 1.0 HEP is Used)**	**Considerations That Suggest Use of Screening HEP > 0.1**	**Considerations That Support Use of Screening HEP < 0.1**
	Task 1 Decide to Abandon		**Task 3 Establish RSD Control & Instrumen-tation**	**Task 4 Restore/ Ensure Decay Heat Removal**	**Task 5 Restore/ Ensure Injection**	**Task 6 Recover from Spurious Operations**			
Complexity			Nominal	Nominal	Nominal	Nominal	See training and communications.	Degraded	Nominal
Procedure			Available and complete	Available and complete	Available and complete	Available and complete	Procedure not available or completion will not result in success.	Procedure is potentially confusing, unclear, or overly subject to interpretation.	Procedure very straightforward, easy to implement, minimal or no steps not directly required for Tasks 1-5.
Training			Subsumed by Complexity	Subsumed by Complexity	Subsumed by Complexity	Subsumed by Complexity	No training	Subsumed by Complexity.	Subsumed by Complexity.
Cues/ Indications			Yes	Yes	Yes	Yes	Cues are in error for given fire scenario.	Cues are provided, but are not clear.	Cues clear and well trained.
Staffing			Adequate	Adequate	Adequate	Adequate	Insufficient staff to perform all required actions.	Expect staff limitations to result in a longer time required to complete each task.	Extra staff available for checking.
Tools/Parts			Not needed	Not needed	Not needed	Not needed	Not available	Need or location unclear. Difficult to obtain.	No special tools or parts required for any execution activities.
Accessibility			Accessible	Accessible	Accessible	Accessible	Not accessible	Limited accessibility (e.g., tight quarters, long access path)	Highly accessible, no impairments, short direct access paths.
Communications			Subsumed by Complexity	Subsumed by Complexity	Subsumed by Complexity	Subsumed by Complexity	Not available or highly questionable reliability.	Subsumed by Complexity	Subsumed by Complexity
Lighting			Normal	Normal	Normal	Normal	None in one or more areas where actions take place.	Portable in one or more locations where actions take place	Normal in all areas where actions take place.

Table 39 – Summary of Assessment for Example 4									
Performance Influence Factor	**Conditions Supporting Use of 0.1 Screening Value**						**"Go/No-Go" Conditions (If Any of These Conditions Exists, 1.0 HEP is Used)**	**Considerations That Suggest Use of Screening HEP > 0.1**	**Considerations That Support Use of Screening HEP < 0.1**
	Task 1 Decide to Abandon	[redacted]	**Task 3 Establish RSD Control & Instrumen-tation**	**Task 4 Restore/ Ensure Decay Heat Removal**	**Task 5 Restore/ Ensure Injection**	**Task 6 Recover from Spurious Operations**			
Timing			5 timing elements for each task	5 timing elements for each task	5 timing elements for each task	5 timing elements for each task	See below	See below	See below
1) System Time window			85 mins. Time Margin (Time Available – Time Required) is at least 35 minutes.	100 mins. Time Margin (Time Available – Time Required) is at least 35 minutes.	85 mins. Time Margin (Time Available – Time Required) is at least 35 minutes.	165 mins Time Margin (Time Available – Time Required) is at least 35 minutes.	Time Required is equal to or greater than Time Available.	Time Margin (Time Available - Time Required) is 5 to 15 minutes.	Time Margin (Time Available – Time Required) is at least 35 minutes.
2) Time of the decision to abandon			15 minutes	15 minutes	15 minutes	15 minutes	n/a	n/a	n/a
3) Time of Cue			25 minutes	25 minutes	25 minutes	20 minutes	See Time Available	See Time Available	See Time Available
4) Diagnosis Time			0 minutes	0 minutes	0 minutes	0 minutes	See Time Available	See Time Available	See Time Available
5) Time to Execute			15 minutes	10 minutes	20 minutes	5 minutes	See Time Available	See Time Available	See Time Available

EXAMPLE 4