

Cicada
(from Google images)

SACADA

A Data Collection Tool for Simulator Training

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This document can be found in NRC's Web-based ADAMS at
https://adams.nrc.gov/wba/ with the access number of ML17053B558

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Presentation Outline

- Brief history
- Introduction of the SACADA*
  - Functions & graphical user interface
- Benefits for operator simulator training
- Framework for collaborating with the U.S. Nuclear Regulatory Commission (NRC) on SACADA

***SACADA: Scenario Authoring, Characterization, and Debriefing Application**

Brief History

- NRC wants to collect operator simulator training data to improve its human reliability analysis (HRA) techniques.
- NRC collaborated with the South Texas Project Nuclear Operating Company (STP) to develop the SACADA system
  - With support of the Idaho National Laboratory and domain experts
- STP has used SACADA for operator simulator training since 2012 with very positive experience

Some of the Developers



Current Collaborations

- STP (since 2011)
- Halden Reactor Project (since 2014)
- Advanced test reactor (since 2016)
- Taiwan Power Company (since 2016, piloting)
- KAERI(Korea) (since 2013*)
- ÚJV Řež, a. s. (Czech Republic)(since 2015*)

*Reviewing taxonomy but not sharing data

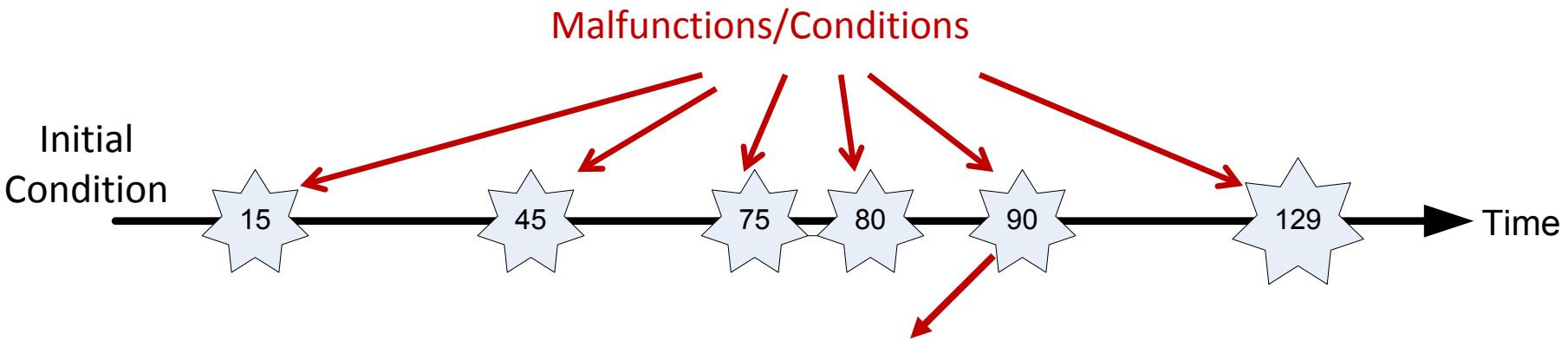
SACADA's Goals

- Capture real simulator performance data to inform HRA
  - The goal here is to determine actual risk, and get possible credit for performance
- Provide a debriefing tool that facilitates improved operator performance

SACADA Software Main Functions

- Design simulation scenarios
- Characterize performance challenges
- Debrief performance results
- Output data (Reports)

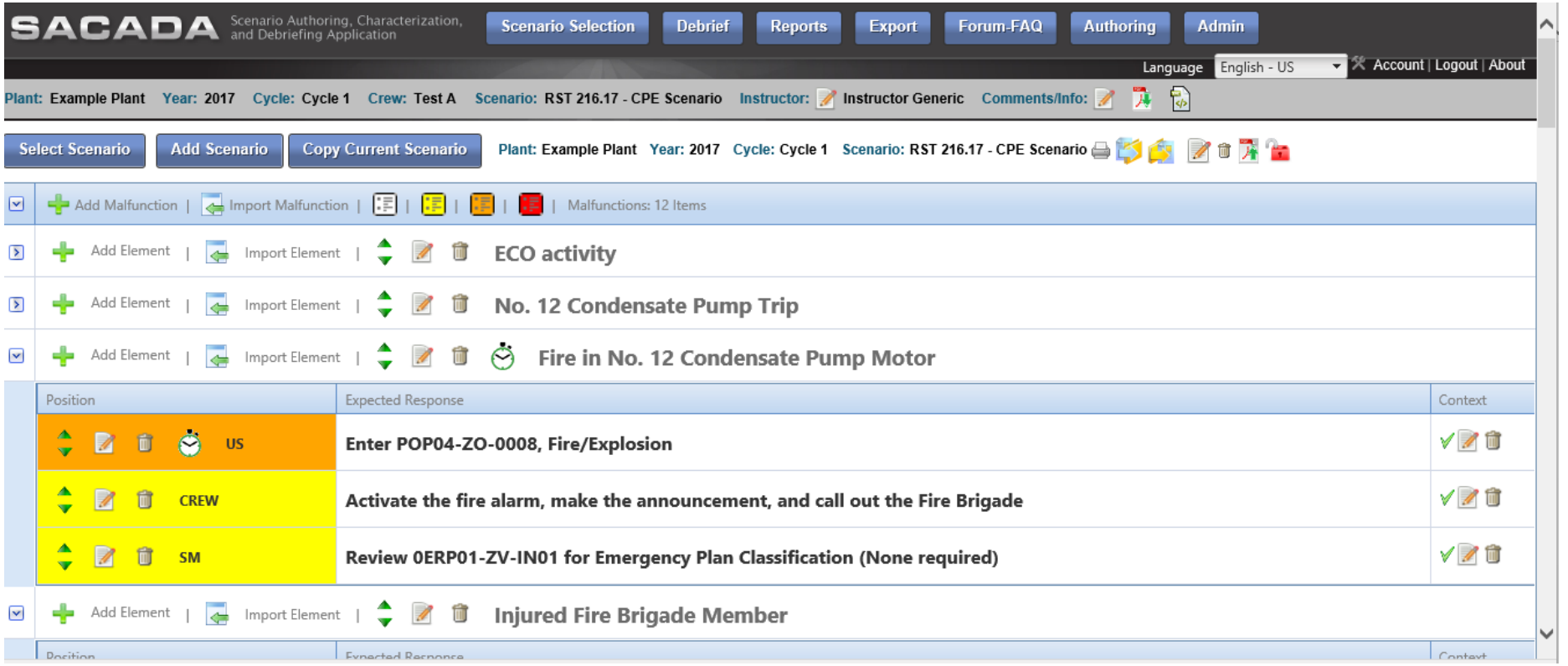
Simulation Scenario Structure



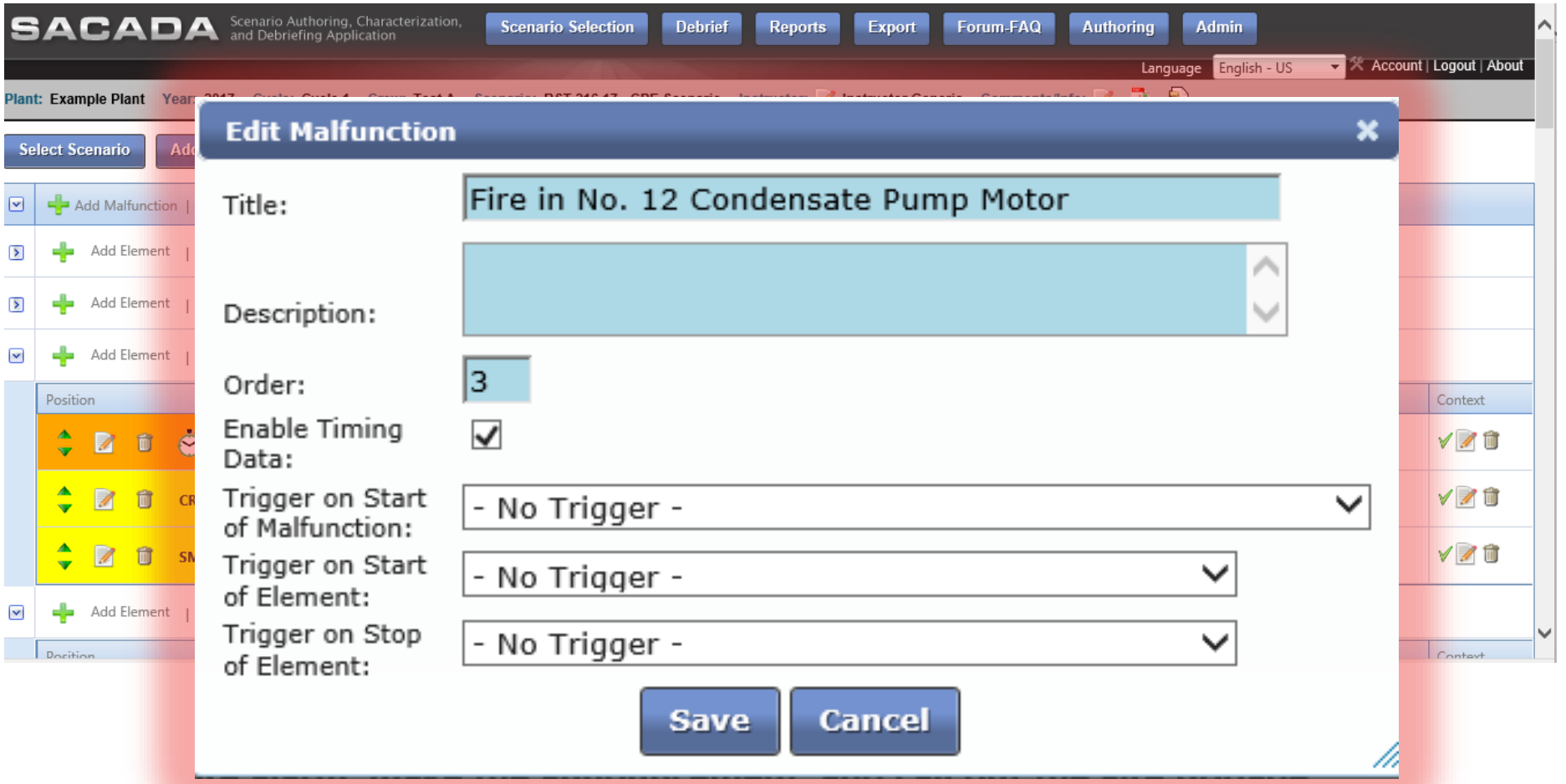
Training Objective Elements

Loss of ECW 1A	
POSITION	**EXPECTED RESPONSE**
CREW	Recognize loss of EW flow to A train.
Crew	Secure ECW pump 1A
SM	Manually trip Diesel Generator prior to any of Diesel Generator trips
Crew	Ensure CCP 1A is in service
Crew	Verifies Natural Circulation
SM	Determines need to cooldown
SM	Declare an Alert HA1/EAL2 due to damage to EW structure or notify ED that escalation is appropriate.

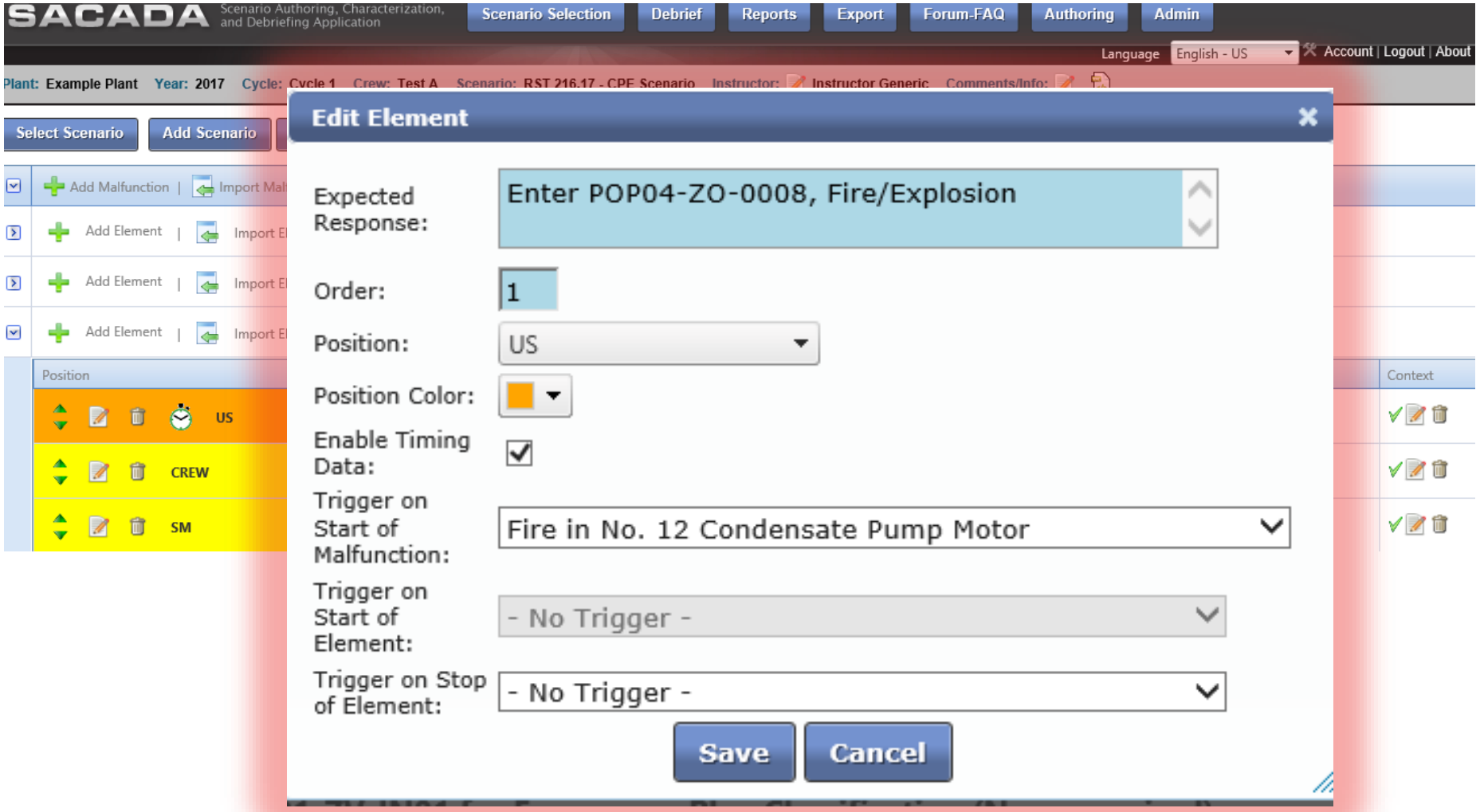
Authoring –
Design Simulation Scenarios



Authoring –
Edit Malfunction/Situation



Authoring –
Edit Elements



Authoring - Four Levels of Element Importance

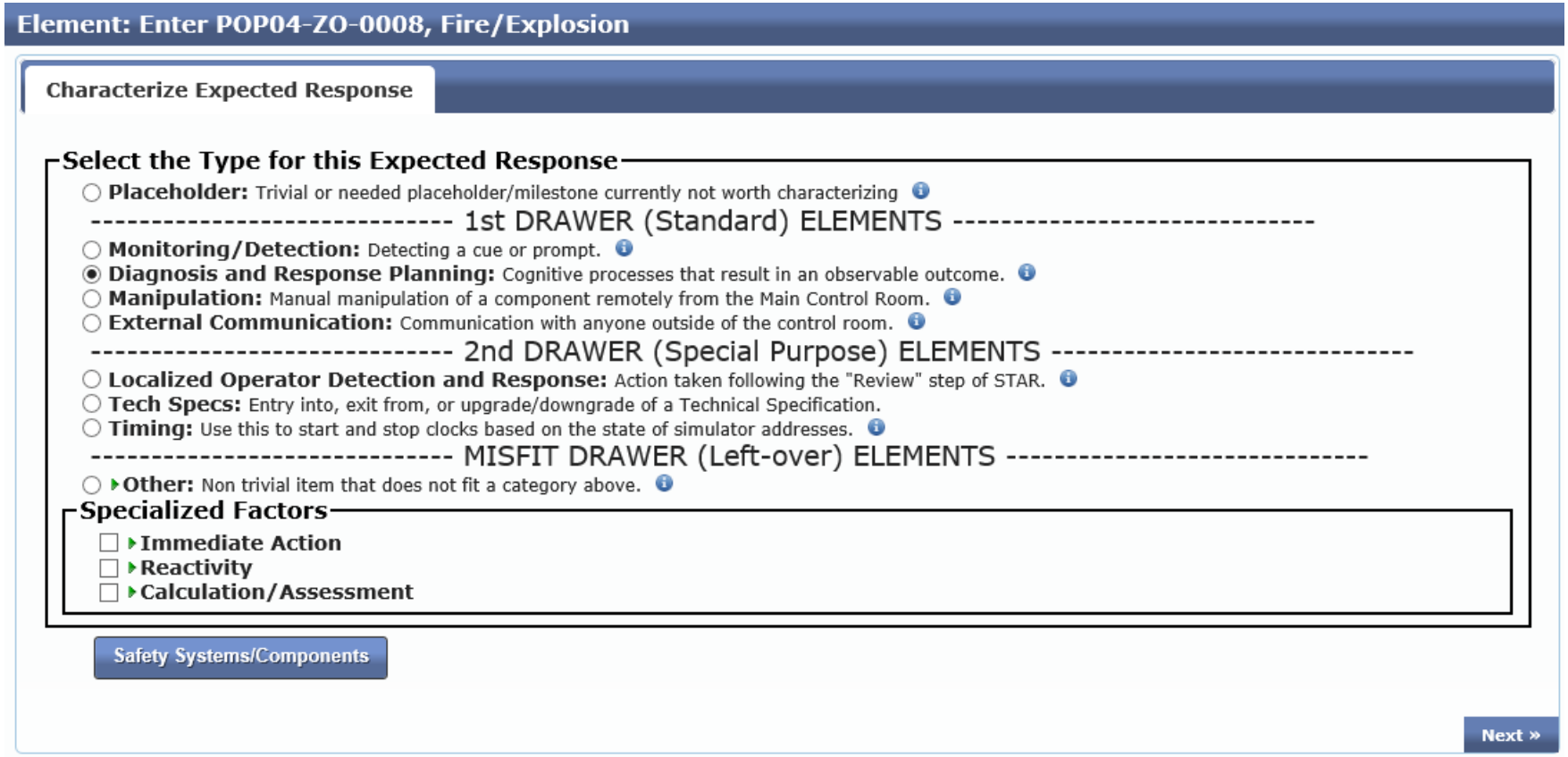
1. Red: Critical tasks directly affect core safety and radioactivity release
   - E.g., manually trip reactor and emergency depressurization
2. Orange: affect the availability and reliability of the equipment related to reactor safety or other items important to safety
   - E.g., enter correct AOPs/EOPs, EAL classification, and training emphases
3. Yellow: Professional tasks, not affecting reactor safety
   - TS LCO and three-way communication
4. White: general tasks

EAL: Emergency Action Level;
TS LCO: Technical Specification Limiting Condition for Operation

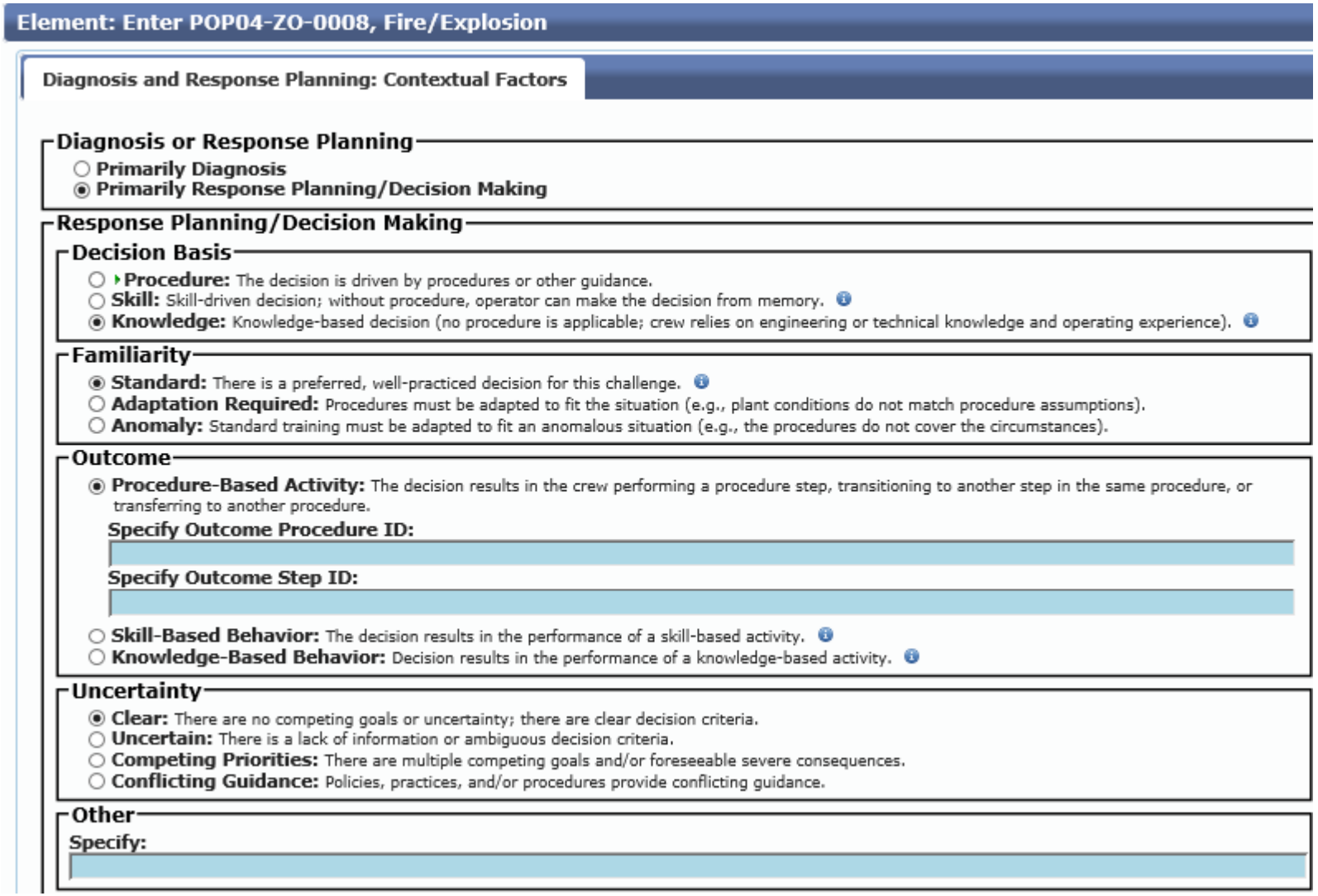
Authoring – Summary

- Four levels of element importance
- Semi-automatic time data collection
- Develop new scenarios based on old scenarios to save effort
- Import/export functions to share information between plants
- Lock scenario to prevent from editing
- Store scenario package
- Group discussion corners: instructors & crews

Characterization – Task Cognitive Type



Characterization – Cognition Specific Factors



Element: Enter POP04-ZO-0008, Fire/Explosion

Diagnosis and Response Planning: Contextual Factors

Diagnosis or Response Planning

- ○ **Primarily Diagnosis**
- ◉ **Primarily Response Planning/Decision Making**

Response Planning/Decision Making

Decision Basis

- ○ **Procedure:** The decision is driven by procedures or other guidance.
- ○ **Skill:** Skill-driven decision; without procedure, operator can make the decision from memory.
- ◉ **Knowledge:** Knowledge-based decision (no procedure is applicable; crew relies on engineering or technical knowledge and operating experience).

Familiarity

- ◉ **Standard:** There is a preferred, well-practiced decision for this challenge.
- ○ **Adaptation Required:** Procedures must be adapted to fit the situation (e.g., plant conditions do not match procedure assumptions).
- ○ **Anomaly:** Standard training must be adapted to fit an anomalous situation (e.g., the procedures do not cover the circumstances).

Outcome

- ◉ **Procedure-Based Activity:** The decision results in the crew performing a procedure step, transitioning to another step in the same procedure, or transferring to another procedure.

Specify Outcome Procedure ID:

Specify Outcome Step ID:

- ○ **Skill-Based Behavior:** The decision results in the performance of a skill-based activity.
- ○ **Knowledge-Based Behavior:** Decision results in the performance of a knowledge-based activity.

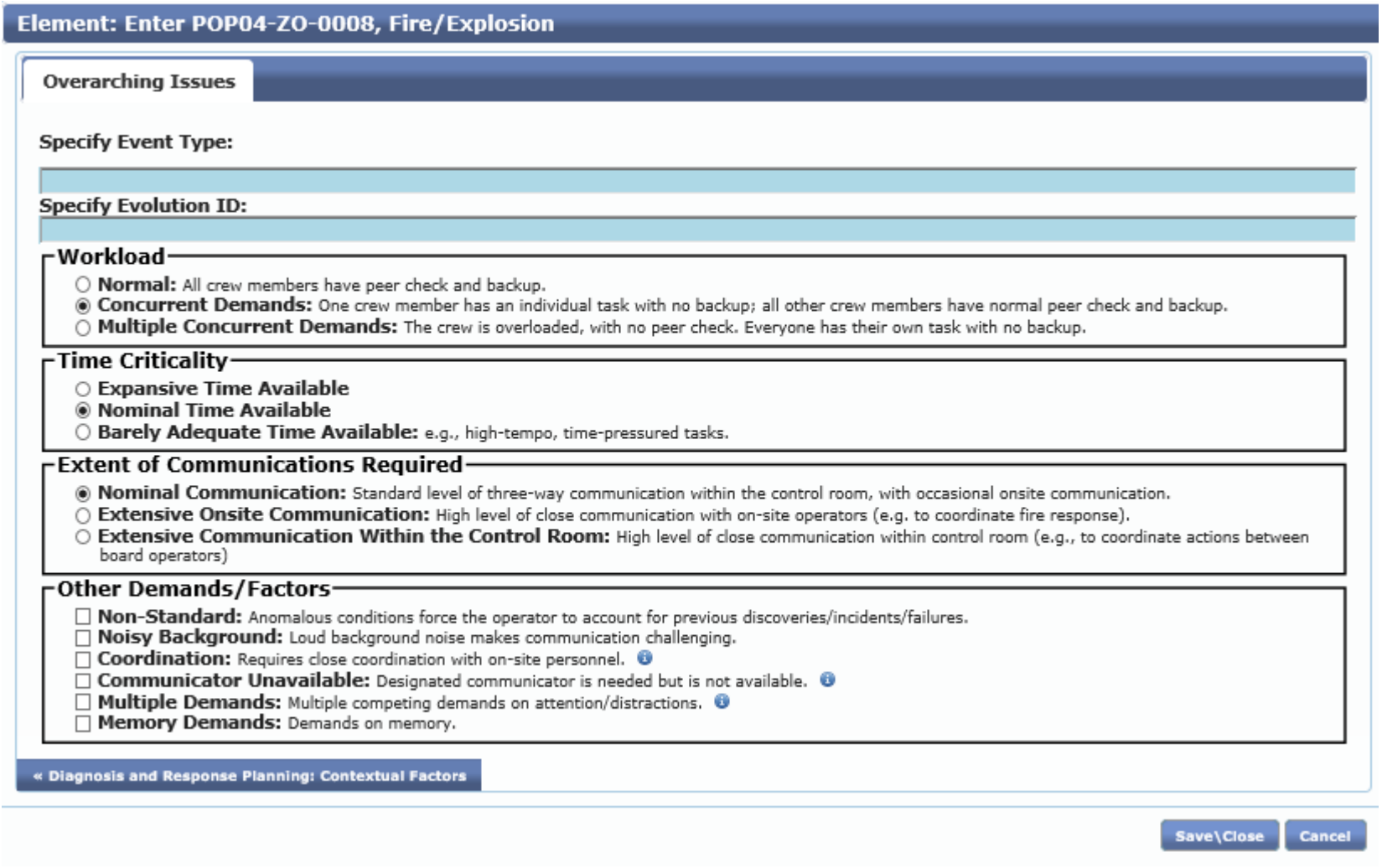
Uncertainty

- ◉ **Clear:** There are no competing goals or uncertainty; there are clear decision criteria.
- ○ **Uncertain:** There is a lack of information or ambiguous decision criteria.
- ○ **Competing Priorities:** There are multiple competing goals and/or foreseeable severe consequences.
- ○ **Conflicting Guidance:** Policies, practices, and/or procedures provide conflicting guidance.

Other

Specify:

Characterization – Overarching Factors



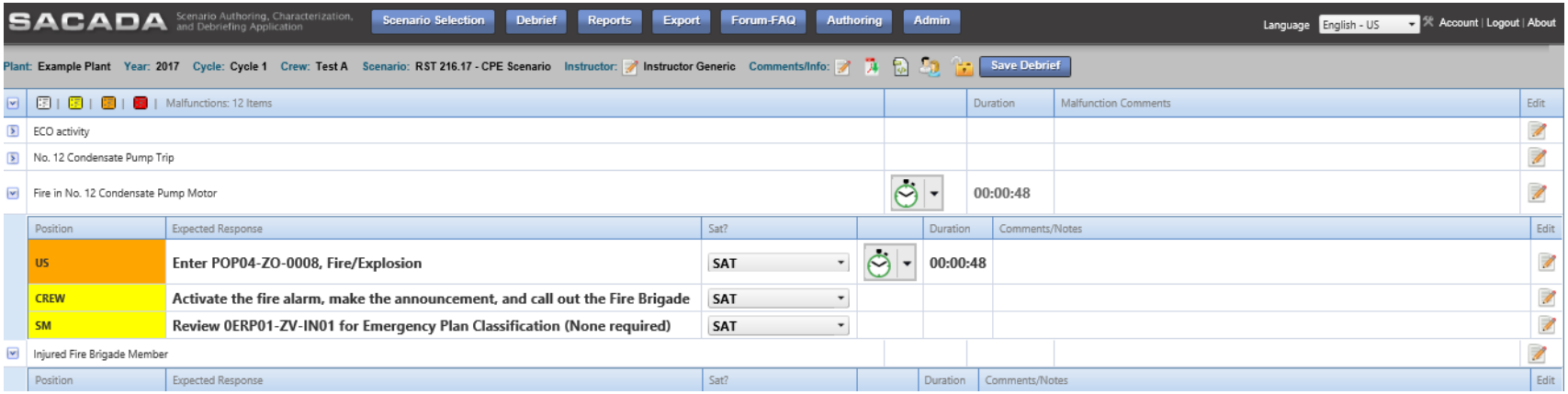
Characterization – Summary

- From a human-centered system-neutral perspective to characterize the task and challenges
- Information is important for data analysis to inform HRA
  - Extract performance information from multiple plants

Timing data

- Initially, SACADA was not designed to input data DURING the scenario
- A need arose to capture the TIMING of specific tasks
- Combined with a mobile platform, SACADA was leveraged to capture the timing of predetermined tasks

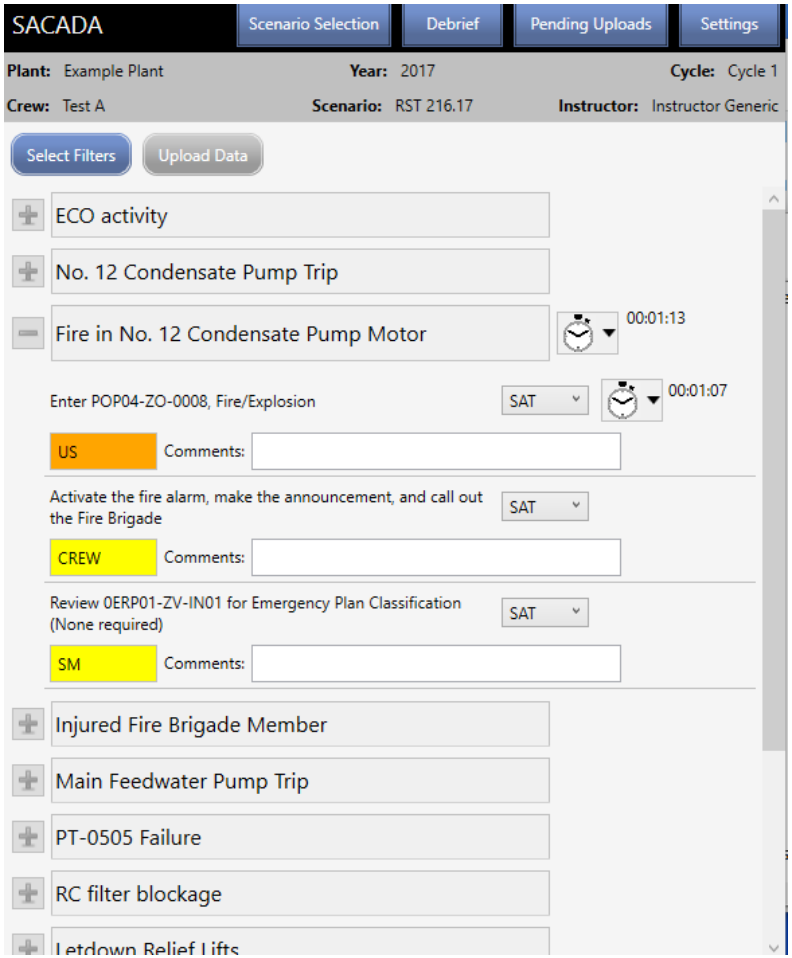
Debriefing – Collect Time Data



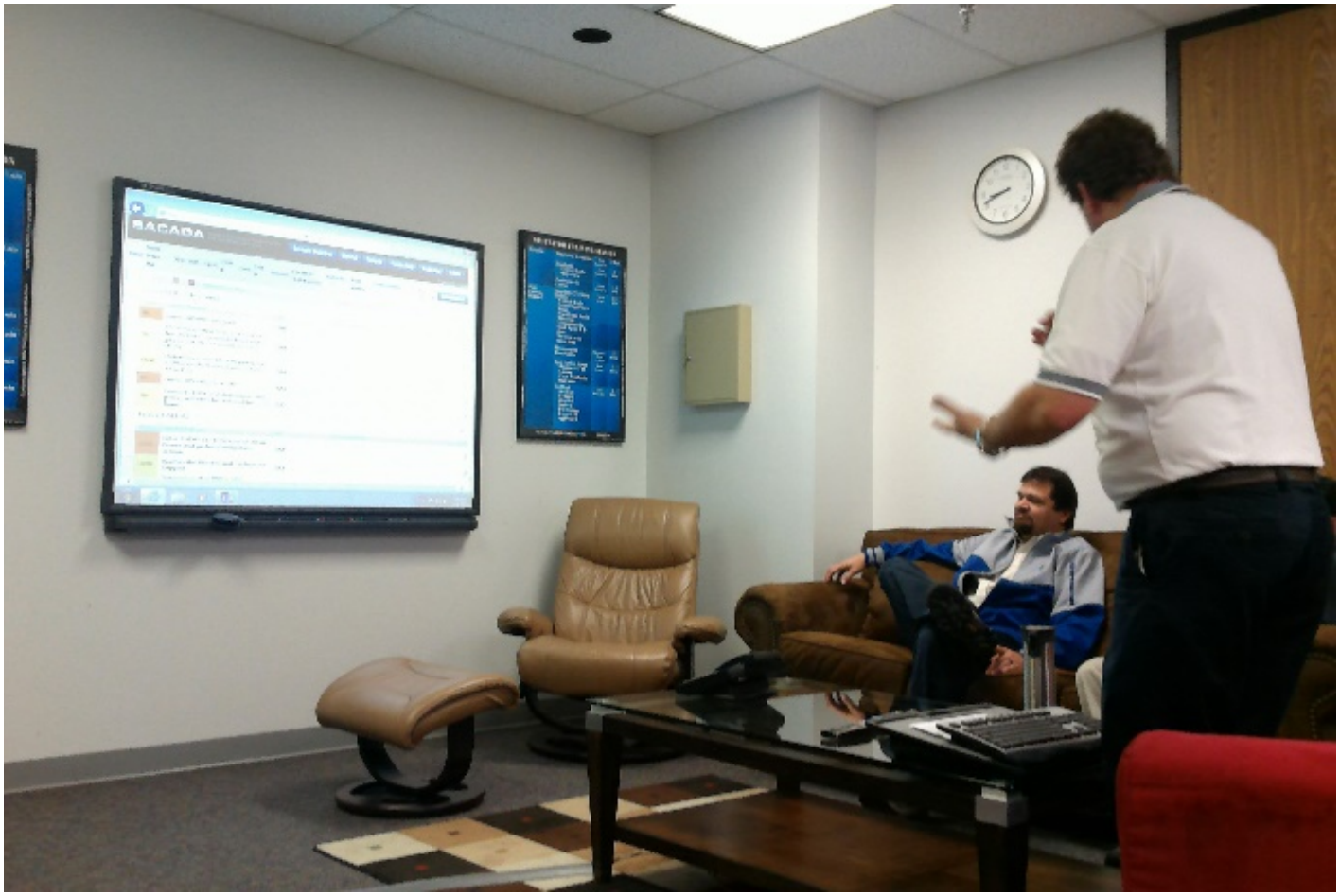
- The only information that needs to be collected while the simulation is running
- Tablet app available to collect time data

Tablet App for Mobility

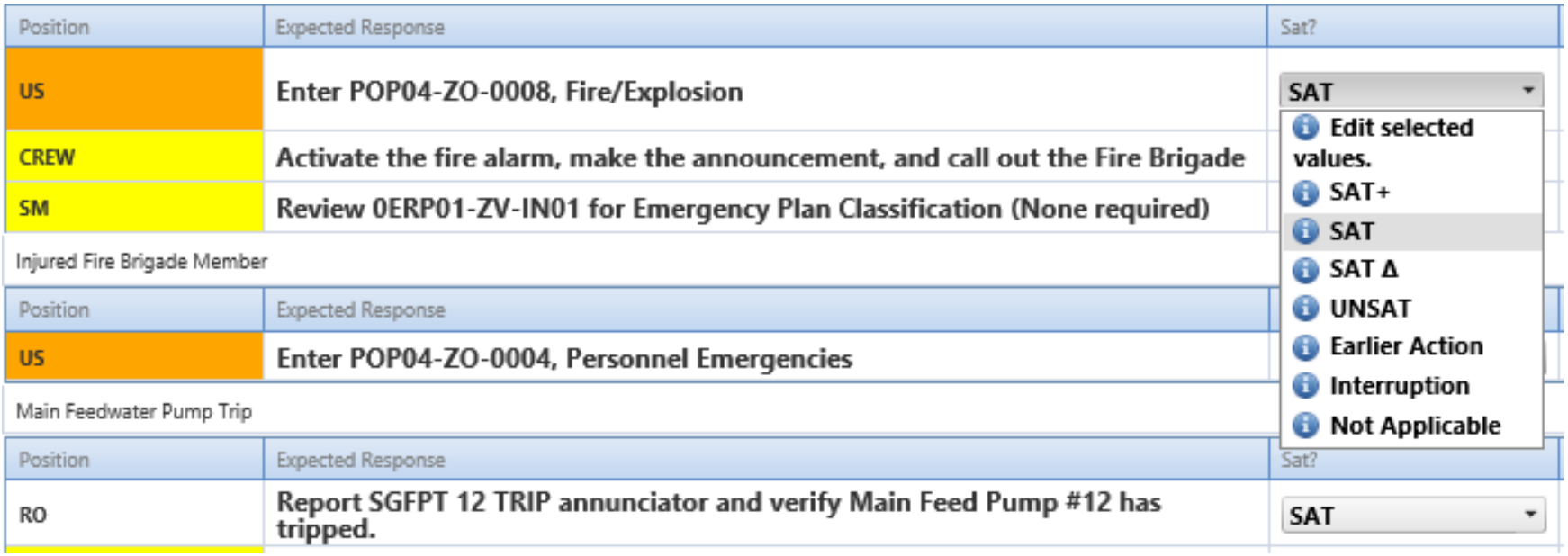
- Collect
  - Time
  - Disposition
  - Comments
- Download/Upload data from/to server
- Windows platform



Debriefing –
How did we do?



Debriefing – Performance Rating



Position	Expected Response	Sat?
US	Enter POP04-ZO-0008, Fire/Explosion	SAT
CREW	Activate the fire alarm, make the announcement, and call out the Fire Brigade	
SM	Review 0ERP01-ZV-IN01 for Emergency Plan Classification (None required)	

Injured Fire Brigade Member

Position	Expected Response	
US	Enter POP04-ZO-0004, Personnel Emergencies	

Main Feedwater Pump Trip

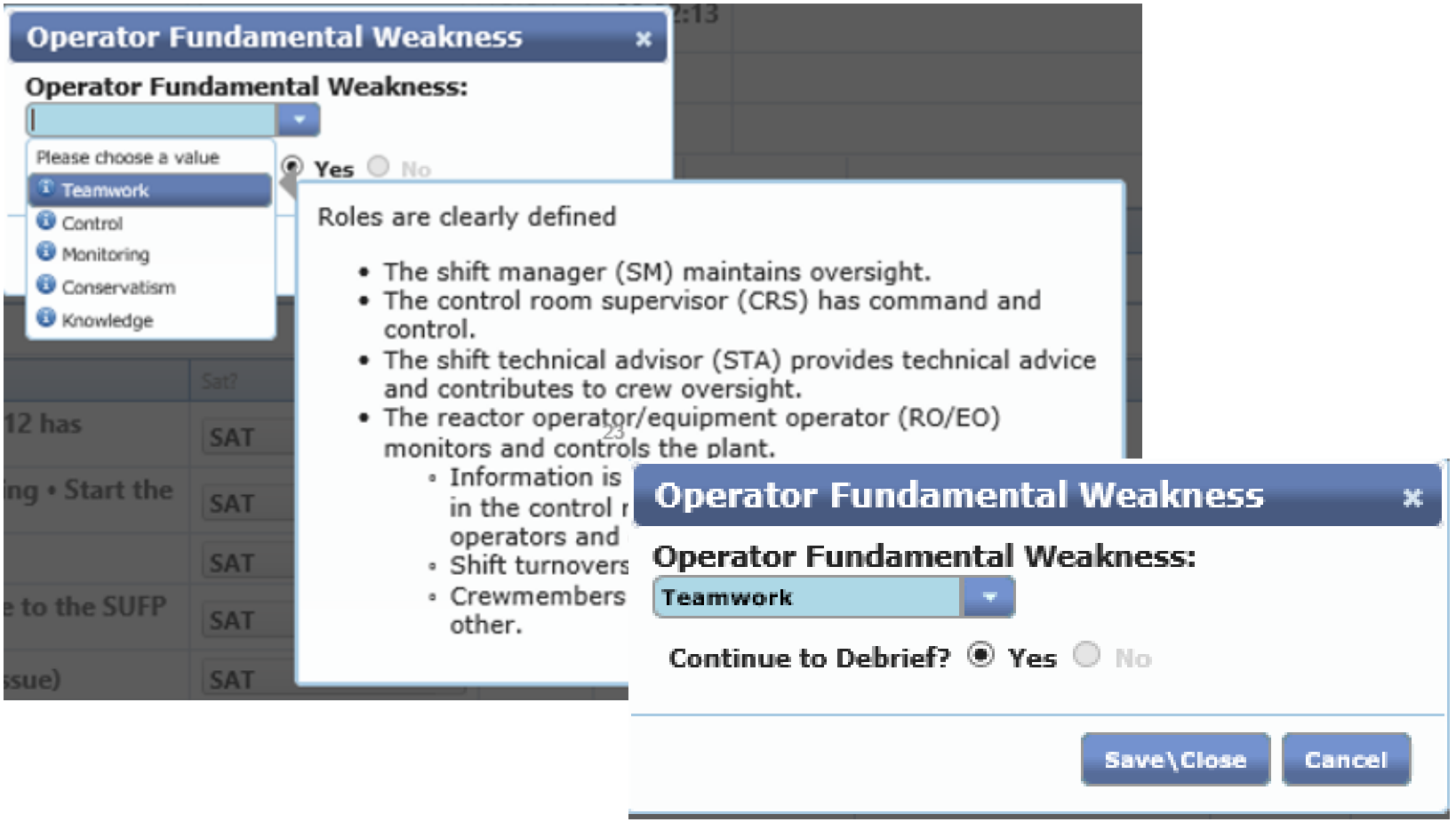
Position	Expected Response	Sat?
RO	Report SGFPT 12 TRIP annunciator and verify Main Feed Pump #12 has tripped.	SAT

- Four classes: SAT+, SAT, SATΔ, and UNSAT
- Default rating: SAT

Debriefing – Deficiency Analysis

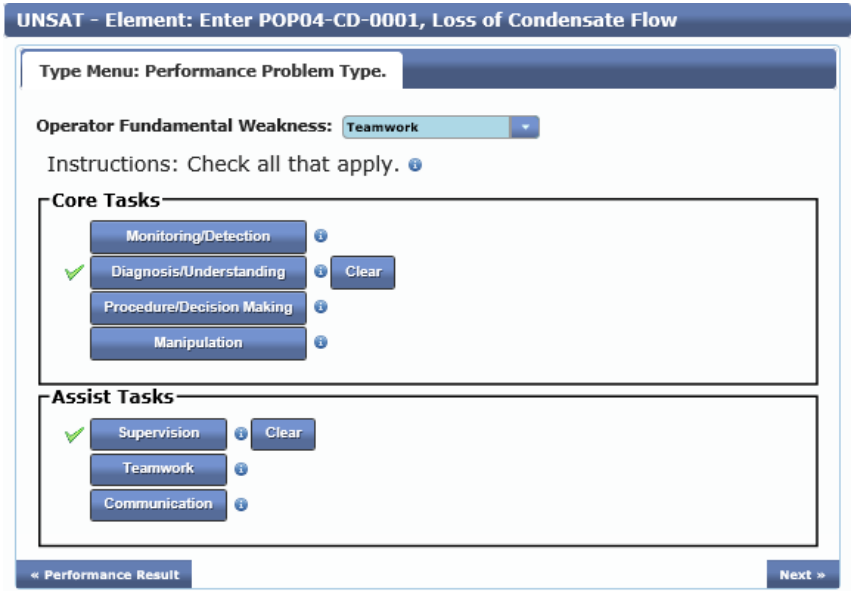
- Importance driven debriefing facilitates wise use of debriefing time
  - Is mandatory when a red or orange element is SATΔ or UNSAT
  - Is optional when a yellow or white element is SATΔ or UNSAT
- Systematic analysis
  - Class of the performance deficiency
    - INPO five operator fundamentals
    - Macrocognitive functions
  - Specifics of the performance deficiency
  - Causes of the performance deficiency
  - Recovery of the deficiency
  - Effects on the scenario
  - Remediation
- Stimulate thinking and discussing in debriefing

Debriefing
– Link to INPO Operator Fundamentals



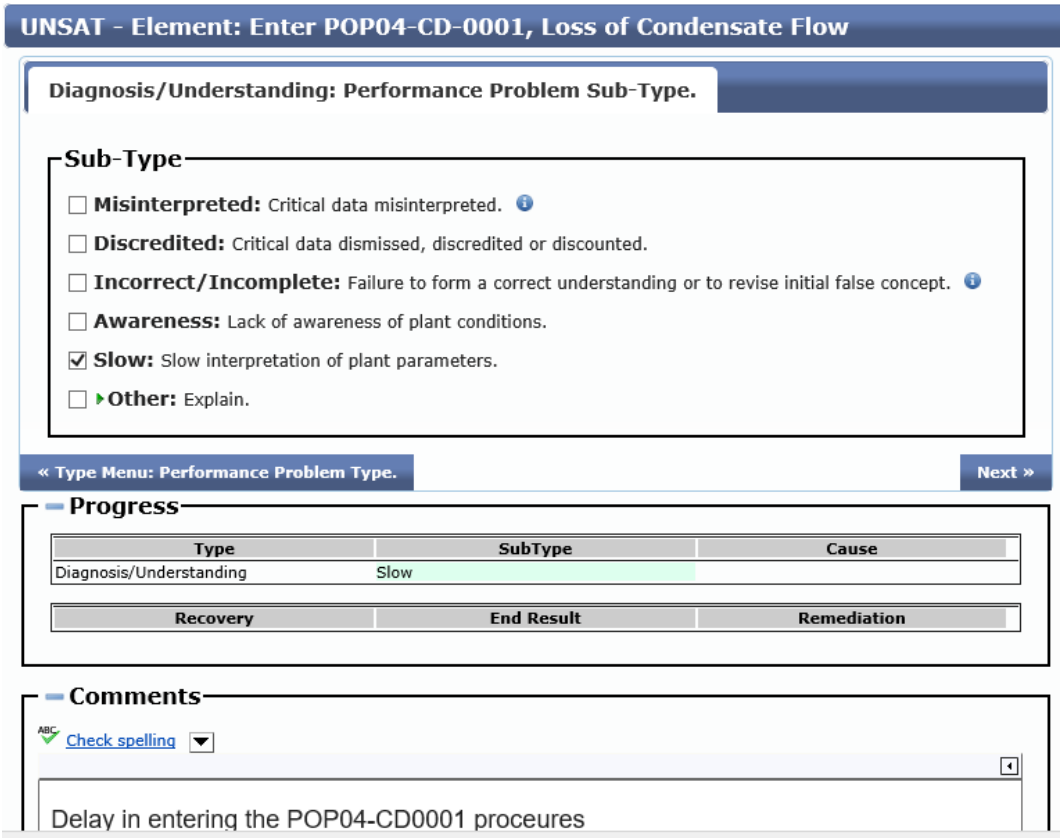
Debriefing –

1. Macrocognition Based Deficiency Classification



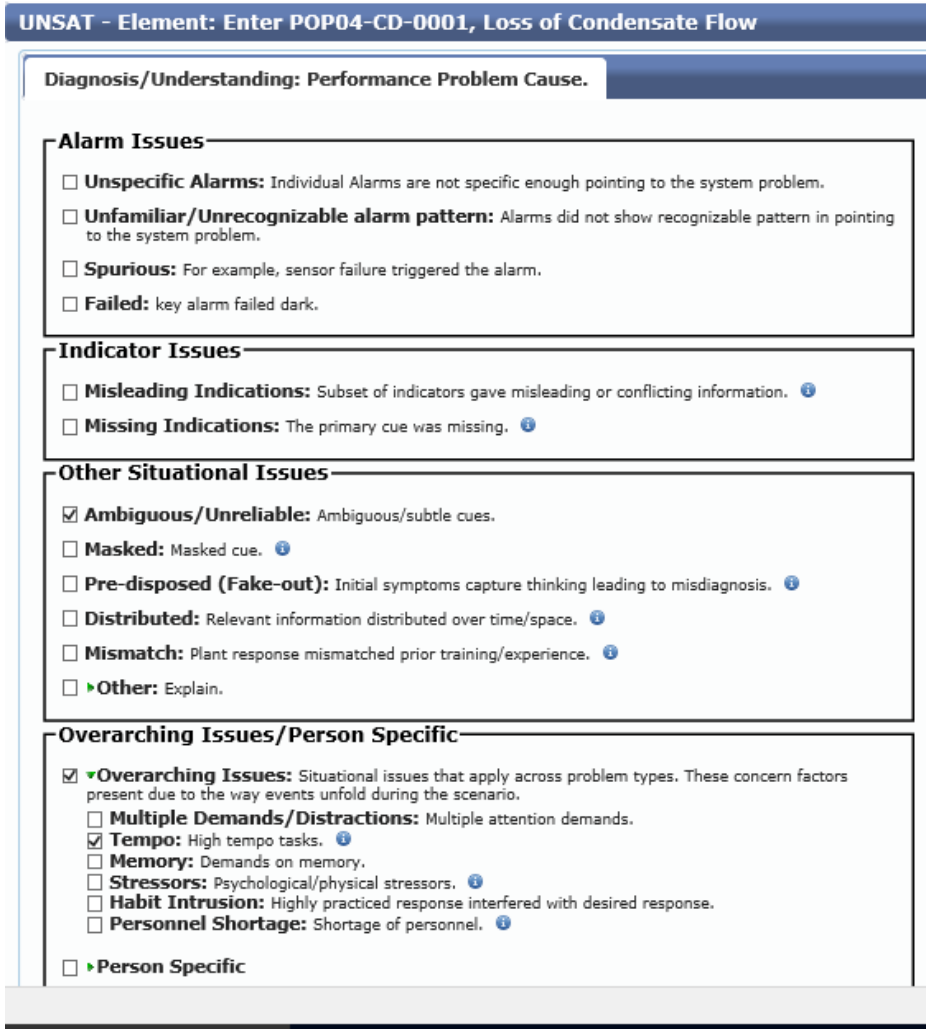
- Seven classes
  - Monitoring/Detection
  - Diagnosis/Understanding
  - Procedure Following/Decision Making
  - Manipulation
  - Supervision
  - Teamwork
  - Communication
- Stimulate crew to think
- Can choose more than one class

Debriefing –
2. Deficiency Specifics - Diagnosis



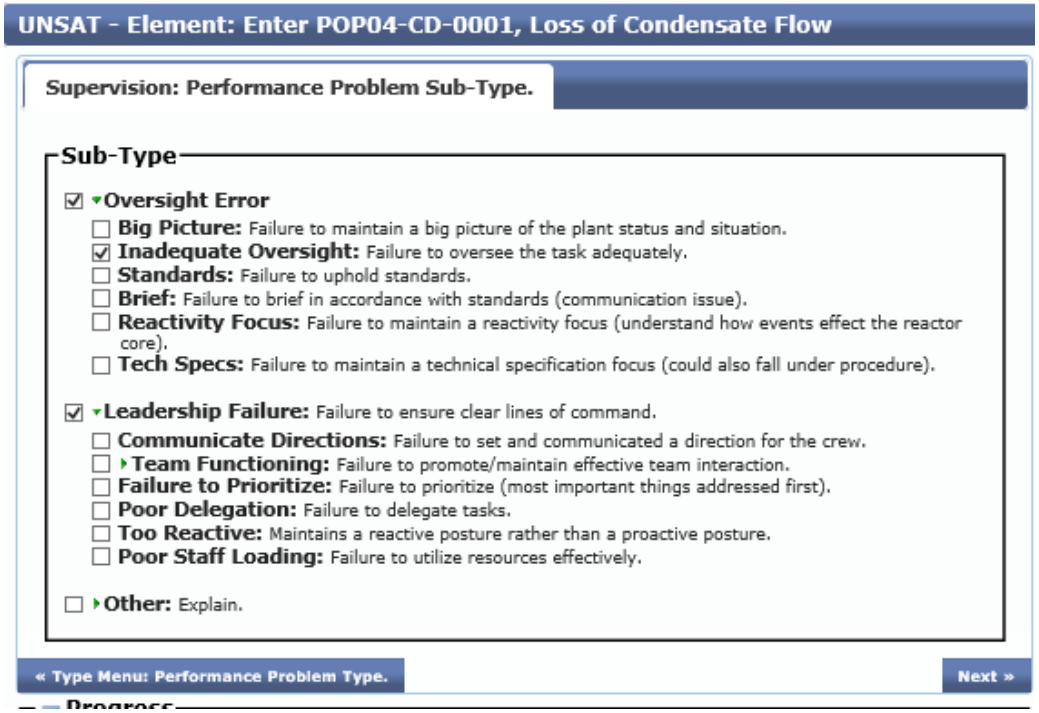
- Classify the type of diagnosis deficiency
- Stimulate crew to think what went wrong
- Other: for other specific behaviors
- Comments

Debriefing –
3. Deficiency Causes - Diagnosis



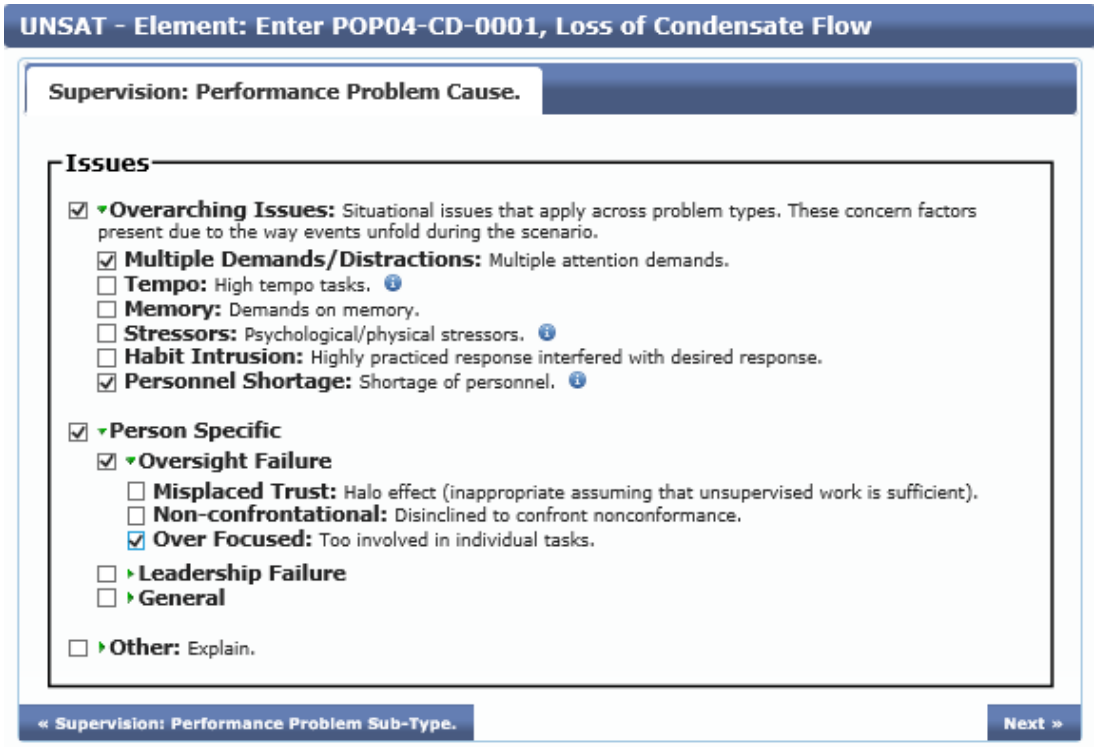
- Identify the reasons contributing to the diagnosis deficiency
- Stimulate the crew to think why it happened

Debriefing –
2. Deficiency Specifics - Supervision



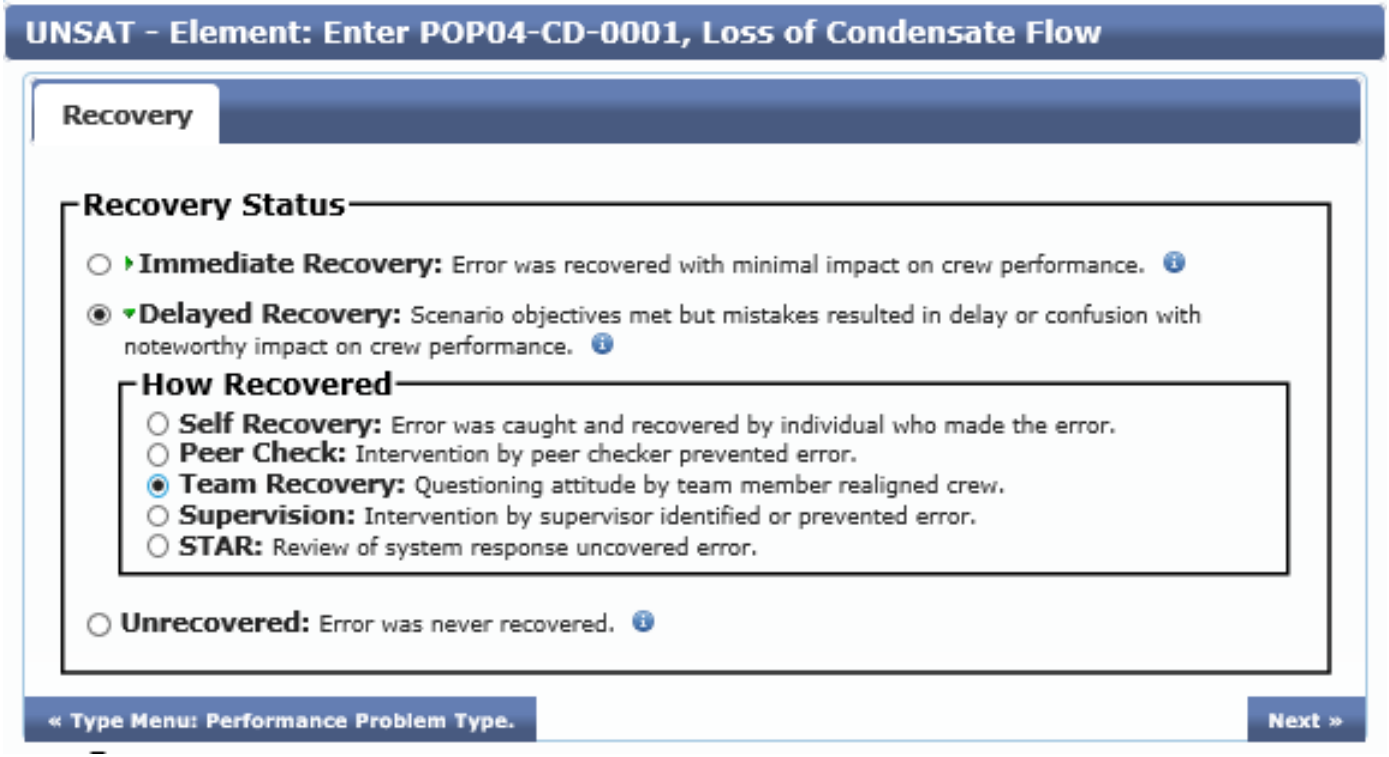
- Classify the supervision deficiency
- Stimulate crew to think what went wrong

Debriefing –
3. Deficiency Causes - Supervision



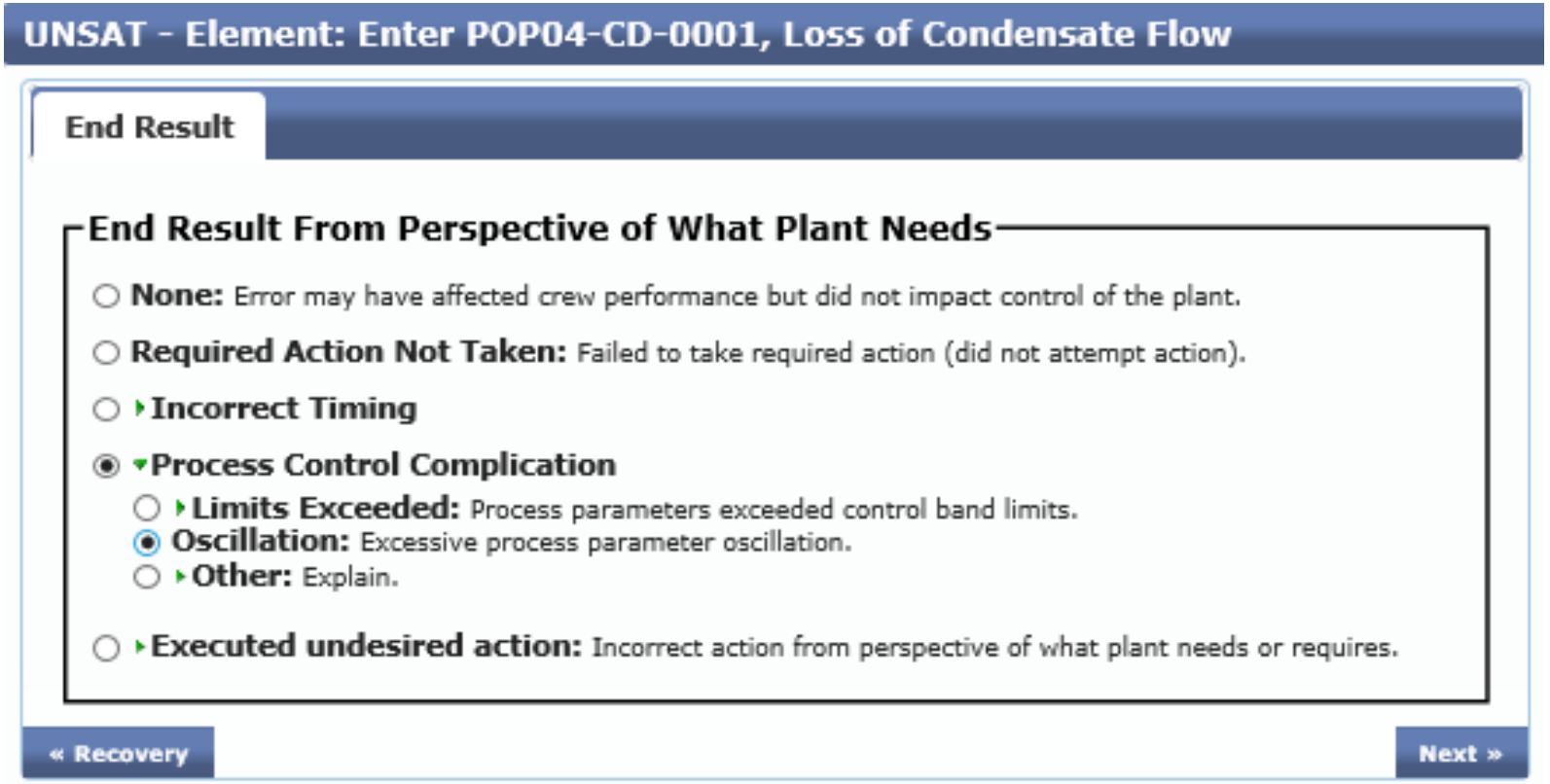
- Identify the reasons contributing to the supervision deficiency
- Stimulate the crew to think why it happened

Debriefing – 4. Deficiency Recovery



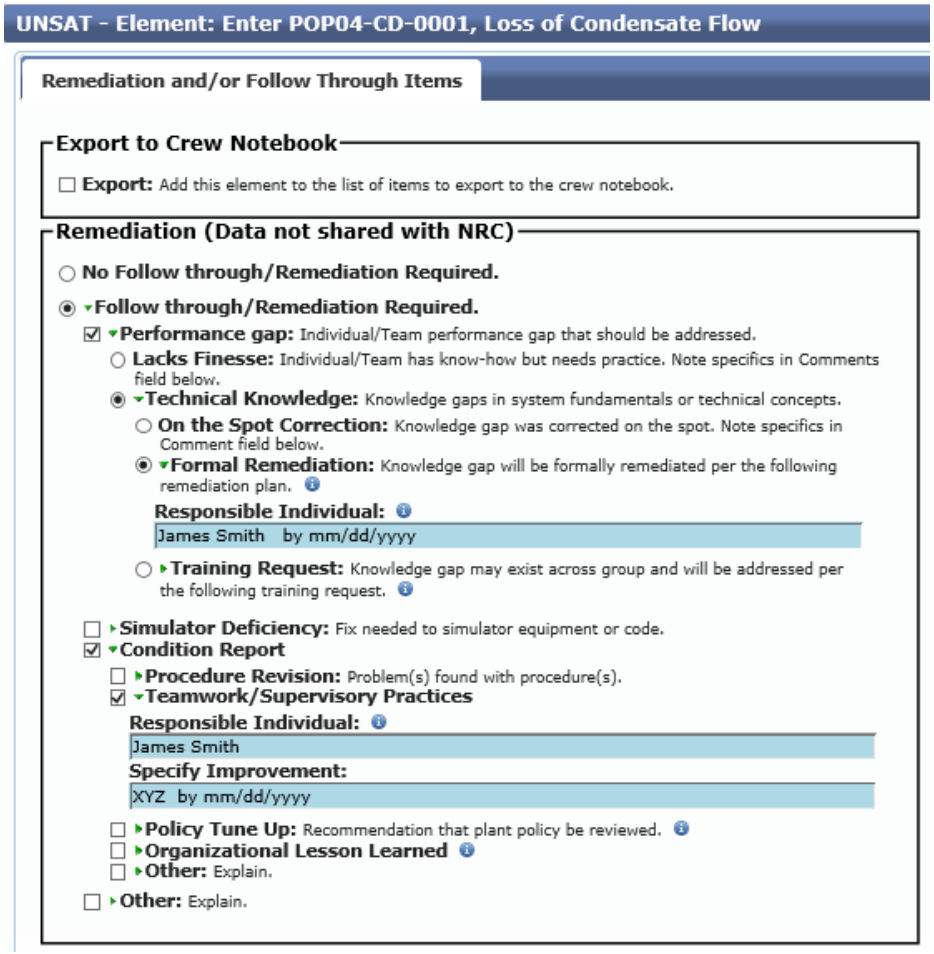
- Explicitly identify the deficiency recovery mechanism and timing

Debriefing – 5. Scenario Impacts



- Explicitly identify the impacts on the scenario

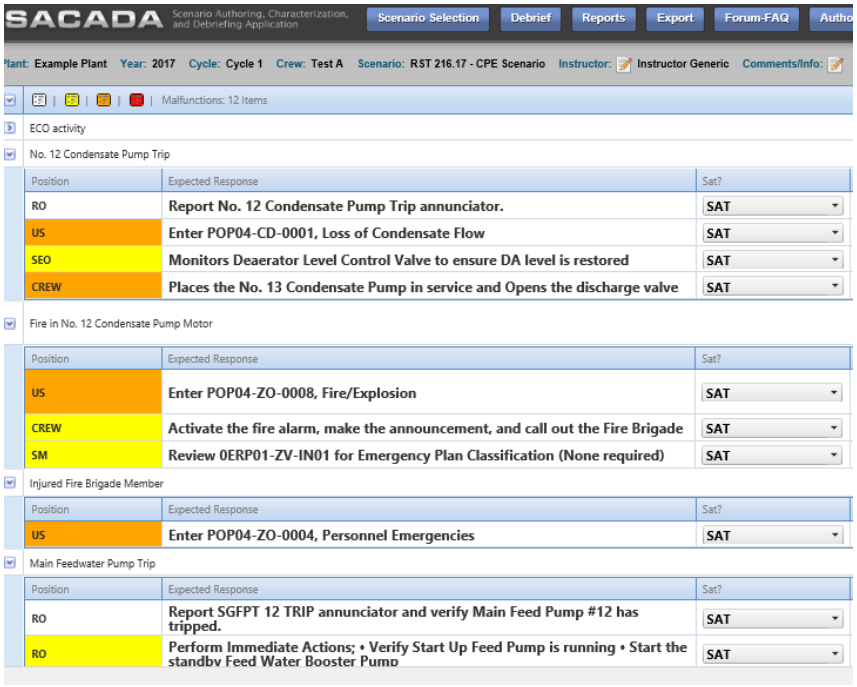
Debriefing – 6. Remediation



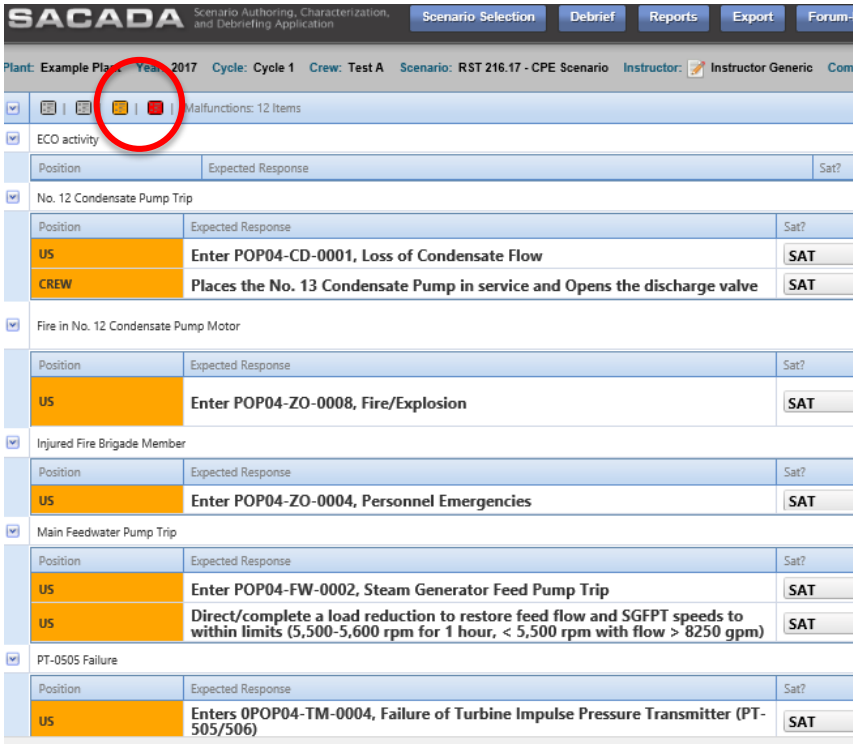
- Specify the remediation approaches and the responsible individuals
- Export to crew notebook to save data entry effort

Debriefing – Importance Driven Debriefing

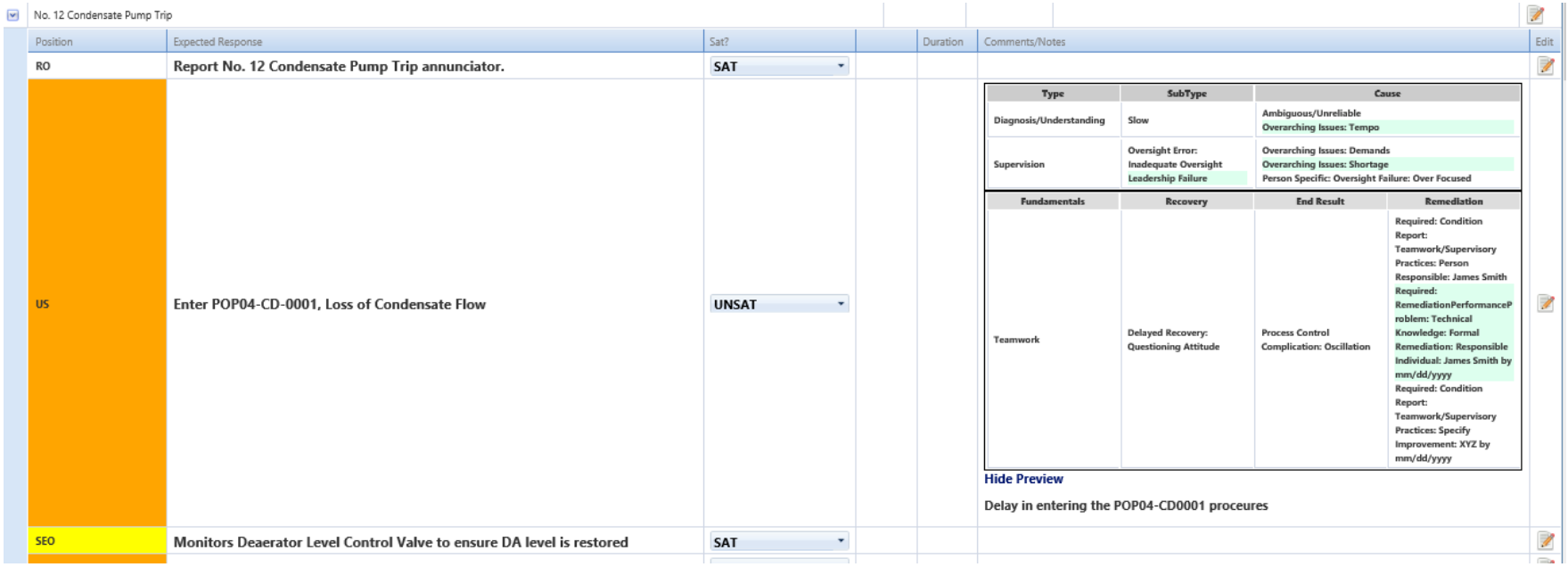
Show all elements
- Chorology driven debriefing



Show only red and orange
- Importance driven debriefing



Summary Table



No. 12 Condensate Pump Trip

Position	Expected Response	Sat?	Duration	Comments/Notes	Edit
RO	Report No. 12 Condensate Pump Trip annunciator.	SAT			
US	Enter POP04-CD-0001, Loss of Condensate Flow	UNSAT			
SEO	Monitors Deaerator Level Control Valve to ensure DA level is restored	SAT			

Type	SubType	Cause
Diagnosis/Understanding	Slow	Ambiguous/Unreliable Overarching Issues: Tempo
Supervision	Oversight Error: Inadequate Oversight Leadership Failure	Overarching Issues: Demands Overarching Issues: Shortage Person Specific: Oversight Failure: Over Focused

Fundamentals	Recovery	End Result	Remediation
Teamwork	Delayed Recovery: Questioning Attitude	Process Control Complication: Oscillation	Required: Condition Report: Teamwork/Supervisory Practices: Person Responsible: James Smith Required: RemediationPerformanceProblem: Technical Knowledge: Formal Remediation: Responsible Individual: James Smith by mm/dd/yyyy Required: Condition Report: Teamwork/Supervisory Practices: Specify Improvement: XYZ by mm/dd/yyyy

Hide Preview

Delay in entering the POP04-CD0001 proceures

- Summarize the entered information

Debriefing Summary

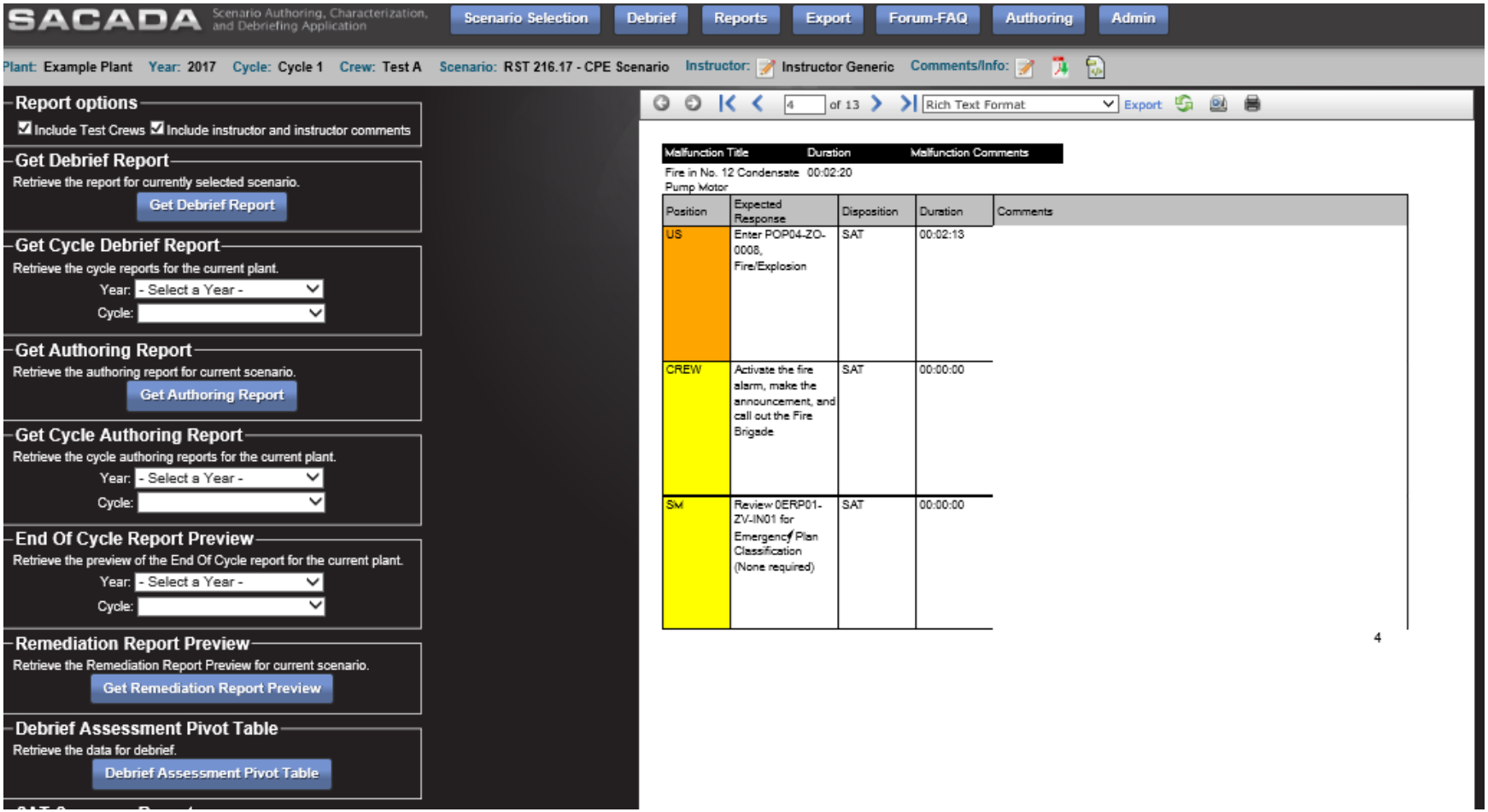
- Facilitate the debriefing based on task importance rather than the chorology
- Minimize eyes away from monitoring crew behavior to collect time data
- A systematic comprehensive taxonomy to stimulate discussion on performance deficiency to improve training effectiveness
- Quick data collection to meet limited debriefing time

Reports

- Various types of reports available
  - Debriefing, authoring, end of cycle, remediation, and all data (for statistical analysis)
- Can be exported to other formats including PDF, MS Word, and Excel
- Flexible to add more report types

Debriefing Reports

Exportable formats: PDF, MS Word, and Excel



Neat Features

- Automatically Email Remediation Report

To training managers and operations managers immediately after saving the debriefing file when there is SATΔ or UNSAT in Red or Orange elements.

Remediation Report

Plant: Example Plant

Crew: Test A

Instructor: Instructor Generic

Scenario	Position	Expected Response	Disposition	Comments
RST 216.18 - CPE Scenario COPY	US	Enter POP04-CD-0001, Loss of Condensate Flow	UNSAT	

Type	Sub Type	Cause
Diagnosis/Understanding	* Slow	* Ambiguous/Unreliable * Overarching Issues: Tempo
Supervision	* Leadership Failure * Oversight Error: Inadequate Oversight	* Overarching Issues: Demands * Overarching Issues: Shortage * Person Specific: Oversight Failure: Over Focused

Fundamentals	Recovery	End Result	Remediation
Teamwork	Delayed Recovery: Questioning Attitude	Process Control Complication: Oscillation	Condition Report: Teamwork/Supervisory Practices: Person Responsible

Delay in entering the POP04-CD0001 proceures

Neat Features

- Crew Composition and Experience



- Three levels of experience
  - Less than 2 years
  - Between 2 and 5 years
  - Greater than 5 years
- Balances information need and privacy

Neat Features
- User Control & Exam Security

- Can be installed on a personal computer or a server computer
  - Install in a dedicated computer for exam security
  - Install in a server for convenience
- User control in the server computer
  - Data accessibility control based on the login identification
  - Software lock to control edits

Benefits for Simulator Training - STP Experience (1)

- Improved debriefing quality
  - Provides consistency between crews in the debriefs
  - Ensure crew addresses an issue
  - The issues cannot be minimized – drill down to the root cause
  - Can be used to track individual crew performance as well as overall department performance
- End of cycle report
  - Used for planning the next training cycle
  - Enables rapidly addressing the identified performance issues
  - Real time comparison against actual performance

Benefits for Simulator Training - STP Experience (2)

ACAD Objective 3.2 – Managers are engaged in training activities through monitoring and oversight to provide feedback and direction

- Automatic reports
- Included in the end-of-cycle roll-up reports along with other cycle observations to get better picture of overall training performance
- Used to identify department issues to make as a focus area for future training cycles
- Allows management to promptly address performance issues

Benefits for Simulator Training - STP Experience (3)

ACAD Objective 3.3 – Personnel performance and feedback during training are used to evaluate and modify training programs

- Tracks and trends simulator performance issues
- Captures good performance and identifies weaknesses
- Feedback issues identified export to crew notebooks
- Helps evaluate and group performance deficiencies by operator fundamentals

STP Overall Experience

- Overall very positive experience
- Has helped in identifying issues and ensuring they are closed out properly
- Have helped improve training by identifying gaps that need to be focused on in later training cycles
- A learning curve in the beginning with crews and instructors on the system and data

Collaboration with NRC

- NRC welcomes collaboration on SACADA
- Collaboration Principals
  - NRC provides free software licenses, training and technical support
  - The collaborators share the data with NRC for HRA researches
    - For NRC licensees, NRC will not perform regulatory actions against the licensees base on the provided SACADA data

Collaboration Process

- Upon request, NRC provides an onsite or web meeting to present the SACADA system and demonstrates the software for initial evaluation
- The potential partners can request to pilot the system for evaluation
  - NRC provides free training (2 days per session), software, and tech support to support the piloting
  - A memorandum of understanding (MOU) to be developed to formalize the partnership
  - A foreign language version of SACADA may need to be developed (Currently English and Chinese versions are available)
- Implement a formal collaboration based on the MOU

Share Data with NRC

- Each partner has its data stored locally
- At the end of each training cycle, the partner exports the cycle data to the SACADA master database (currently operated and maintained by the Idaho National Laboratory)
  - The remediation data will not be exported
  - The exported data contains no individual identifications
  - NRC hosts but does not own the data. The data are proprietary to the data providers.

Sharing Data Insights

- NRC plans to analyze the master database's data focusing on generic instead of plant-specific human performance insights
- Plan to analyze the data on a regular basis. The frequency is tentatively to be annually
- NRC will share the insights with the SACADA partners

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