AUTOMATING THE SIMULATOR TESTING AND DATA COLLECTION PROCESS

T. Magi, R. Dimitri-Hakim
L-3 Communications MAPPS Inc., Montréal, Québec, Canada

1. Introduction

Scenario-based training is a key process in the use of Full Scope Simulators (FSS) for operator training. Scenario-based training can be defined as any set of simulated plant operations performed with a specific training objective in mind. In order to meet this training objective, the ANSI/ANS-3.5-2009 [1] standard requires that certain simulator training scenarios be tested to ensure that they reproduce the expected plant responses, that all plant procedures can be followed, and that scenario-based training objectives can be met. While malfunction testing provided a narrow view of the simulator performance revolving around the malfunction itself, scenario testing provides a broader, overall view. The concept of instructor validation of simulator scenarios to be used for training and evaluation, and oversight of simulator performance during the validation process, work hand-in-hand [2]. This is where Scenario-Based Testing comes into play. With the description of Scenario-Based Testing (SBT) within Nuclear Energy Institute's NEI 09-09 white paper [2] and within the ANSI/ANS-3.5-2009 standard, the industry now has a way forward that reduces the regulatory uncertainty.

Together, scenario-based testing and scenario-based training combine to produce better simulators which in turn can be used to more effectively and efficiently train new and existing power plant operators. However, they also impose a significant data gathering and analysis burden on FSS users. L-3 MAPPS' Orchid® Instructor Station (Orchid® IS) facilitates this data gathering and analysis by providing features that automate this process with a simple, centralized, easy to use interface.

2. Automated data gathering using Orchid® Instructor Station

In December 2009, the NEI published a white paper entitled "Nuclear Power Plant-Referenced Simulator Scenario-Based Testing Methodology" (NEI 09-09). The purpose of the white paper is to provide a consistent approach and methodology to the industry for the conduct of simulator Scenario-Based Testing (SBT) described in ANSI/ANS-3.5-2009 as well as to define the data that should be collected to document the tests.

Orchid® IS already includes separate features for test automation, and data collection, designed to provide a simple interface to manage all components, launch tests, and present the results. These features include tracking of operator and instructor actions, configurable recording of

parameters, trending and comparison of parameters (Figure 1), as well as a configurable event logger.

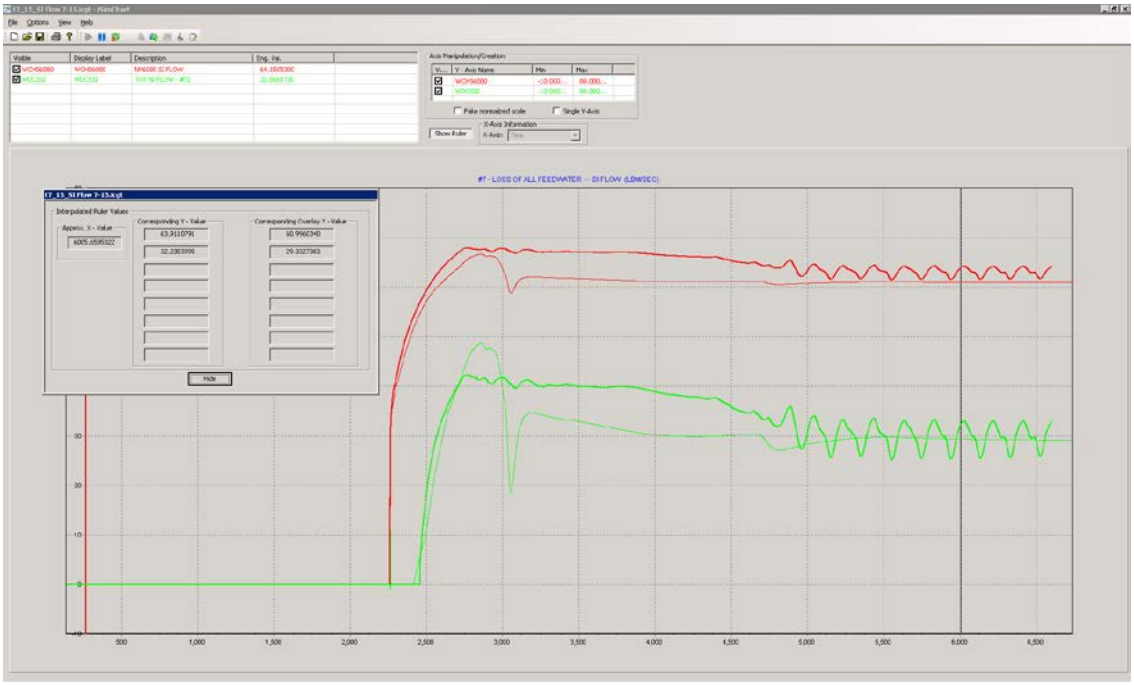

Figure 1: Orchid® Instructor Station Trend

Tools are also available to create and execute automated test procedures through a graphical flow chart interface (Figure 2). L-3 MAPPS' latest functionality within Orchid® IS--Scenario Manager--provides the instructor with the framework for repeatable, structured and efficient training through the use of automated scenarios. With Scenario Manager, the instructor can:

- Create/modify scenarios
- Execute scenarios
- Visualize and monitor scenario progress and results
- Evaluate the performance of students based on a highly sophisticated evaluation criteria system
- Automate instructor inputs such as executing local controls or injecting malfunctions
- Make decisions based on student actions and inputs from instructors.

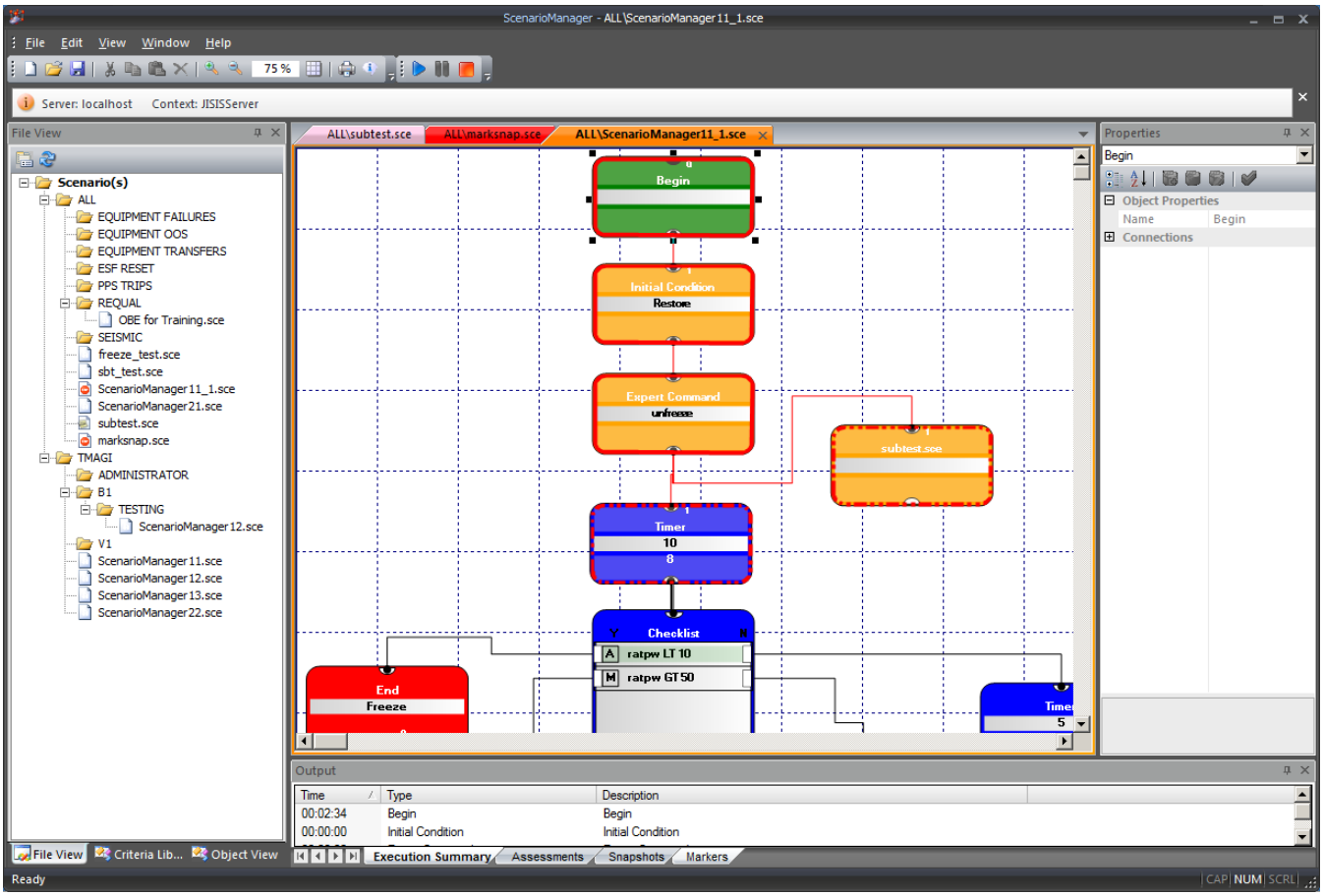

Figure 2: Orchid® Instructor Station Automated Test Procedure example

The latest SBT features expand on the already available functionality by collating the various data sources through a single user interface with minimum configuration or instructor input. These features will permit the user to acquire data easily in order to meet regulatory requirements for SBT. Data can be acquired in parallel as part of an actual training session or in series as part of a purpose run test.

In the context of scenario-based testing, the single button Scenario-Based Testing and Training (SBT^2) feature will capture and intelligently collate the following data automatically:

- Initial Condition used during the test
- Scenario Description Document (if available)
- Operator and instructor actions
- Plant automatic actions and alarm logs
- Recording of critical and user-selected plant parameters
- Trends of critical and user-selected plant parameters
- Automated test procedure (if applicable)

Users can use Simple SBT (Figure 3) that allows quickly creating and running a scenario. Testing can also be performed in a semi-automated manner with SBT Manager (Figure 4), which provides more options to create and save SBT sessions that will be used more than once. Users can then perform SBT on different scenarios one after another.

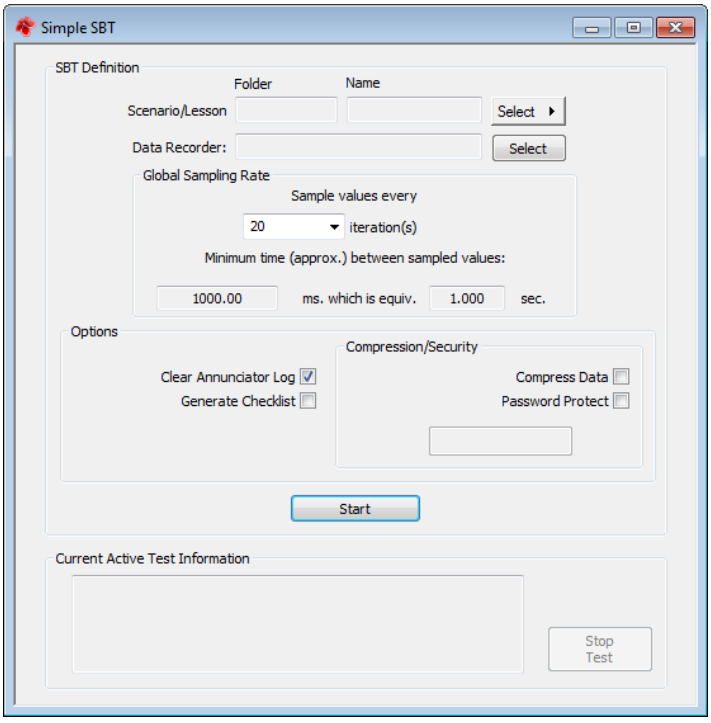

Figure 3: Simple SBT User Interface

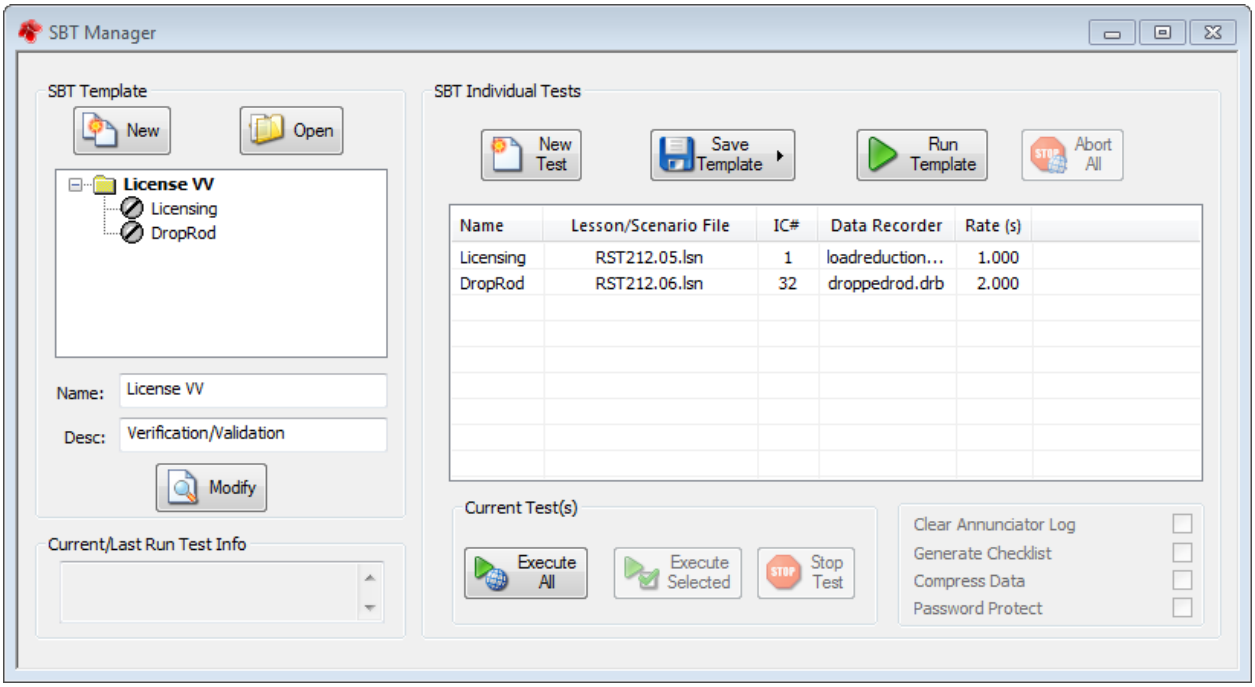

Figure 4: SBT Manager User Interface

At the end of each test, Orchid® IS also records the highest and lowest value for each monitored parameter, the greatest amount of time that each parameter has remained outside of its limits, as well as the number of times each parameter has exceeded its limits. In turn, the simulator staff can import plant data into the trending tool to facilitate comparisons against simulator data. Recorded data can also be exported to Microsoft Excel charts for further analysis. The test itself, depending on the complexity, can be run manually by simulator staff or converted into a scenario to be run automatically by the Scenario Manager. In the latter case, the testing can also be scheduled to run automatically at a time chosen by the simulator staff. The collected data in turn are automatically saved to a user-defined location at the end of the test.

In short, the SBT^2 facility as implemented within Orchid® IS will provide the following:

- Monitoring of critical parameters
- Trend analysis tool
- Data collection
- Repeatable scenarios
- Alarm summaries
- Electronic copies of data in a recoverable format (archived in a centralized location)
- Consistent presentation of data
- Logging of operator actions
- Monitoring of user-defined simulation parameters
- Checklist stating pass or fail of various items

The SBT Report (a.k.a. “checklist”, see NEI 09-09 for information) does not require the simulator instructor station software or the simulator itself to be loaded in order to properly generate the report. It is an offline tool (SBT Post Processor, Figure 5) which handles the task of collating the various data collected into a report.

In the context of scenario-based training, Orchid® IS’s Training Performance Review (TPR) facility captures and permanently archives the same data, but does it for each training session and group of trainees. TPR also automatically evaluates the trainee’s performance against performance indicators defined for each scenario and compares plant parameters recorded during the training session against baseline data according to preset tolerances. The result of a particular training session can be examined at any time through the user interface.

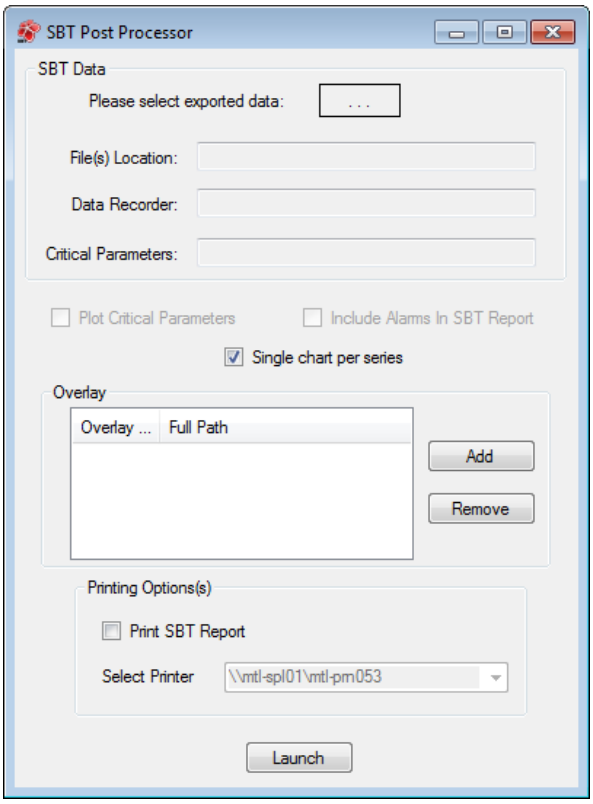

Figure 5: SBT Post Processor User Interface

3. Results/Conclusion

The main reason for scenario-based testing being implemented within Orchid® IS is to automate the testing and data gathering required to support the ANSI/ANS-3.5-2009 requirements for `SBT. At the same time, these features allow the user to move away from simple malfunction based testing towards a more robust testing methodology designed to reveal problems that would never be caught by simply inserting failures and poring over data/trends. Essentially the goal is to go beyond malfunctions and into actual model response for varying plant conditions. This in turn provides better and more effective training sessions for all current and future power plant personnel.

SBT^2 has been released and is currently being used by L-3 MAPPS nuclear power plant simulator customers. Existing versions of Orchid® IS can be easily upgraded to include the new SBT^2 facility which adds to already existing automation, verification and validation features and further facilitates the simulator staff's workload by automatically collecting and collating all required data.

4. References

[1] T. Magi, R. Boire, “Scenario-Based Testing and Training”, presented at American Nuclear Society’s Conference on Nuclear Training and Education (CONTE 2011), Jacksonville, Florida, USA, 7 February 2011.

[2] Nuclear Energy Institute, Nuclear Power Plant-Referenced Simulator Scenario Based Testing Methodology”, December 2009.