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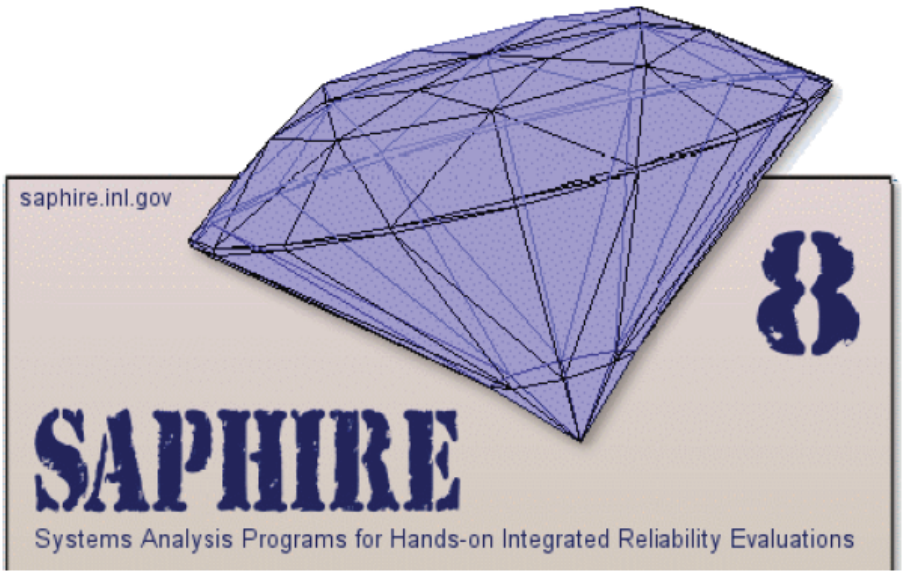
Independent Verification and Validation SAPHIRE Version 8 Final Report

April 2010



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Independent Verification and Validation SAPHIRE Version 8 Final Report

April 2010

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1.0 Executive Summary

The purpose of the Independent Verification and Validation (IV&V) role in the evaluation of the SAPHIRE (System Analysis Program for Hands-on Integrated Reliability Evaluation) version 8 software product is to assess the activities and practices that are being incorporated into the development of the software. The IV&V team began this endeavor after the software engineering and software development of SAPHIRE version 8 had already been in production. IV&V reviewed SAPHIRE version 8 documentation and evaluated the planned and systematic pattern of all actions necessary to provide adequate confidence that the SAPHIRE version 8 software product conforms to established technical requirements specified within the NUREG/BR-0167 Software Quality Assurance Program and Guidelines, and where applicable, the IEEE Std 1012-2004 Standard for Software Verification and Validation as a secondary reference.

The requirements for development of the SAPHIRE 8 Software Independent Verification and Validation Plan (INL/EXT-09-15649) were extracted primarily from the NUREG/BR-0167 Software Quality Assurance Program and Guidelines but also included an examination of best software engineering methods provided in the IEEE Std 1012-2004 Standard for Software Verification and Validation. Refer to APPENDIX B – IV&V Plan (INL/EXT-09-15649). IV&V developed checklists that mapped these requirements with these standards which were used in the evaluations. The checklists provide comprehensive coverage of the NUREG/BR-0167 Verification and Validation activities associated with Table 3-1 "*Verification and Validation Activities by Major Life Cycle Activity*". Verification and Validation (V&V) activities associated with Requirements Definition, Design, Implementation, Qualification Testing, and Installation and Acceptance Testing are included in the checklists. Since SAPHIRE version 8 is not yet in maintenance or operations, the V&V activities are not yet applicable.

Traceability of requirements is the greatest of concerns. Requirements traceability is essential to all software development activities. The requirements define the functionality, performance, design constraints, attributes, and external interfaces the software product must satisfy. Without a well documented Requirements Traceability Matrix (RTM), design components may be overlooked, and test cases missed. The requirements form the basis for the software plans, products, and activities.

For IV&V to properly evaluate the original RTM at the beginning of the IV&V effort to assess the mapping of the test cases to design components and to requirements as documented in the SAPHIRE Version 8 Software Verification and Validation Plan (SVVP) Volume I (INL/EXT-05-00821) and SAPHIRE Version 8 Software Verification and Validation Plan Volume II (INL/EXT-05-00821), IV&V had to obtain requirements from the Nuclear Regulatory Commission (NRC) Form 189s, and develop an RTM used for the requirements traceability analysis (file: "*NRC Form 189 Requirements Table.xls"*). The intent of IV&V in developing the RTM used for the requirements traceability analysis is strictly for use in evaluation. The RTM used for the requirements traceability analysis will be included as documentary evidence in the IV&V report provided to the sponsor and the Idaho National Laboratory (INL) Project Manager.

Per the requirements and document outline provided in the SAPHIRE 8 Software Independent Verification and Validation Plan (INL/EXT-09-15649), this report and all subsequent reports will be included as attachments and/or background evidence of the evaluation as well as the results of the SAPHIRE version 8 assessments.

2.0 Background Information

NUREG/BR-0167, Software Quality Assurance Program and Guidelines, requires the development of a planned and systematic pattern of all actions necessary to provide adequate confidence that a software product conforms to established technical requirements and to ensure that the project manager incorporates the sponsor's contractual agreements. The actions necessary include verification and validation activities; documentation and deliverables; project management; configuration management, nonconformance reporting and corrective action; and quality assessment and improvement.

This report provides an evaluation of the SAPHIRE version 8 software product. SAPHIRE version 8 is being developed with a phased or cyclic iterative rapid application development methodology. Due to this approach, a similar approach has been taken for the IV&V activities on each vital software object. IV&V and Software Quality Assurance (SQA) activities occur throughout the entire development life cycle and therefore, will be required through the full development of SAPHIRE version 8. Later phases of the software life cycle, the operation and maintenance phases, are not applicable in this effort since the IV&V is being done prior to releasing Version 8.

The development of SAPHIRE version 8 includes new features and capabilities. These features and capabilities are related to working with larger, more complex models and improving the user-friendliness of the SAPHIRE interfaces while retaining key functionality of SAPHIRE version 7. SAPHIRE version 8 is being developed to support the Simplified Plant Analysis Risk (SPAR) models and to run them as an integrated model (e.g., Level 1 with external events). The graphical user interface has also improved from SAPHIRE version 7 to support NRC programs such as the Significance Determination Process (SDP) and the Accident Sequence Precursor (ASP). A tailored interface for the SDP and the ASP programs is being developed. An interface for general analyses and model construction is also being developed. The interfaces for the SDP, ASP, and general analysis introduce the concept of a "workspace" in which the analyst may run and save different analyses. The use of workspaces enables the user to separate the model construction from the model analysis.

Independent Verification and Validation evaluates and assesses the processes and products developed during each phase of the Software Development Life Cycle (SDLC). The software life cycle provides the basis for planning and implementing a software development or maintenance project. Each major activity is accompanied by verification actions that ensure that the products and processes of the major activity meet the requirements for those products and processes. The SAPHIRE version 8 development team is implementing a "spiral" rapid application approach to the product development. One of the roles that IV&V performs, regardless of the development methodology, is to analyze products developed throughout the development process. The intent is to provide a level of confidence to the sponsor that the quality of the software product and supporting documentation is built into the software, not tested in. Evaluating the supporting documentation for each product is one aspect of providing this level of confidence.

IV&V supports and is complementary to the Quality Assurance, Project Management, and product development activities. To achieve this support, IV&V must also evaluate the processes identified in the documentation to ensure that the development team is implementing the processes and methodology that ensures a high-level software product.

To provide direction in the evaluation process, IV&V has developed checklists to support the requirements for the SDLC. These checklists are included in the SAPHIRE 8 Software Independent Verification and Validation Plan (INL/EXT-09-15649).

3.0 Project Summary

The Nuclear Regulatory Commission (NRC) developed the SAPHIRE computer code for performing probabilistic risk assessments (PRAs) using a personal computer (PC) at the INL under Job Code Number (JCN) L1429. SAPHIRE started out as a feasibility study for a PRA code to be run on a desktop personal PC and evolved through several phases into a state-of-the-art PRA code. The developmental activity of SAPHIRE was the result of two concurrent important events: The tremendous expansion of PC software and hardware capability of the 90s and the onset of a risk-informed regulation era.

Three SAPHIRE versions have been released to date. Version 5 was a DOS version that became a production code a number of years ago. Version 6 was a Windows NT version that became a production code in 1998. Version 7 is also a Windows NT (or above) version that is currently the standard that is being used by the NRC.

Work began on a new version of SAPHIRE, version 8, under JCN Y6394, "*Maintenance and User Support for SAPHIRE Code and Library of PRAs*". Version 8 is being designed to meet current NRC program needs such as those related to Simplified Plant Analysis Risk (SPAR) model development, the Significance Determination Process (SDP) program, the Risk Assessment Standardization Project (RASP), as well as the Accident Sequence Precursor (ASP) Program. Development of version 8 continued under JCN N6203, "*Maintain and Support SAPHIRE Code and Library*". JCN N6423 "*SAPHIRE version 8*" will support the beta and final version 8, testing, verification, and validation.

The organizational structure of the SAPHIRE version 8 software development team influences and controls the software quality. Roles and responsibilities within the organizational structure provide the development team with the freedom, flexibility and objectivity to evaluate and monitor the software quality as well as verify problem resolutions. This structure enables the development team to tailor the maintenance and development activities, techniques, and methodologies for problem identification, reporting and resolution, testing, records retention, and configuration management.

The SAPHIRE 8 Software Independent Verification and Validation Plan (INL/EXT-09-15649) is structured around NUREG/BR-0167, Software Quality Assurance Program and Guidelines, February 1993. The Nuclear Regulatory Research Office Instruction No.: PRM-12, Software Quality Assurance for Office of Research (RES) Sponsored Codes, March 26, 2007 specifies that RES-sponsored software is to be evaluated against NUREG/BR-0167. Per the guidance in NUREG/BR-0167, SAPHIRE is classified as "Level 1." Level 1 software corresponds to technical application software used in a safety decision. SAPHIRE version 8 will follow the requirements for Level 1 software defined in Section 1.2 of NUREG/BR-0167. The NRC will perform an audit of the software Quality Assurance (QA) implementation once a year against the requirement of NUREG/BR-0167.

The required software activities and contractual commitments; planning process and details of managing the SAPHIRE version 8 project along with project tracking and oversight; risk management; nonconformance reporting and corrective action; the developer's approach to quality assessment and improvement; design completion criteria; and the overall verification and validation plan are explained in the Software Project Plan (INL/EXT-09-15853) for SAPHIRE version 8.

The software quality assurance activities that include both management and technical aspects of software development and maintenance are specified in the Software Quality Assurance Plan (INL/EXT-09-16697) for SAPHIRE version 8.

The required activities associated with configuration management such as; Identifying and defining project baselines, including or referencing procedures for: change control; determining status of baselines, proposed changes, and implemented changes; release control; the software development library; and code, access, and media control are specified in the Software Configuration Management Plan (INL/EXT-09-16696) for SAPHIRE version 8, the Software Quality Assurance Plan (INL/EXT-09-16697) for SAPHIRE version 8 and the Software Project Plan (INL/EXT-09-15853) for SAPHIRE version 8.

The software requirements describing functionality, performance, design constraints, attributes, and external interfaces from the NRC Form 189s that the SAPHIRE version 8 software must satisfy are listed in the SAPHIRE Version 8 Software Verification and Validation Plan – Volume I, section 2 Software Requirements and section 3 Interface Requirements Specification (INL/EXT-05-00821).

Design components specifying the overall structure of the software so that it can be translated into code and meet the requirements defined in the software requirements documentation, are in the SAPHIRE Version 8 Software Verification and Validation Plan – Volume I, section 4, Design Specification (INL/EXT-05-00821).

The test specification, test methodologies, test phases; and development and test environment for acceptance tests that will be used to demonstrate that SAPHIRE version 8 is ready for official release are listed in the SAPHIRE Version 8 Software Verification and Validation Plan Volume II (INL/EXT-05-00821). Included in Appendix D of this document is the requirements traceability matrix. This matrix when complete will provide the mapping of the test cases to design components and to requirements. Appendix C contains the Modula-2 and Delphi coding standards.

Information prescribing the approach to be taken for intended testing activities is specified in the System Test Plan (INL/EXT-09-16455) for SAPHIRE version 8.

The acceptance tests and test acceptance criteria that will be used to formally test the implemented software and reviewing and analyzing the test results to ensure that the implemented software meets requirements and that the software produces correct results for all test cases executed and demonstrate that SAPHIRE version 8 is ready for official release are listed in the Software Acceptance Test Plan (INL/EXT-09-16236) for SAPHIRE version 8.

NUREG/BR-0167 section 2.4 Implementation and section 4.5 Software Implementation Documentation require documentation that includes unit designs (Usually presented as a commentary prologue to the unit's source code) and the unit code itself. This process is the set of activities that results in software that has been constructed in accordance with the design documentation and coding standards; and undergone informal unit and integration testing. The SAPHIRE version 8 coding standard used for spot check evaluations of the Modula-2 and Delphi code is located in the SAPHIRE Version 8 Software Verification and Validation Plan – Volume II, Appendix C Coding Standards (INL/EXT-05-00821). More rigorous reviews may be considered at higher levels for life cycle activities such as "Implementation" and/or "Test" if the schedule and budget permit. The software evaluation tools for evaluating the SAPHIRE version 8 software are Coverage Validator, Memory Validator, Performance Validator and Thread Validator. Another source code analysis and verification tool, CodeHealer, is used to detect mistakes and inconsistencies in the SAPHIRE version 8 software.

It is the insight of the Independent Verification and Validation after performing the SAPHIRE version 8 assessment that the SAPHIRE version 8 software project development team, according to the requirements specified in NUREG/BR-0167 Software Quality Assurance Program and Guidelines for Level 1 software defined in Section 1.2 of NUREG/BR-0167, are implementing

and currently following all actions necessary to provide adequate confidence that the SAPHIRE version 8 software product conforms to established technical requirements.

4.0 Summary of Findings

NUREG/BR-0167, Software Quality Assurance Program and Guidelines, requires the development of a planned and systematic pattern of all actions necessary to provide adequate confidence that a software product conforms to established technical requirements. The software life cycle provides the basis for planning and implementing a software development or maintenance project. Each major activity leads to specific products that can be measured, evaluated, approved, and controlled. Each major activity is accompanied by verification actions that ensure that the products and processes of the major activity meet the requirements for those products and processes; and meet the contractual commitments prepared by the sponsor; the Nuclear Regulatory Commission. The following sections present the verification and validation findings of the SAPHIRE version 8 product.

The requirements for IV&V review were extracted primarily from the NUREG/BR-0167 Software Quality Assurance Program and Guidelines, but also included an examination of best software engineering methods provided in the IEEE Standard for Software Verification and Validation. IV&V developed checklists that mapped these requirements with these standards which were used in the evaluations.

The IV&V team began this endeavor after the software engineering and software development of SAPHIRE version 8 had already been in production.

4.1 Software Project Plan including Project Tracking and Oversight

The purpose of the Independent Verification and Validation role in the evaluation of the SAPHIRE 8 Software Project Plan is to assess the activities and practices that will be incorporated in the development of the software. The IV&V team reviewed the plan to evaluate the development team's methods to integrate the project management, quality assurance practices, and development methodology against the requirements specified in NUREG/BR-0167 as well as IEEE-1012-98.

NUREG/BR-0167, Software Quality Assurance Program and Guidelines, requires the development of a Software Project Plan that details the process for managing the software project and to ensure that the project manager incorporates the sponsor's contractual agreements. The Software Project Plan activities that must be performed include Project Planning and Organization as well as Project Tracking and Oversight.

The Software Project Plan is intended to provide the high-level direction that documents the required software activities to meet the contractual commitments.

Independent Verification and Validation Of SAPHIRE 8 Software Project Plan Document ID: INL/EXT-09-17022 Revision 0 Effective Date: October 13, 2009.

An Independent Verification and Validation evaluation of the Software Project Plan Document ID: INL/EXT-09-15853 for SAPHIRE 8 was performed. The checklist containing the criteria for the requirements of the Project Plan as well as the Project Tracking and Oversight was extracted from the SAPHIRE IV&V Plan for use in evaluating the SOFTWARE PROJECT PLAN for SAPHIRE Version 8 N6423, INL/EXT-09-15853. There were thirty-nine criteria identified for the assessment. Although IV&V failed eleven of the criteria (28%), many of these failures can be corrected easily as many were minor. One criterion (#32) could not be assessed as there was insufficient information to assess the criteria at this time. Also, one criterion (#26) was considered to be not applicable as IV&V will observe acceptance testing and will not perform separate acceptance testing activities. Finally, IV&V passed some of the criteria but also

requested/included in these criteria, suggestions for improvement and/or where additional detail would have been helpful.

Independent Verification and Validation Of SAPHIRE 8 Software Project Plan Document ID: INL/EXT-09-17022 Revision 1 Effective Date: December 15, 2009.

An Independent Verification and Validation evaluation of the Software Project Plan Document ID: INL/EXT-09-15853 for SAPHIRE 8 was performed. The checklist containing the criteria for the requirements of the Software Project Plan as well as the Project Tracking and Oversight was extracted from the SAPHIRE IV&V Plan for use in evaluating the SOFTWARE PROJECT PLAN for SAPHIRE Version 8 N6423, INL/EXT-09-15853. There were thirty-eight criteria identified for the assessment. Although IV&V failed four of the criteria (11%), many of these failures can be corrected easily as they are minor. One criterion (#31) could not be assessed as there was insufficient information to assess the criteria at this time.

Independent Verification and Validation Of SAPHIRE 8 Software Project Plan Document ID: INL/EXT-09-17022 Revision 2 Effective Date: March 09, 2010.

An Independent Verification and Validation evaluation of the Software Project Plan Document ID: INL/EXT-09-15853 for SAPHIRE 8 was performed. The checklist containing the criteria for the requirements of the Software Project Plan as well as the Project Tracking and Oversight was extracted from the SAPHIRE IV&V Plan for use in evaluating the SOFTWARE PROJECT PLAN for SAPHIRE Version 8 N6423, INL/EXT-09-15853. Of the thirty-eight criteria listed for the required information to be provided within the SAPHIRE 8 Software Project Plan all criteria were satisfied.

4.2 Risk Management Plan

The purpose of the Independent Verification and Validation role in the evaluation of the SAPHIRE risk management is to assess the activities that results in the process to identify, assess, document, and rank technical, cost, resource, and schedule risks associated with the SAPHIRE software product.

NUREG/BR-0167, Software Quality Assurance Program and Guidelines, requires the development of risk management activities that:

1. Identify, assess, document, and rank technical, cost, resource, and schedule risks.
2. Develop a risk mitigation plan.
3. Formalize the risk management program.
4. Review the risk management program regularly.

Risk management is intended to ensure a methodology for conducting risk management planning, identification, analysis, responses, and monitoring and control activities associated with the SAPHIRE project work.

Independent Verification and Validation Of SAPHIRE 8 Risk Management Document ID: INL/EXT-09-17207 Revision 0 Effective Date: November 13, 2009.

An Independent Verification and Validation evaluation of risk management within the Software Project Plan Document ID: INL/EXT-09-15853 for SAPHIRE 8 was performed. The checklist containing the criteria for the requirements of the SAPHIRE 8 risk management was extracted from the SAPHIRE 8 Software Independent Verification and Validation Plan Document ID: INL/EXT-09-15649. Of the three criteria listed for the required information to be provided within the SAPHIRE 8 risk management all criteria were satisfied. It is the recommendation of IV&V that a Risk Management and Risk Mitigation plan be developed for the SAPHIRE 8 software development.

4.3 Software Quality Assurance Plan

The purpose of the Independent Verification and Validation role in the evaluation of the SAPHIRE Software Quality Assurance Plan is to assess the planned and systematic pattern of all actions necessary to provide adequate confidence that a software product conforms to established technical requirements.

NUREG/BR-0167, Software Quality Assurance Program and Guidelines, requires the development of software quality assurance activities that includes both management and technical aspects of software development and maintenance.

The Software Quality Assurance Plan is intended to ensure all actions necessary for the software life cycle; verification and validation activities; documentation and deliverables; project management; configuration management, nonconformance reporting and corrective action; and quality assessment and improvement have been planned and a systematic pattern of all actions necessary to provide adequate confidence that a software product conforms to established technical requirements.

Independent Verification and Validation Of SAPHIRE 8 Software Quality Assurance Plan Document ID: INL/EXT-10-17828 Revision 0 Effective Date: February 08, 2010.

An Independent Verification and Validation evaluation of the Software Quality Assurance Plan Document ID: INL/EXT-09-16697 for SAPHIRE 8 was performed. The evaluation criteria were extracted from the guidance specified in NUREG/BR-0167, Software Quality Assurance Program and Guidelines. Of the criteria listed for the required information to be provided within the Software Quality Assurance Plan all criteria were satisfied. Minor corrections for the Software Quality Assurance Plan are listed.

Independent Verification and Validation Of SAPHIRE 8 Software Quality Assurance Plan Document ID: INL/EXT-10-17828 Revision 1 Effective Date: March 01, 2010.

An Independent Verification and Validation evaluation of the Software Quality Assurance Plan Document ID: INL/EXT-09-16697 for SAPHIRE 8 was performed. The evaluation criteria were extracted from the guidance specified in NUREG/BR-0167, Software Quality Assurance Program and Guidelines. Of the criteria listed for the required information to be provided within the Software Quality Assurance Plan all criteria were satisfied.

4.4 Software Configuration Management Plan

The purpose of the Independent Verification and Validation role in the evaluation of the SAPHIRE configuration management is to assess the activities that results in the process of identifying and defining the baselines associated with the SAPHIRE software product; controlling the changes to baselines and release of baselines throughout the life cycle; recording and reporting the status of baselines and the proposed and actual changes to the baselines; and verifying the correctness and completeness of baselines.

NUREG/BR-0167, Software Quality Assurance Program and Guidelines, requires the development of configuration management activities that establish and maintain integrity of the software and its documentation as they evolve throughout the life cycle. The four major functions of configuration management include:

1. The identification and establishment of baselines.
2. Controlling both changes to baselines and the release of baselines.

3. Recording and reporting the status of baselines, change requests, and implemented changes.
4. Verifying, through auditing, the correctness and completeness of baselines prior to release.

The Software Configuration Management Plan is intended to ensure the content and status of the software and documentation baselines are known at all times; the developer follows a written configuration management policy that has the following characteristics: (a) Responsibility for configuration management for each project is explicitly assigned. (b) Configuration management is implemented on products throughout the product's life cycle. (c) Configuration management is implemented for externally-deliverable products and for appropriate products used inside the organization. (d) All projects have a repository for storing key software engineering elements and associated configuration management records. (e) The software baselines and configuration management activities are audited on a regular basis; a group that is responsible for coordinating and implementing configuration management for the project exists or is established; adequate resources and budget for performing configuration management activities are provided; members of the configuration management group are trained in the objectives, procedures, and methods for performing their assigned activities; the configuration management activities are reviewed with the project manager on a regular basis.

Independent Verification and Validation Of SAPHIRE 8 Software Configuration Management Plan Document ID: INL/EXT-09-17141 Revision 0 Effective Date: October 20, 2009.

An Independent Verification and Validation evaluation of the Software Configuration Management Plan Document ID: INL/EXT-09-16696 for SAPHIRE 8 was performed. The checklist containing the criteria for the requirements of the SAPHIRE 8 Software Configuration Management Plan was extracted from the SAPHIRE 8 Software Independent Verification and Validation Plan Document ID: INL/EXT-09-15649. Of the twelve criteria listed for the required information to be provided within the Software Configuration Management Plan two failed. Minor corrections for the Software Configuration Management Plan are listed.

Independent Verification and Validation Of SAPHIRE 8 Software Configuration Management Plan Document ID: INL/EXT-09-17141 Revision 1 Effective Date: February 01, 2010.

An Independent Verification and Validation evaluation of the Software Configuration Management Plan Document ID: INL/EXT-09-16696 for SAPHIRE 8 was performed. The checklist containing the criteria for the requirements of the SAPHIRE 8 Software Configuration Management Plan was extracted from the SAPHIRE 8 Software Independent Verification and Validation Plan Document ID: INL/EXT-09-15649. Of the twelve criteria listed for the required information to be provided within the SAPHIRE 8 Software Configuration Management Plan all criteria were satisfied. Documentation and procedures required to be included within configuration management are currently being implemented.

4.5 Software Requirements

The purpose of the Independent Verification and Validation role in the evaluation of the SAPHIRE version 8 requirements definition is to assess the activities that results in the specification, documentation, and review of the requirements that the software product must satisfy, including functionality, performance, design constraints, attributes and external interfaces. IV&V reviewed the requirements specified in the NRC Form 189s to verify these

requirements were included in the SAPHIRE Version 8 Software Verification and Validation Plan (SVVP) Volume I (INL/EXT-05-00821).

NUREG/BR-0167, Software Quality Assurance Program and Guidelines, requires the development of Software Requirements Documentation that specifies the requirements that the software to be developed/maintained must meet. An item can be called a software requirement only if its achievement can be verified and validated. It is important that each software requirement be traceable throughout the stages of the software life cycle.

The Software Requirements Documentation is intended to provide the specification, documentation, and review of the requirements.

Independent Verification and Validation Of SAPHIRE 8 Software Requirements Document ID: INL/EXT-09-16789 Revision 0 Effective Date: September 30, 2009.

An Independent Verification and Validation evaluation of the Software Verification and Validation Plan – Volume I, section 2 Software Requirements and section 3 Interface Requirements Specification, Document ID: INL/EXT-05-00821 for SAPHIRE 8 was performed. The requirements are included in section 2 Software Requirements and section 3 Interface Requirements Specification within the SAPHIRE Version 8 Software Verification and Validation Plan Volume I Document ID: INL/EXT-05-00821. Section 2 Software Requirements, states "*The requirements are briefly described in NRC Form 189, Y6394, Revision 11 and NRC Form 189 N6203, Revision 3*". Section 2.1 Graphical User Interface Requirements, states "*The graphical user interface (GUI) requirements are described in NRC Form 189, Revision 10, subtasks 9.5 and 9.6*". Requirements are also found in:

- NRC Form 189, Y6394, Revision 7,
- NRC Form 189, N6423, Revision 0 and
- NRC Form 189, N6423, Revision 5.

There is no Software Requirements Documentation containing all requirements.

The requirements are not all documented or uniquely identified, but requirements that are documented are specified in paragraphs and referenced in the Requirements Traceability Matrix as section numbers within the SAPHIRE Version 8 Software Verification and Validation Plan Volume I. Sentences within paragraphs containing the words "shall" and "will" are assumed requirements. Other sentences containing the words "is", "must", "can be" and "are" were assumed requirements. Since multiple requirements are specified within paragraphs and not uniquely identified, traceability and testability of individual requirements will be difficult and violates sound software engineering practices. Of the twenty-one criteria listed for the required information to be provided within the Software Requirements Documentation twenty failed.

Independent Verification and Validation Of SAPHIRE 8 Software Requirements Document ID: INL/EXT-09-16789 Revision 1 Effective Date: March 25, 2010.

An Independent Verification and Validation evaluation of the Software Verification and Validation Plan – Volume I, section 2 Software Requirements and section 3 Interface Requirements Specification, Document ID: INL/EXT-05-00821 for SAPHIRE 8 was performed. The checklist containing the criteria for the requirements of the SAPHIRE 8 requirements definition was extracted from the SAPHIRE 8 Software Independent Verification and Validation Plan Document ID: INL/EXT-09-15649. Of the twenty-one criteria listed for the required information to be provided within the Software Requirements Documentation six failed. In order for these criteria to pass, the requirements in section 2 Software Requirements and section 3 Interface Requirements Specification within the Software Verification and Validation Plan – Volume I need to be uniquely identified. Minor corrections for the Software Verification and

Validation Plan – Volume I sections 2 Software Requirements and 3 Interface Requirements Specification are listed.

SAPHIRE 8 Requirements Traceability Matrix (RTM) Dated: April 20, 2010.

The Requirements Traceability Matrix dated April 20, 2010 was reviewed by IV&V. The information provided within this RTM shows the traceability of requirements to design components and test cases. The requirements are uniquely identified as functional, performance, design constraints, attributes and external interface requirements and have been updated in the Software Verification and Validation Plan – Volume I sections 2 Software Requirements and 3 Interface Requirements Specification. Design components have been uniquely identified and are currently being updated in section 4 Design Specification within the SAPHIRE Version 8 Software Verification and Validation Plan Volume I (INL/EXT-05-00821). Test case identifiers are currently being updated to show the testability of the requirements.

4.6 Software Design and Interface Design

The purpose of the Independent Verification and Validation role in the evaluation of the SAPHIRE 8 software design and interface design is to assess the activities that results in the development, documentation, and review of a software design that meets the requirements defined in the software requirements documentation. IV&V reviewed the requirements specified in the NRC Form 189s to verify these requirements were included in the SAPHIRE Version 8 Software Verification and Validation Plan (SVVP) Volume I (INL/EXT-05-00821) section 4 Design Specification.

NUREG/BR-0167, Software Quality Assurance Program and Guidelines, requires the development of Software Design Documentation that specifies the overall structure of the software so that it can be translated into code. The Software Design Documentation includes a description of the major elements of the software as they relate to the requirements; a description of the theoretical basis, physical model, mathematical model, control flow, data flow, control logic, and data structure; and an identification and detailed definition of the software units and data elements of the software architecture.

The Software Design Documentation is intended to provide the development, documentation, and review of the software design that meets the requirements defined in the Software Requirements Documentation.

Independent Verification and Validation Of SAPHIRE 8 Software Design and Interface Design Document ID: INL/EXT-09-17069 Revision 0 Effective Date: October 20, 2009.

An Independent Verification and Validation evaluation of the Software Verification and Validation Plan – Volume I, section 4 Design Specification, Document ID: INL/EXT-05-00821 and the Software Verification and Validation Plan – Volume II, Document ID: INL/EXT-05-00821 for SAPHIRE 8 was performed. The design is included in section 4 Design Specification within the SAPHIRE Version 8 Software Verification and Validation Plan Volume I. A requirements traceability analysis was performed to trace design components to requirements, and requirements and design components to test cases. The results of the requirements traceability analysis is in attachment NRC Form 189 Requirements Table.xls.

There is no Software Design Documentation containing all design components that meet the requirements.

The software design does not completely meet the requirements defined in the SAPHIRE Version 8 Software Verification and Validation Plan Volume I section 2 Software Requirements and section 3 Interface Requirements Specification. The software design needs to specify the

overall structure of the software so that it can be translated into code. The consistency of detail between design components and software requirements varies.

The design components are not all documented or uniquely identified, but design components that are documented are specified in paragraphs and referenced in the Requirements Traceability Matrix as section numbers within the SAPHIRE Version 8 Software Verification and Validation Plan Volume I. Of the fifteen criteria listed for the required information to be provided within the Software Design Documentation thirteen failed.

Independent Verification and Validation Of SAPHIRE 8 Software Design and Interface Design Document ID: INL/EXT-09-17069 Revision 1 Effective Date: March 24, 2010.

An Independent Verification and Validation evaluation of the Software Verification and Validation Plan – Volume I, section 4 Design Specification, Document ID: INL/EXT-05-00821 and the Software Verification and Validation Plan – Volume II, Document ID: INL/EXT-05-00821 for SAPHIRE 8 was performed. The checklist containing the criteria for the requirements of the SAPHIRE 8 design was extracted from the SAPHIRE 8 Software Independent Verification and Validation Plan Document ID: INL/EXT-09-15649. A requirements traceability analysis was performed to trace design components to requirements, and requirements and design components to test cases. The results of the requirements traceability analysis is in attachment NRC Form 189 Requirements Table.xls. Of the fifteen criteria listed for the required information to be provided within the Software Design Documentation four failed. Minor corrections for the Software Verification and Validation Plan – Volume I section 4 Design Specification and the Software Verification and Validation Plan – Volume II are listed.

4.7 System Test Plan

The purpose of the Independent Verification and Validation role in the evaluation of the SAPHIRE System Test Plan is to assess the approach to be taken for intended testing activities associated with the SAPHIRE software product.

NUREG/BR-0167, Software Quality Assurance Program and Guidelines, requires the development of a document prescribing the approach to be taken for intended testing activities.

Testing is the process of exercising or evaluating a software product or part of a software product by manual or automated means to verify that it satisfies specified requirements or to identify differences between expected and actual results.

The System Test Plan is intended to identify the items to be tested, the requirements being tested, the testing to be performed, test schedules, personnel requirements, reporting requirements, evaluation criteria, and any risks requiring contingency planning.

Independent Verification and Validation Of SAPHIRE 8 System Test Plan Document ID: INL/EXT-10-17816 Revision 0 Effective Date: February 05, 2010.

An Independent Verification and Validation evaluation of the System Test Plan Document ID: INL/EXT-09-16455 for SAPHIRE 8 was performed. The checklist containing the criteria for the requirements of the SAPHIRE 8 System Test Plan was extracted from the SAPHIRE 8 Software Independent Verification and Validation Plan Document ID: INL/EXT-09-15649. Of the three criteria listed for the required information to be provided within the SAPHIRE 8 System Test Plan all criteria were satisfied.

4.8 Software Acceptance Test Plan

The purpose of the Independent Verification and Validation role in the evaluation of the SAPHIRE 8 Software Acceptance Test Plan is to assess the approach to be taken for intended testing activities. The plan typically identifies the items to be tested, the requirements being tested, the testing to be performed, test schedules, personnel requirements, reporting requirements, evaluation criteria, and any risks requiring contingency planning.

NUREG/BR-0167, Software Quality Assurance Program and Guidelines, requires the development of a testing process of exercising or evaluating a software product or part of a software product by manual or automated means to verify that it satisfies specified requirements or to identify differences between expected and actual results. Testing approaches depend on the number of levels of testing. For most cases, four levels of testing are sufficient: (1) Unit testing, (2) Integration testing, (3) Qualification testing, and (4) Acceptance testing.

The Software Acceptance Test Plan is intended to ensure the SAPHIRE software product testing activities and reporting results in accordance with an approved test plan satisfies the specified requirements.

Independent Verification and Validation Of SAPHIRE 8 Software Acceptance Test Plan Document ID: INL/EXT-10-18081 Revision 0 Effective Date: March 10, 2010.

An Independent Verification and Validation evaluation of the Software Acceptance Test Plan Document ID: INL/EXT-09-16236 for SAPHIRE 8 was performed. The evaluation criteria were extracted from the guidance specified in NUREG/BR-0167, Software Quality Assurance Program and Guidelines. All requirements from NUREG/BR-0167, Software Quality Assurance Program and Guidelines were satisfied. Minor corrections for the Software Acceptance Test Plan are listed.

4.9 Volume 3 Users' Guide

The purpose of the Independent Verification and Validation role in the evaluation of the SAPHIRE 8 Volume 3 Users' Guide is to assess the user documentation for its completeness, correctness, and consistency with respect to requirements for user interface and for any functionality that can be invoked by the user.

NUREG/BR-0167, Software Quality Assurance Program and Guidelines, requires the development of user documentation with respect to requirements for user interface and for any functionality that can be invoked by the user and in planning an acceptance test that is representative of the operational environment. User documentation includes:

1. A description of the user's interaction with the software, and a description of any required training necessary to use the software.
2. Input and output specifications and formats, including sample cases.
3. A description of the limitations of the software.
4. A description of anticipated errors and how the user can respond.
5. For each error message, provide the message, an explanation of the message, how the message may have come about, and actions that may or should be taken.
6. Information about obtaining user and sustaining engineering support.

The SAPHIRE 8 Volume 3 Users' Guide is intended to provide readability and effectiveness to end users.

Independent Verification and Validation Of SAPHIRE 8 Volume 3 Users' Guide Document ID: INL/EXT-10-18081 Revision 0 Effective Date: March 10, 2010.

An Independent Verification and Validation evaluation of the Volume 3 Users' Guide for SAPHIRE 8 was performed. The checklist containing the criteria for the requirements of the SAPHIRE 8 Volume 3 Users' Guide was extracted from the SAPHIRE 8 Software Independent Verification and Validation Plan Document ID: INL/EXT-09-15649. Of the five criteria listed for the required information to be provided within the SAPHIRE 8 Volume 3 Users' Guide three failed. Minor corrections for the SAPHIRE 8 Volume 3 Users' Guide are listed.

5.0 Summary of Analysis

The Software Project Plan Document ID: INL/EXT-09-15853 for SAPHIRE 8 is intended to provide the high-level direction that documents the required software activities to meet the contractual commitments prepared by the sponsor; the Nuclear Regulatory Commission. Of the thirty-eight criteria listed for the required information to be provided within the SAPHIRE 8 Software Project Plan all criteria were satisfied.

Risk management within the Software Project Plan Document ID: INL/EXT-09-15853 for SAPHIRE 8 is intended to ensure a methodology for conducting risk management planning, identification, analysis, responses, and monitoring and control activities associated with the SAPHIRE project work, and to meet the contractual commitments prepared by the sponsor; the Nuclear Regulatory Commission. Of the three criteria listed for the required risk management information to be provided within the SAPHIRE 8 Software Project Plan all criteria were satisfied. It is the recommendation of IV&V that a Risk Management and Risk Mitigation plan be developed for the SAPHIRE 8 software development.

The Software Quality Assurance Plan Document ID: INL/EXT-09-16697 for SAPHIRE 8 is intended to ensure all actions necessary for the software life cycle; verification and validation activities; documentation and deliverables; project management; configuration management, nonconformance reporting and corrective action; and quality assessment and improvement have been planned and a systematic pattern of all actions necessary to provide adequate confidence that a software product conforms to established technical requirements; and to meet the contractual commitments prepared by the sponsor; the Nuclear Regulatory Commission. Of the criteria listed for the required information to be provided within the SAPHIRE 8 Software Quality Assurance Plan all criteria were satisfied.

The Software Configuration Management Plan Document ID: INL/EXT-09-16696 for SAPHIRE 8 is intended to ensure the content and status of the software and documentation baselines are known at all times; the developer follows a written configuration management policy that has the following characteristics: (a) Responsibility for configuration management for each project is explicitly assigned. (b) Configuration management is implemented on products throughout the product's life cycle. (c) Configuration management is implemented for externally-deliverable products and for appropriate products used inside the organization. (d) All projects have a repository for storing key software engineering elements and associated configuration management records. (e) The software baselines and configuration management activities are audited on a regular basis; a group that is responsible for coordinating and implementing configuration management for the project exists or is established; adequate resources and budget for performing configuration management activities are provided; members of the configuration management group are trained in the objectives, procedures, and methods for performing their assigned activities; the configuration management activities are reviewed with the project manager on a regular basis, and to meet the contractual commitments prepared by the sponsor; the Nuclear Regulatory Commission. Of the twelve criteria listed for the required information to be provided within the SAPHIRE 8 Software Configuration Management Plan all criteria were satisfied.

The Software Verification and Validation Plan – Volume I, section 2 Software Requirements and section 3 Interface Requirements Specification, Document ID: INL/EXT-05-00821 for SAPHIRE 8 is intended to provide the specification, documentation, and review of the requirements to meet the contractual commitments prepared by the sponsor; the Nuclear Regulatory Commission. Of the 21 criteria listed for the required information to be provided within section 2 Software Requirements and section 3 Interface Requirements Specification 6

failed. Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Requirements Revision 1 Document ID: INL/EXT-09-16789.

The Software Verification and Validation Plan – Volume I, section 4 Design Specification, Document ID: INL/EXT-05-00821 for SAPHIRE 8 is intended to provide the development, documentation, and review of the software design that meets the requirements defined in section 2 Software Requirements and section 3 Interface Requirements Specification and to meet the contractual commitments prepared by the sponsor; the Nuclear Regulatory Commission. Of the 15 criteria listed for the required information to be provided within section 4 Design Specification 4 failed. Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Design and Interface Design Revision 1 Document ID: INL/EXT-09-17069.

The Software Verification and Validation Plan – Volume II, Document ID: INL/EXT-05-00821 for SAPHIRE 8 is intended to address the Test Plan and Test Suite for validating the software along with the acceptance criteria for specifying how to determine the validity of the software given the results of the test cases and to meet the contractual commitments prepared by the sponsor; the Nuclear Regulatory Commission. The criteria listed for the required information to be provided was evaluated with the Software Verification and Validation Plan – Volume I, section 4 Design Specification, Document ID: INL/EXT-05-00821 for SAPHIRE 8. Of the criteria listed for the required information to be provided within the Software Verification and Validation Plan – Volume II all criteria were satisfied. Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Design and Interface Design Revision 1 Document ID: INL/EXT-09-17069 for minor corrections for the Software Verification and Validation Plan – Volume II.

The Requirements Traceability Matrix for SAPHIRE 8 is intended to provide traceability from requirements to design components to test cases and to meet the contractual commitments prepared by the sponsor; the Nuclear Regulatory Commission. The criteria listed for the required information to be provided was evaluated with the Software Verification and Validation Plan – Volume I, section 2 Software Requirements, section 3 Interface Requirements Specification and section 4 Design Specification, Document ID: INL/EXT-05-00821 for SAPHIRE 8. Of the criteria listed for the required information to be provided within the Requirements Traceability Matrix most failed. Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Requirements Revision 1 Document ID: INL/EXT-09-16789 and the Independent Verification and Validation Of SAPHIRE 8 Software Design and Interface Design Revision 1 Document ID: INL/EXT-09-17069.

The Data Dictionary, file "saphire-data-dictionary.html" for SAPHIRE 8 is intended to provide items computed in the code, what they are and what they do and to meet the contractual commitments prepared by the sponsor; the Nuclear Regulatory Commission. Currently the Data Dictionary contains only database table names, descriptions of the database tables and data types, data lengths and key information. The criteria listed for the required information to be provided was evaluated with the Software Verification and Validation Plan – Volume I, section 4 Design Specification, Document ID: INL/EXT-05-00821 for SAPHIRE 8. IV&V passed this criterion based on "*the Data Dictionary has been developed*". It is the recommended by IV&V that the Data Dictionary also contain items computed in the code, what they are and what they do. Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Design and Interface Design Revision 1 Document ID: INL/EXT-09-17069.

The System Test Plan Document ID: INL/EXT-09-16455 for SAPHIRE 8 is intended to identify the items to be tested, the requirements being tested, the testing to be performed, test schedules, personnel requirements, reporting requirements, evaluation criteria, and any risks requiring contingency planning and to meet the contractual commitments prepared by the sponsor; the

Nuclear Regulatory Commission. Of the three criteria listed for the required information to be provided within the SAPHIRE 8 System Test Plan all criteria were satisfied.

The Software Acceptance Test Plan Document ID: INL/EXT-09-16236 for SAPHIRE 8 is intended to ensure the SAPHIRE software product testing activities and reporting results in accordance with an approved test plan satisfies the specified requirements and to meet the contractual commitments prepared by the sponsor; the Nuclear Regulatory Commission. Of the seventeen criteria listed for the required information to be provided within the SAPHIRE 8 Software Acceptance Test Plan all criteria were satisfied. Minor corrections for the SAPHIRE 8 Software Acceptance Test Plan are provided in the Independent Verification and Validation Of SAPHIRE 8 Software Acceptance Test Plan Revision 0 Document ID: INL/EXT-10-18081.

The Volume 3 Users' Guide for SAPHIRE 8 is intended to provide readability and effectiveness to end users, and to meet the contractual commitments prepared by the sponsor; the Nuclear Regulatory Commission. Of the five criteria listed for the required information to be provided within the Volume 3 Users' Guide for SAPHIRE 8 three failed. Refer to the Independent Verification and Validation Of SAPHIRE 8 Volume 3 Users' Guide Revision 0 Document ID: INL/EXT-10-18028.

Code Walkthroughs are intended to verify that various naming and coding conventions documented in the Software Verification and Validation Plan – Volume II Appendix C Coding Standards, Document ID: INL/EXT-05-00821 for SAPHIRE 8 are being implemented. Common mistakes are in headers, commenting, indenting, and some use of the "with" statements. Suggestions for the checklist used for the code walkthroughs and the coding standard are pending.

6.0 Summary of Recommendations

The Software Project Plan Document ID: INL/EXT-09-15853 for SAPHIRE 8. Of the thirty-eight criteria listed for the required information to be provided within the SAPHIRE 8 Software Project Plan all criteria were satisfied.

Risk management within the Software Project Plan Document ID: INL/EXT-09-15853 for SAPHIRE 8. Of the three criteria listed for the required risk management information to be provided within the SAPHIRE 8 Software Project Plan all criteria were satisfied. It is the recommendation of IV&V that a Risk Management and Risk Mitigation plan be developed for the SAPHIRE 8 software development. NUREG/BR-0167 Software Quality Assurance Program and Guidelines section 5.8 Risk Management bullet 1 specifies "*The following activities are typical of a risk management program: Identify, assess, document, and rank technical, cost, resource, and schedule risks*".

The Software Quality Assurance Plan Document ID: INL/EXT-09-16697 for SAPHIRE 8. Of the criteria listed for the required information to be provided within the SAPHIRE 8 Software Quality Assurance Plan all criteria were satisfied.

The Software Configuration Management Plan Document ID: INL/EXT-09-16696 for SAPHIRE 8. Of the twelve criteria listed for the required information to be provided within the SAPHIRE 8 Software Configuration Management Plan all criteria were satisfied. IV&V recommends referring to NUREG-BR-0167 Software Quality Assurance Program and Guidelines, section 6.2 Baselines for reference to all required information to be included in baselines. Section 1.3 does not specifically address the items included in the baselines; referring to NUREG-BR-0167 Software Quality Assurance Program and Guidelines, section 6.3 Change Control for reference to all required information to be included in the change control procedure; referring to NUREG-BR-0167 Software Quality Assurance Program and Guidelines, section 6.6 Software, Access, and Media Control for reference to all required information to be included in the software, access, and media control procedure.

The Software Verification and Validation Plan – Volume I, section 2 Software Requirements and section 3 Interface Requirements Specification, Document ID: INL/EXT-05-00821 for SAPHIRE 8. Of the 21 criteria listed for the required information to be provided within section 2 Software Requirements and section 3 Interface Requirements Specification 6 failed. Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Requirements Revision 1 Document ID: INL/EXT-09-16789 for the specific parts of the NUREG/BR-0167 Software Quality Assurance Program and Guidelines requirements the SAPHIRE 8 Software Verification and Validation Plan – Volume I sections 2 and 3 failed to satisfy and minor corrections for the Software Verification and Validation Plan – Volume I sections 2 Software Requirements and 3 Interface Requirements Specification.

The Software Verification and Validation Plan – Volume I, section 4 Design Specification, Document ID: INL/EXT-05-00821 for SAPHIRE 8. Of the 15 criteria listed for the required information to be provided within section 4 Design Specification 4 failed. Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Design and Interface Design Revision 1 Document ID: INL/EXT-09-17069 for the specific parts of the NUREG/BR-0167 Software Quality Assurance Program and Guidelines requirements the SAPHIRE 8 Software Verification and Validation Plan – Volume I section 4 Design Specification failed to satisfy and minor corrections for the Software Verification and Validation Plan – Volume I section 4 Design Specification.

The Software Verification and Validation Plan – Volume II, Document ID: INL/EXT-05-00821 for SAPHIRE 8. Of the criteria listed for the required information to be provided within the Software Verification and Validation Plan – Volume II all criteria were satisfied. Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Design and Interface Design Revision 1 Document ID: INL/EXT-09-17069 for minor corrections for the Software Verification and Validation Plan – Volume II.

The Requirements Traceability Matrix for SAPHIRE 8. Of the criteria listed for the required information to be provided within the Requirements Traceability Matrix most failed. Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Requirements Revision 1 Document ID: INL/EXT-09-16789 and the Independent Verification and Validation Of SAPHIRE 8 Software Design and Interface Design Revision 1 Document ID: INL/EXT-09-17069 for the specific parts of the NUREG/BR-0167 Software Quality Assurance Program and Guidelines requirements the SAPHIRE 8 Requirements Traceability Matrix failed to satisfy and minor corrections for the Requirements Traceability Matrix.

The Data Dictionary, file "saphire-data-dictionary.html" for SAPHIRE 8. The criteria listed for the required information to be provided was evaluated with the Software Verification and Validation Plan – Volume I, section 4 Design Specification, Document ID: INL/EXT-05-00821 for SAPHIRE 8. IV&V passed this criterion based on "*the Data Dictionary has been developed*". It is the recommended by IV&V that the Data Dictionary also contain items computed in the code, what they are and what they do. Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Design and Interface Design Revision 1 Document ID: INL/EXT-09-17069.

The System Test Plan Document ID: INL/EXT-09-16455 for SAPHIRE 8. Of the three criteria listed for the required information to be provided within the SAPHIRE 8 System Test Plan all criteria were satisfied.

The Software Acceptance Test Plan Document ID: INL/EXT-09-16236 for SAPHIRE 8. Of the seventeen criteria listed for the required information to be provided within the SAPHIRE 8 Software Acceptance Test Plan all criteria were satisfied. Minor corrections for the SAPHIRE 8 Software Acceptance Test Plan are provided in the Independent Verification and Validation Of SAPHIRE 8 Software Acceptance Test Plan Revision 0 Document ID: INL/EXT-10-18081.

The Volume 3 Users' Guide for SAPHIRE 8. Of the five criteria listed for the required information to be provided within the Volume 3 Users' Guide for SAPHIRE 8 three failed. Refer to the Independent Verification and Validation Of SAPHIRE 8 Volume 3 Users' Guide Revision 0 Document ID: INL/EXT-10-18028 for the specific parts of the NUREG/BR-0167 Software Quality Assurance Program and Guidelines requirements the Volume 3 Users' Guide for SAPHIRE 8 failed to satisfy and minor corrections for the Volume 3 Users' Guide for SAPHIRE 8.

The Software Verification and Validation Plan – Volume II Appendix C Coding Standards, Document ID: INL/EXT-05-00821 for SAPHIRE 8. Suggestions for the checklist used for the code walkthroughs and the coding standard are currently being implemented.

7.0 Summary of Best Practices

- The SAPHIRE team is improving the software development process by conducting Independent Verification and Validation activities.
- The SAPHIRE Independent Verification and Validation activities are being conducted by a team that is both technically and managerially separate from the organization responsible for developing the product.
- The SAPHIRE product is implementing and following the requirements for Level 1 software defined in Section 1.2 of NUREG/BR-0167 Software Quality Assurance Program and Guidelines.
- The NRC will perform an audit of the software Quality Assurance implementation once a year against the requirements of NUREG/BR-0167 Software Quality Assurance Program and Guidelines.
- SAPHIRE configuration management for version control, source code and documentation uses the Revision Control System (RCS).
- The organization, tasks, roles and responsibilities within the SAPHIRE team are defined.
- Peer reviews and Code Walkthroughs are being implemented.
- SAPHIRE has a defined quality assessment and improvement approach.

8.0 Summary of Lessons Learned

- Ensure that all software requirements are documented.
- Ensure that all software requirements are uniquely defined as functional, performance, design constraints, attributes and external interface.
- Ensure that all software requirements are testable. If a software requirement is not testable, then it is not a software requirement.
- Conduct the Software Requirements Review at the end of the requirements definition to assure the intent, completeness, verifiability, consistency and technical feasibility of the requirements.
- Ensure that all software design components are documented.
- Ensure that all software design components are uniquely defined.
- Conduct the Preliminary Design Review when the preliminary design has been designed.
- Conduct the Critical Design Review when the design is complete.
- Ensure that the Requirements Traceability Matrix shows all software requirements are mapped to design components and test cases.
- Conduct formal peer inspections in order to find errors.
- Ensure that documentation is maintained.

Attachment 1: List of Personnel Contacted

- Curtis L. Smith, INL Project Manager
- Kurt G. Vedros, Software Quality Assurance
- S. Ted Wood, SAPHIRE 8 Support Manager

Attachment 2: List of Documents Reviewed

- Nuclear Regulatory Form 189, Job Code Y6394, Revision 07, 06/28/04
- Nuclear Regulatory Form 189, Job Code Y6394, Revision 10, 06/08/05
- Nuclear Regulatory Form 189, Job Code Y6394, Revision 11, 06/08/05
- Nuclear Regulatory Form 189, Job Code N6423, Revision 00, 05/21/07
- Nuclear Regulatory Form 189, Job Code N6203, Revision 03, 06/01/07
- Nuclear Regulatory Form 189, Job Code N6423, Revision 05, 04/20/09
- saphire-data-dictionary.html – SAPHIRE 8 Data Dictionary
- SAPHIRE 8 – Requirements Traceability Matrix 21Jan10.xlsx
- SAPHIRE 8 – Requirements Traceability Matrix 01Feb10.xlsx
- SAPHIRE 8 – Requirements Traceability Matrix 24Feb10.xlsx
- SAPHIRE 8 – Requirements Traceability Matrix 25Feb10.xlsx
- SAPHIRE 8 – Requirements Traceability Matrix 03Mar10.xlsx
- SAPHIRE Version 8 Software Verification and Validation Plan – Volume I, Revision ID: 03, Document ID: INL/EXT-05-00821
- SAPHIRE Version 8 Software Verification and Validation Plan – Volume I, Revision ID: 05, Document ID: INL/EXT-05-00821
- SAPHIRE Version 8 Software Verification and Validation Plan – Volume II, Revision ID: 03, Document ID: INL/EXT-05-00821
- SAPHIRE Version 8 Software Verification and Validation Plan – Volume II, Revision ID: 05, Document ID: INL/EXT-05-00821
- Software Acceptance Test Plan for SAPHIRE Version 8, Revision ID: 04, Project Number N6423, Document ID: INL/EXT-09-16236
- Software Acceptance Test Plan for SAPHIRE Version 8, Revision ID: 05, Project Number N6423, Document ID: INL/EXT-09-16236
- Software Configuration Management Plan for SAPHIRE Version 8, Revision ID: 00, Project Number N6423, Document ID: INL/EXT-09-16696
- Software Configuration Management Plan for SAPHIRE Version 8, Revision ID: 01, Project Number N6423, Document ID: INL/EXT-09-16696
- Software Project Plan for SAPHIRE Version 8, Revision ID: 01, Project Number N6423, Document ID: INL/EXT-09-15853
- Software Project Plan for SAPHIRE Version 8, Revision ID: 02, Project Number N6423, Document ID: INL/EXT-09-15853
- Software Project Plan for SAPHIRE Version 8, Revision ID: 03, Project Number N6423, Document ID: INL/EXT-09-15853
- Software Project Plan for SAPHIRE Version 8, Revision ID: 04, Project Number N6423, Document ID: INL/EXT-09-15853
- Software Quality Assurance Plan for SAPHIRE Version 8, Revision ID: 00, Project Number N6423, Document ID: INL/EXT-09-16697
- Software Quality Assurance Plan for SAPHIRE Version 8, Revision ID: 01, Project Number N6423, Document ID: INL/EXT-09-16697
- System Test Plan for SAPHIRE Version 8, Revision ID: 02, Project Number N6423, Document ID: INL/EXT-09-16455
- Volume 3 Users' Guide for SAPHIRE Version 8 - DRAFT

Attachment 3: List of Software Test Tools and Tool Descriptions

- *CodeHealer for Delphi* © Version 2.5.0 – CodeHealer is an efficient, powerful and easy to use program source code analysis and verification tool that will help find and fix a significant number of programming bugs, mistakes and inconsistencies in programs before they are released. The information provided by CodeHealer will also help developers understand and improve existing code that they have not written.
- *Coverage Validator* © Version 4.10 – Coverage Validator automatically detects which lines of your program have been executed, provides visit counts for each line and calculates visit percentages for files that are visited. Coverage Validator can also be used for unit testing and as part of a regression testing strategy used by Quality Assurance teams.
- *Memory Validator* © Version 4.86 – Memory Validator detects memory leaks, handle leaks, memory corruptions, uninitialized memory, buffer over runs and buffer under runs. Memory Validator can also be used to detect performance problems related to memory and resource allocation and deallocation, and performance problems related to fragmented memory heaps.
- *Performance Validator* © Version 2.63 – Performance Validator automatically calculated performance data for your application as it executes. Performance Validator can also be used for unit testing and as part of a regression testing strategy used by Quality Assurance teams.
- *Thread Validator* Version 1.52 – Thread Validator detects deadlocks, potential deadlocks, bad lock strategies, and performs deadlock postmortem analysis.

Attachment 4: Detailed Findings and Recommendations Tables

Table 4-1 Software Project Plan

Software Project Plan			
Criteria	**Source**	**Findings**	**Recommendations**
Has the developer created a software Project Plan?	NUREG/BR-0167 Section 4.2 and 5.2.4	**Revision 0 IV&V Review** The project plan has been developed and assigned Document ID: INL/EXT-09-15853.	**Revision 0 IV&V Review** An effective date should not be assigned until approval from the Project Sponsor, Project Manager, and Department Manager has been obtained. Please modify the plan to have an effective date of TBD. Once all approvals have been made, then an effective date can be assigned with a date AFTER the last signature date on the signature page.
		Revision 1 IV&V Review The Software Project Plan has been developed and details how the developer will manage the SAPHIRE 8 software project. The Software Project Plan is assigned Document ID: INL/EXT-09-15853. The Software Project Plan includes the table of contents suggested by NUREG/BR-0167. Once all approvals have been made, then an effective date can be assigned with a date AFTER the last signature date on the signature page.	**Revision 1 IV&V Review** None.
		Revision 2 IV&V Review Criteria satisfied.	**Revision 2 IV&V Review** None.
Does the Project Plan provide project background and objectives?	NUREG/BR-0167 Section 5.2.4	**Revision 0 IV&V Review** The plan provides an excellent background and includes objectives for the forthcoming version (SAPHIRE 8). IV&V recognizes that development began prior to the issue of the project plan and therefore, accepts activities that have already been completed although this is a plan for what will be done.	**Revision 0 IV&V Review** None.
		Revision 1 IV&V Review Section 1.1 of the Software Project Plan provides the Project Background and Objectives for SAPHIRE 8. The plan provides an excellent background and includes objectives for the forthcoming version (SAPHIRE 8). IV&V recognizes that development began prior to the issue of the project plan and therefore, accepts	**Revision 1 IV&V Review** Minor EDITORIAL comments: Paragraph 1 uses the acronym “INL” for the first time. IV&V suggests providing the definition in front of the acronym and then enclosing the acronym in parentheses (INL). Paragraph 5 uses the acronym “SPAR” for the first time. IV&V suggests providing the definition in front of the acronym and then enclosing the acronym in parentheses (SPAR).

Software Project Plan			
Criteria	**Source**	**Findings**	**Recommendations**
		activities that have already been completed although this is a plan for what will be done.	
		Revision 2 IV&V Review Criteria satisfied.	**Revision 2 IV&V Review** None.
Does the Project Plan address plan scope and organization?	NUREG/BR-0167 Section 5.2.4	**Revision 0 IV&V Review** Section 1.2 of the Project Plan provides the Project Scope and Organization for SAPHIRE 8. The author of this section should be commended on the extent of the process for the review implemented regarding DOE O 414.1C, 10 CFR 830 Subpart A, 10 CFR 835, the DEAR Integrated Safety Management System (DEAR clause), NQA-1, and the process used to determine the INL Software Quality Level/Analysis.	**Revision 0 IV&V Review** However, IV&V has a couple of questions. Discussion regarding the effective date of the INL SQA Program. The plan states "When the revised INL SQA Program **becomes effective (3/29/2007)**." The wording is confusing. Should it be became effective? Minor EDITORIAL comment: The last sentence of section 1.2 states that the NRC will perform an audit of the software QA implementation "one a year". I believe this should be "once a year".
		Revision 1 IV&V Review Section 1.2 of the Software Project Plan provides the Project Scope and Organization for SAPHIRE 8. The author of this section should be commended on the extent of the process for the review implemented regarding DOE O 414.1C, 10 CFR 830 Subpart A, 10 CFR 835, the DEAR Integrated Safety Management System (DEAR clause), NQA-1, and the process used to determine the INL Software Quality Level/Analysis.	**Revision 1 IV&V Review** Minor EDITORIAL comments: Paragraph 6 refers to "10 CFR 830 Subpart A, Nuclear Safety Management", 10 CFR 830 Subpart A is "Quality Assurance Requirements". Paragraph 8 starts "Per LWP-13610". I believe this should be "PDD-13610". Paragraph 19 uses the acronym "RES" for the first time. IV&V suggests providing the definition in front of the acronym and then enclosing the acronym in parentheses (RES).
		Revision 2 IV&V Review Criteria satisfied.	**Revision 2 IV&V Review** None.
Does the Project Plan address plan maintenance (i.e., Project Plan updates)?	NUREG/BR-0167 Section 5.2.4	**Revision 0 IV&V Review** The Plan Maintenance is identified in section 1.3 of the plan. This section states that the plan is updated as required by the NRC Project Management. Section 5.2.4 states that consideration should require the developer to modify the plan and submitted with the monthly progress reports.	**Revision 0 IV&V Review** IV&V's concern is that the NRC Project Management will not be aware of modifications that the INL has found that reflect a need for a change to the plan unless the NRC Project Management obtains an updated copy with the monthly status reports. Please consider adding (or replacing) a statement that indicates that updates will be provided to the NRC Project Management for approval in the monthly status reports, as needed.
		Revision 1 IV&V Review Section 1.3 of the Software Project Plan provides the Plan Maintenance for SAPHIRE 8. This section states "*The SPP will be updated as needed as required by the NRC Project Management*". Section 5.2.4 The Software Project Plan of NUREG/BR-0167 paragraph 2 states "*Because the*	**Revision 1 IV&V Review** IV&V's concern is that the NRC Project Management will not be aware of modifications that the INL has found that reflect a need for a change to the plan unless the NRC Project Management obtains an updated copy with the monthly status reports. Please consider adding (or replacing) a statement that indicates that updates will be

Software Project Plan			
Criteria	**Source**	**Findings**	**Recommendations**
		plan should be kept up to date, consider requiring the developer to submit any changes to the plan with the monthly progress reports".	provided to the NRC Project Management for approval in the monthly status reports, as needed.
		Revision 2 IV&V Review Criteria satisfied.	**Revision 2 IV&V Review** None.
Has the Project Plan been approved by the NRC sponsor?	NUREG/BR-0167 Section 5.2.4	**Revision 0 IV&V Review** The Project Plan states", The signed NRC Form 173 authorizes the transfer of funds from the NRC to DOE-ID and serves as the official authorization to commence work…". This approves the funding authorization, not the approval of the Project Plan.	**Revision 0 IV&V Review** It is recommended that a signature page containing the sponsor approval signature as well as the INL project manager and INL Department Manager be included in the document. This is required by the INL PEP format.
		Revision 1 IV&V Review The Software Project Plan Section 2.1 Planning Approach last paragraph states, "*The signed NRC Form 173 authorizes the transfer of funds from the NRC to DOE-ID and serves as the official authorization to commence work…*". This approves the funding authorization, not the approval of the Project Plan. The Software Project Plan as of this review has not been approved by the NRC sponsor.	**Revision 1 IV&V Review** None.
		Revision 2 IV&V Review The Software Project Plan has been approved by the NRC sponsor. Signature date of 2/25/10. Criteria satisfied.	**Revision 2 IV&V Review** None.
Does the Project Plan describe the approach used to plan the project?	NUREG/BR-0167 Section 5.2.4.1	**Revision 0 IV&V Review** Section 2.1 of the Project Plan provides the information required by Section 5.2.4.1 of the NUREG.	**Revision 0 IV&V Review** None.
		Revision 1 IV&V Review Section 2.1 Planning Approach of the Software Project Plan provides the information required by Section 5.2.4.1 of the NUREG.	**Revision 1 IV&V Review** Minor EDITORIAL comments: Section 2.1 Planning Approach first paragraph uses the acronym "OCOI" for the first time. IV&V suggests providing the definition in front of the acronym and then enclosing the acronym in parentheses (OCOI). Section 2.1 Planning Approach, and various other sections, uses the acronyms "PCFS" and "PFCS". IV&V suggests clarification on the acronym and providing the definition in front of the first occurrence of the acronym and then enclosing the acronym in parentheses.
		Revision 2 IV&V Review Criteria satisfied.	**Revision 2 IV&V Review** None.

Software Project Plan			
Criteria	**Source**	**Findings**	**Recommendations**
Does the Project Plan describe the approach used to track technical progress?	NUREG/BR-0167 Section 5.2.4.2	**Revision 0 IV&V Review** Sections 2.1, 2.2, and 2.3 of the Project Plan provide the information required by Section 5.2.4.2 of the NUREG.	**Revision 0 IV&V Review** None.
		Revision 1 IV&V Review Sections 1.2 Project Scope and Organization, 1.5 Security, 2.1 Planning Approach, 2.2 Risk Management, 2.3 Tracking and Oversight Approach, 2.5 Scheduling, 3.1 Implementing the Life cycle Tasks of the Statement of Work and 3.6 Use of Project Metrics of the Software Project Plan provide the information required by Section 5.2.4.2 of the NUREG.	**Revision 1 IV&V Review** Minor EDITORIAL comments: Section 2.2 Risk Management uses the acronym RCS for the first time. IV&V suggests providing the definition in front of the acronym and then enclosing the acronym in parentheses (RCS).
		Revision 2 IV&V Review Criteria satisfied.	**Revision 2 IV&V Review** None.
Does the Project Plan describe the approach used to track conformance to the planned schedule?	NUREG/BR-0167 Section 5.2.4.2	**Revision 0 IV&V Review** Sections 2.1, 2.2, and 2.3 of the Project Plan provide the information required by Section 5.2.4.2 of the NUREG.	**Revision 0 IV&V Review** None.
		Revision 1 IV&V Review Sections 1.4 Schedule, 2.1 Planning Approach, 2.3 Tracking and Oversight Approach and 2.5 Scheduling of the Software Project Plan provides the information required by Section 5.2.4.2 of the NUREG.	**Revision 1 IV&V Review** None.
		Revision 2 IV&V Review Criteria satisfied.	**Revision 2 IV&V Review** None.
Does the Project Plan describe the approach used to track costs as related to actual work performed?	NUREG/BR-0167 Section 5.2.4.2	**Revision 0 IV&V Review** Sections 2.1, 2.2, and 2.3 of the Project Plan provide the information required by Section 5.2.4.2 of the NUREG.	**Revision 0 IV&V Review** None.
		Revision 1 IV&V Review Sections 2.1 Planning Approach, 2.3 Tracking and Oversight Approach, 2.6 Resources and 3.6 Use of Project Metrics of the Software Project Plan provides the information required by Section 5.2.4.2 of the NUREG.	**Revision 1 IV&V Review** None.
		Revision 2 IV&V Review Criteria satisfied.	**Revision 2 IV&V Review** None.
Does the Project Plan describe the approach used to track metrics?	NUREG/BR-0167 Section 5.2.4.2	**Revision 0 IV&V Review** The plan discusses metrics in only one location – a section regarding the Integrity Level on page 36.	**Revision 0 IV&V Review** IV&V believes that metrics are not only performed routinely, and metrics can be established per the

Software Project Plan			
Criteria	**Source**	**Findings**	**Recommendations**
		It states, "Furthermore, no metrics to support an IEEE-1012 classification higher than a "1" currently exist." The NUREG requires that metrics be part of the Tracking and Oversight function in Section 5.2.4.	requirements of the NUREG. For example, Earned Value can be used as a "routine" metric to track cost and schedule variances. Another metric can be used to obtain a percentage of anomalies (errors) discovered by developers as opposed to those errors discovered by IV&V. A recent example of the "error tracking" metric is the errors discovered by IV&V while evaluating the Significance Determination Process (SDP). However, to enable this metric, the development team must track coding errors (for example) that can be used for comparisons. McCabe's complexity measure is another useful metric that can be applied to modules (objects) within the code. This metric should not exceed a value of 10 but IV&V has identified several modules with complexity measures greater than 50. High complexity measures indicate the potential difficulty to perform code maintenance and hence, difficult to understand without comments in the code. As such, IV&V does not believe the code is "self documenting" as stated by the development team. Therefore, an additional metric would be (and should be) the number of comments per 100 lines of code, for example.
		Revision 1 IV&V Review Section 3.6 Use of Project Metrics of the Software Project Plan provides the information required by Section 5.2.4.2 of the NUREG.	**Revision 1 IV&V Review** None.
		Revision 2 IV&V Review Criteria satisfied.	**Revision 2 IV&V Review** None.
Does the Project Plan describe the approach used to track security?	NUREG/BR-0167 Section 5.2.4.2	**Revision 0 IV&V Review** IV&V could find one instance in which security was addressed – in the table for IEEE definitions of consequences.	**Revision 0 IV&V Review** If security has been determined to as not applicable for this software, please provide a statement in the document as well as a defensible reason why security should not be discussed.
		Revision 1 IV&V Review Section 1.5 Security of the Software Project Plan provides the information required by Section 5.2.4.2 of the NUREG.	**Revision 1 IV&V Review** None.
		Revision 2 IV&V Review Criteria satisfied.	**Revision 2 IV&V Review** None.
Does the Project Plan describe the approach to track risk?	NUREG/BR-0167 Section 5.2.4.2	**Revision 0 IV&V Review** IV&V is aware that a Risk Assessment for the software (INL's PREPS requirement) was performed but no evidence could be found	**Revision 0 IV&V Review** No evidence could be found regarding this requirement in the Project Plan.

Software Project Plan			
Criteria	**Source**	**Findings**	**Recommendations**
		regarding this requirement could be found in the Project Plan.	
		Revision 1 IV&V Review Section 2.2 Risk Management of the Software Project Plan provides the information required by Section 5.2.4.2 of the NUREG.	**Revision 1 IV&V Review** None.
		Revision 2 IV&V Review Criteria satisfied.	**Revision 2 IV&V Review** None.
Does the Project Plan address the organization, tasks, and responsibilities (i.e., Show how the tasks in the SOW are assigned to responsible elements of the project organization?	NUREG/BR-0167 Section 5.2.4.3	**Revision 0 IV&V Review** Section 2.3 of the plan provides a discussion of the Organization, Tasks, and Responsibilities. There is a discussion indicating that the PI "makes all technical and administrative work assignments". It is assumed that the PI makes these assignments based upon the requirements in the SOW and Requirements Specification. Therefore, IV&V will Pass this requirement at this time.	**Revision 0 IV&V Review** Code walkthroughs and Peer Reviews would assist in making this determination apparent but IV&V has not identified evidence that these requirements/reviews have been performed (they are not under Configuration Control). IV&V has been directed to attend these reviews but it does not appear that these reviews are being performed.
		Revision 1 IV&V Review Section 2.4 Organization, Tasks, and Responsibilities of the Software Project Plan provides a discussion of the Organization, Tasks, and Responsibilities. There is a discussion indicating that the PI "makes all technical and administrative work assignments". It is assumed that the PI makes these assignments based upon the requirements in the SOW and Requirements Specification. Therefore, IV&V will Pass this requirement at this time.	**Revision 1 IV&V Review** Code walkthroughs and Peer Reviews would assist in making this determination apparent but IV&V has not identified evidence that these requirements/reviews have been performed (they are not under Configuration Control). IV&V has been directed to attend these reviews but it does not appear that these reviews are being performed.
		Revision 2 IV&V Review Criteria satisfied.	**Revision 2 IV&V Review** None.
Does the Project Plan provide the initial, top-level project schedule and the rationale for arriving at this schedule?	NUREG/BR-0167 Section 5.2.4.4	**Revision 0 IV&V Review** A high level schedule is provided in Section 2.4 of the plan. It provides the schedule for the Beta release dates and final version release date.	**Revision 0 IV&V Review** None.
		Revision 1 IV&V Review A high level schedule is provided in Section 2.5 Scheduling of the Software Project Plan. It provides the schedule for the Beta release dates and final version release date.	**Revision 1 IV&V Review** None.
		Revision 2 IV&V Review Criteria satisfied.	**Revision 2 IV&V Review** None.
Does the Project Plan	NUREG/BR-0167	**Revision 0 IV&V Review**	**Revision 0 IV&V Review**

Software Project Plan			
Criteria	**Source**	**Findings**	**Recommendations**
identify project resources including staffing, software engineering environment, and support tools?	Section 5.2.4.5	Section 2.5 of the plan provides an excellent breakout of the various project resources, including processes for status reporting of funding, Estimate at Completion, responsibilities of higher level management, software engineering requirements for staff and PIs, overall staffing levels and team resumes. It also includes the process for obtaining subcontractors, if needed.	None.
		Revision 1 IV&V Review Section 2.6 Resources of the Software Project Plan provides an excellent breakout of the various project resources; including processes for status reporting of funding, Estimate at Completion, responsibilities of higher level management, software engineering requirements for staff and PIs, overall staffing levels and team resumes. It also includes the process for obtaining subcontractors, if needed.	**Revision 1 IV&V Review** None.
		Revision 2 IV&V Review Criteria satisfied.	**Revision 2 IV&V Review** None.
Does the Project Plan address Configuration Management, specifically, project baselines, change control, baseline status, proposed changes, implemented changes, software development library, documentation and code and does it address the establishment of a change control board to review and approve (or disapprove) recommended changes? Has the Change Control Process/Procedure been finalized? Does the Project Plan address Configuration Management,	NUREG/BR-0167 Section 5.2.4.6 – Software Best Practices	**Revision 0 IV&V Review** Configuration Management and Change Control processes are described in detail in Section 2.6 of the plan. The plan states that for each formal release (does this include Beta releases?) an acceptance test is performed using an automated test suite. IV&V is required to review the acceptance testing process per NRC direction. IV&V has not been notified of any test activities (since development has started prior to IV&V assignment). In addition, section 2.6 states, "Quality assurance reviews configuration management and control processes to ensure that only authorized changes are made to the software. All software modules that have been tested, documented, and approved for inclusion into the next release of the software are baselined."	**Revision 0 IV&V Review** IV&V must be involved with the SQA reviews of configuration management and control processes. (Due to the loss of two personnel, IV&V may need to assume some of the SQA responsibilities). As of this review of this plan, a Configuration Control Plan has not been reviewed by IV&V and therefore, cannot be approved. Finally, since development has started and beta release(s) have been issued, IV&V should have reviewed (and the plan stating that IV&V will review) testing, documentation, etc. prior to release and baseline. There is no mention in the plan regarding a change control board and as such, the role (charter) of a change control board. Version control is not sufficient as a substitute for a change control board. Refer to the SAPHIRE 8 Software Independent Verification and Validation Plan Document ID: INL/EXT-09-15649 for the substitution of Peer Review in place of Configuration Control Board (CCB).
		Revision 1 IV&V Review Section 2.7 Configuration Management of the Software Project Plan provides the information required by Section 5.2.4.6 of the NUREG.	**Revision 1 IV&V Review** Minor EDITORIAL comment: Paragraph 8, the sentence "Prior to check-in, programmers must explain…". IV&V suggest changing "explain" to "document" to be consistent

Software Project Plan			
Criteria	**Source**	**Findings**	**Recommendations**
specifically, project baselines, change control, baseline status, proposed changes, implemented changes, software development library, and documentation and code? Has the Change Control Process/Procedure been identified?		Configuration Management and Change Control processes are described in detail in Section 2.7 of the plan.	with the sentence in paragraph 5 "Prior to check-in, programmers must document…".
		Revision 2 IV&V Review Criteria satisfied.	**Revision 2 IV&V Review** None.
Does the Project Plan describe how each major life-cycle task of the SOW work will be implemented?	NUREG/BR-0167 Section 5.2.4	**Revision 0 IV&V Review** The SAPHIRE team has developed an internal Work Development Plan and is provided in Appendix A of the Project Plan. The Work Development provides an excellent description of the tasks and subtask breakdown, and an estimated level-of-effort. Section 3.1 of the plan states, "an extensive discussion of the Software Requirement[s] have been specified in the … SVVP document" which was developed by SQA prior to IV&V involvement. IV&V is reviewing the Form 189s, SOW, and SVVP to evaluate the RTM. The RTM has failed to map requirements to design components to test cases, etc. It has major problems. A separate IV&V report will be issued that includes the evaluation of the RTM issues. Section 3.2 of the project plan also discusses the SVVP and how it will ensure that ALL requirements are implemented and that it is a consolidated document used for tracking software development, testing, and implementation. The Project Plan does a good job in identifying how the SVVP should be used, however.	**Revision 0 IV&V Review** A separate IV&V report will be issued that includes the evaluation of the RTM issues.
		Revision 1 IV&V Review Sections 3.1 Implementing the Life Cycle Tasks of the Statement of Work, 3.2 Verification and Validation Approach and Appendix A SAPHIRE 8 Work Development Plan provides the information required by Section 5.2.4 of the NUREG. Section 3.1 of the plan states, "an extensive discussion of the Software Requirement[s] have been specified in the … SVVP document" which was developed	**Revision 1 IV&V Review** None.

Software Project Plan			
Criteria	**Source**	**Findings**	**Recommendations**
		by SQA prior to IV&V involvement. Section 3.2 of the project plan also discusses the SVVP and how it will ensure that ALL requirements are implemented and that it is a consolidated document used for tracking software development, testing, and implementation. The Project Plan does a good job in identifying how the SVVP should be used. The SAPHIRE team has developed an internal Work Development Plan and is provided in Appendix A of the Project Plan. The Work Development provides an excellent description of the tasks and subtask breakdown, and an estimated level-of-effort.	
		Revision 2 IV&V Review Criteria satisfied.	**Revision 2 IV&V Review** None.
Does the Project Plan describe the nonconformance reporting and corrective action process, including nonconformance detection and reporting, impact assessment and corrective action and tracking, and tracking and management reports?	NUREG/BR-0167 Section 5.2.4	**Revision 0 IV&V Review** Nonconformance Reporting and Corrective Action is identified in Section 3.3 of the Project Plan. Details are defined in the second paragraph.	**Revision 0 IV&V Review** IV&V's only concern is the issue regarding what will be done vs. what has been done. For example, the first sentence of the second paragraph states "…corrective actions **should be** reported to the NRC". Instead of should be, it should state **will be**. Please review this paragraph to correct this "editorial" issue.
		Revision 1 IV&V Review Section 3.3 Nonconformance Reporting and Corrective Action of the Software Project Plan provide the information required by Section 5.2.4 of the NUREG.	**Revision 1 IV&V Review** None.
		Revision 2 IV&V Review Criteria satisfied.	**Revision 2 IV&V Review** None.
Does the Project Plan identify all deliverables and the dates they are due?	NUREG/BR-0167 Section 5.2.4	**Revision 0 IV&V Review** The NUREG states "Provide the initial, top-level project schedule and the rationale for arriving at this schedule". Per section 1.4 of the plan, it is stated that each JCN has its own start and end dates on Form 189 and Form 173. No rationale is provided but it is assumed that the rationale is contained in these NRC forms. However, Appendix A, the SAPHIRE 8 Work Development Plan dated almost 2 years ago has 6 subtasks that are described as well as a schedule, level of effort, etc. that has preliminary dates for beta releases. As this is a plan, there is no issue with these dates	**Revision 0 IV&V Review** None.

Software Project Plan			
Criteria	**Source**	**Findings**	**Recommendations**
		as they are expected to change as work progresses and updates to the Project Plan are made.	
		Revision 1 IV&V Review The NUREG states "Provide the initial, top-level project schedule and the rationale for arriving at this schedule". Per section 1.4 Schedule of the plan, it is stated that each JCN has its own start and end dates on Form 189 and Form 173. No rationale is provided but it is assumed that the rationale is contained in these NRC forms. However, Appendix A, the SAPHIRE 8 Work Development Plan dated almost 2 years ago has 6 subtasks that are described as well as a schedule, level of effort, etc. that has preliminary dates for beta releases. As this is a plan, there is no issue with these dates as they are expected to change as work progresses and updates to the Project Plan are made.	**Revision 1 IV&V Review** None.
		Revision 2 IV&V Review Criteria satisfied.	**Revision 2 IV&V Review** None.
Does the Project Plan address standards, procedures, conventions and metrics to be used? This includes product standards, such as documentation standards and coding standards and process standards, including inspection and review procedures.	NUREG/BR-0167 Section 5.2.4 – Software Best Practices	**Revision 0 IV&V Review** Metrics are required by the NUREG and examples of value-added metrics that could (and should) be performed were provided in one of the criteria provided above. However, the development group has provided a link to the CodeGear Object Pascal Style Guide. The only reference IV&V could find in the plan was reviews performed by external (non-INL) entities, i.e., NRC. This is unacceptable.	**Revision 0 IV&V Review** Information regarding the elements of the style guide that will be used should be in the Project Plan to comply with the NUREG. Inspections and review procedures by the developers with the development team and IV&V in attendance must include code walkthroughs and peer reviews.
		Revision 1 IV&V Review Section 1.2 Project Scope and Organization references: NRC Directive 11.7 NRC Procedures for Placement and Monitoring of Work with the Department of Energy. NRC Directive 11.7 establishes a controlled and monitored process for requesting services of a national lab, work planning, work authorization and initiation, work progress monitoring, reporting, work termination and project closeout; DOE Order 414.1C Quality Assurance, 10 CFR 830 Subpart A Quality Assurance Requirements, ASME NQA-1-200 Quality Assurance Requirements for Nuclear	**Revision 1 IV&V Review** None.

Software Project Plan			
Criteria	**Source**	**Findings**	**Recommendations**
		Facility Applications, PDD-13610 Software Quality Assurance Program, LRD-13600 Software Quality Assurance, LWP-13620 Software Quality Assurance for software quality assurance requirements; LWP-4001 Material Acquisitions, LWP-4002 Service Acquisitions, LWP-13014 Determining Quality Levels, LWP-1202 Records Management Plan; NUREG/BR-0167 Software Quality Assurance Program and Guidance. Section 1. Introduction also addresses Plan Maintenance, Schedule and Security. Section 2. Management Approach addresses standards, procedures, and conventions for the Planning Approach, Risk Management, Tracking and Oversight Approach, Organization, Tasks, and Responsibilities, Scheduling, Resources and Configuration Management. Section 3. Technical Approach addresses standards, procedures, and conventions for Implementing the Life Cycle Tasks of the Statement of Work, Verification and Validation Approach, Nonconformance Reporting and Corrective Action, Peer Reviews and Code Walkthroughs, Quality Assessment (QA) and Improvement Approach, Use of Project Metrics and Deliverables. Section 1.5 Security specifies the INL agrees to safeguard information in accordance with 10 Code of Federal Regulations (CFR) 2.790. Section 2.1 Planning Approach specifies overall Project Control and Reporting for NRC work is governed by NRC Directive 11.7. The Program Manager will assure that the NRC Customer Relationship Manager is sufficiently informed of the proposed work to meet the requirements of the NRC OCOI Mitigation Plan. Section 2.2 Risk Management specifies prior to starting the SAPHIRE 8 development project, and INL Proposal Risk and Evaluation Preparation System (PREPS) entry was created. Section 2.3 Tracking and Oversight Approach specifies work scope management is maintained through NRC Directive 11.7 process.	

Software Project Plan			
Criteria	**Source**	**Findings**	**Recommendations**
		Section 2.4 Organization, Tasks, and Responsibilities specifies the graded approach integrates the INL software management processes, standard, and procedures. Section 2.5 Scheduling specifies schedules for development work to be performed are documented in the project NRC Form 189. Section 2.6 Resources specifies all NRC work is under the supervision and direction of the Nuclear Safety and Regulation Division Director who serves as the NRC Customer Relationship Manager. This section also specifies developers of the SAPHIRE team need to be familiar with DELPHI © Version 7 IDE, Modula-2 IDE, DOS batch files and scripting, and use of the Microsoft Windows platforms. Section 2.7 Configuration Management specifies Records Management will be performed for all NRC projects in accordance with LWP-1201 (Document Management), LWP-1202 (Records Management), and the Records Management Plan for Nuclear Programs, PLN-2224. This section also specifies that each formal release of SAPHIRE will have passed an acceptance test described in the Software Acceptance Test Plan (INL/EXT-09-16236). Section 3. Technical Approach addresses Implementing the Life Cycle Tasks of the Statement of Work, Verification and Validation Approach, Nonconformance Reporting and Corrective Action, Peer Reviews and Code Walkthroughs, Quality Assessment (QA) and Improvement Approach, Use of Project Metrics and Deliverables. Section 3.1 Implementing the Life Cycle Tasks of the Statement of Work specifies to assist in managing the technical work, a SAPHIRE specific Work Development Plan has been developed that guides the general aspect of the work. The most current version of the plan is included in Appendix A of the Software Project Plan. This section also specifies that Technical documentation to be published as a NUREG/CR follows guidance in	

Software Project Plan			
Criteria	**Source**	**Findings**	**Recommendations**
		NUREG-0650, Revision 2, Preparing NUREG Series Publications. Section 3.2 Verification and Validation Approach specifies the SAPHIRE product development team uses the SVVP to track, verify and validate requirements to ensure that all requirements are implemented and that all requirements are included in the automated test scripts and test results. Section 3.3 Nonconformance Reporting and Corrective Action specifies project-level nonconformance and associated corrective actions will be reported to the NRC via the MLSR. Section 3.4 Peer Reviews and Code Walkthroughs specifies the team will perform and document, as appropriate, periodic peer reviews and code walkthroughs, including reviews of preliminary and critical designs proposals. This section also specifies the guidance for external peer reviews is found in the NRC's office instruction, PRM-10, Revision 0, Peer Review of RES Projects, dated March 19, 2007. Section 3.5 Quality Assessment (QA) and Improvement Approach specifies each JCN will have a quality level determination made by a Quality Level Analyst in accordance with LWP-13014 and documented on INL Form 414.A89. Section 3.7 Deliverables specifies software releases are managed via the SAPHIRE Release Management process. Section 3.7 also specifies project closure will be accomplished in accordance with NRC Directive 11.7.	
		Revision 2 IV&V Review Criteria satisfied.	**Revision 2 IV&V Review** None.
Does the Software Project Plan provide information on tracking and oversight?	NUREG/BR-0167 Figure 5-1 and Section 5.3	**Revision 0 IV&V Review** Tracking and Oversight is discussed in Section 2.2 of the Plan.	**Revision 0 IV&V Review** Details pertaining to the compliance requirements are provided in evaluation criteria provided below.
		Revision 1 IV&V Review Section 2.3 Tracking and Oversight Approach of the Software Project Plan provide the information required by NUREG.	**Revision 1 IV&V Review** None.
		Revision 2 IV&V Review Criteria satisfied.	**Revision 2 IV&V Review** None.

Software Project Plan			
Criteria	**Source**	**Findings**	**Recommendations**
Does the schedule include milestones for life-cycle reviews, such as requirements reviews, preliminary design reviews, and critical design reviews for IV&V review?	NUREG/BR-0167 Section 3.	**Revision 0 IV&V Review** Life cycle reviews, PDRs, CDRs, and Test Readiness Reviews are required by the NUREG. Internal INL procedures (LWP-13620) referenced for QL-3 software do not require these types of reviews. It is IV&V's understanding that a NUREG "rule" supersedes any procedure "Order".	**Revision 0 IV&V Review** IV&V agrees that if requirements and processes not specifically addressed by the NRC, NUREG procedures should follow the INL processes to ensure product quality and address those items that do not provide direction when they are not found in the NUREG. NUREG/BR-0167 addresses the need for these reviews and therefore must be performed internally. Also, due to the complexity of the migration of the code, these reviews are essential to the quality of the software. It is also IV&V's understanding that reviews are required by the NRC. IV&V also has a commitment to ensure that the quality is built-in to the software and not tested-in as being done primarily by the Beta Testing efforts. IV&V cannot provide assistance and recommendations if these reviews are not performed.
		Revision 1 IV&V Review Section 3.4 Peer Reviews and Code Walkthroughs states "As part of the SAPHIRE 8 development, the team will perform and document, as appropriate, periodic peer reviews and code walkthroughs, including reviews of preliminary and critical designs proposals.", and "Peer reviews and code walkthroughs will be reviewed independently when possible by IV&V members.	**Revision 1 IV&V Review** The guidance for external peer reviews is found in the NRC's office instruction, PRM-10, Revision 0, Peer Review of RES Projects, dated March 19, 2007." Appendix A, Quality Assurance Recommendations of the Software Project Plan b) discuss products associated with each formal review, c) V&V activities to be performed by a functionally independent V&V person and the time frame for performing independent V&V activities. Table 3-2 of NUREG/BR-0167 summarizes the formal major life cycle reviews and audits by major life-cycle activities. IV&V could not determine if milestones for life-cycle reviews exist in the schedules contained within the Software Project Plan.
		Revision 2 IV&V Review Section 3.4 Peer Reviews and Code Walkthroughs states "As part of the SAPHIRE 8 development, the team will perform and document, as appropriate, periodic peer reviews and code walkthroughs, including reviews of preliminary and critical designs proposals.", and "Peer reviews and code walkthroughs will be reviewed independently when possible by IV&V members. The guidance for external peer reviews is found in the NRC's office instruction, PRM-10, Revision 0, Peer Review of RES Projects, dated March 19, 2007." Appendix A, Quality Assurance Recommendations of the Software Project Plan b)	**Revision 2 IV&V Review** None.

Software Project Plan			
Criteria	**Source**	**Findings**	**Recommendations**
		discuss products associated with each formal review, c) V&V activities to be performed by a functionally independent V&V person and the time frame for performing independent V&V activities. Table 3-2 of NUREG/BR-0167 summarizes the formal major life cycle reviews and audits by major life-cycle activities. Section 3.4 Peer Reviews and Code Walkthroughs Table 1 Summary of Major Live Cycle Reviews and Audits provides schedule milestones. Criteria satisfied.	
Does the Software Project Plan map the tasks in the SOW to elements in the WBS? Has the WBS been developed and under CM control?	NUREG/BR-0167 Section 1.4, Section 5.2, Software Best Practices	**Revision 0 IV&V Review** This requirement can be addressed by evaluating the RTM as the RTM must identify each requirement, design component, and test case(s) to ensure the requirements meet the design and that all requirements identified in the NRC documents (SOW) are adequately, completely, and correctly implemented. The results must also be repeatable and defensible. IV&V is evaluating the RTM identified in the SVVP and mapping the RTM to the NRC requirements, etc. The results of the RTM evaluation (to date) are failing miserably. In fact, IV&V is essentially developing the RTM for the development team which puts into question the IV&V's role of independence – the developers should have generated the RTM and IV&V evaluate it. But for IV&V to evaluate the RTM and provide results, IV&V has had to generate the RTM.	**Revision 0 IV&V Review** A report regarding the RTM is under development.
		Revision 1 IV&V Review Section 2.1 Planning Approach addresses the Statement of Work (SOW) which "*provides all the pertinent information required for the PI to prepare an NRC Form 189 proposal: Project Title, JCN, Budget and Reporting number, NRC issuing office, NRC Project Manager's name and contact information, NRC Technical Monitor's name and contact information, project background, project objectives, scope of work, deliverables and schedules, period of performance, reporting requirements, and so on.*" Section 2.5 Scheduling addresses the Work	**Revision 1 IV&V Review** None.

Software Project Plan			
Criteria	**Source**	**Findings**	**Recommendations**
		Breakdown Structure (WBS) which provides the budgetary control for the schedule. Supporting the WBS is a budget Basis of Estimate document that reflects the level of effort specified in the NRC Form 189 for the project. Appendix A Work Development plan in the Software Project Plan contains the Detailed Task/SubTask Breakdown. This includes information related to technical activities for the tasks and subtasks to finish the beta and general-released version of SAPHIRE 8.	
		Revision 2 IV&V Review Criteria satisfied.	**Revision 2 IV&V Review** None.
Does the Software Project Plan provide a project schedule, such as a GANTT chart, and rationale for tasks identified in the project schedule?	NUREG/BR-0167 Figure 5-1	**Revision 0 IV&V Review** The Work Development Plan contains a high level schedule.	**Revision 0 IV&V Review** None.
		Revision 1 IV&V Review Appendix A SAPHIRE 8 Work Development Plan contains a high level schedule.	**Revision 1 IV&V Review** None.
		Revision 2 IV&V Review Criteria satisfied.	**Revision 2 IV&V Review** None.
Does the Software Project Plan identify resources needed (equipment, personnel, tools)?	NUREG/BR-0167 Section 5.2.4	**Revision 0 IV&V Review** The Project Plan discusses resources in Section 2.5. It provides information on funding, management direction, staffing levels and staff requirements needed to be part of the development team, and developer requirements/qualifications. Section 3.5 discuses project closeout and the identification (and return) of remaining fund and NRC owned equipment	**Revision 0 IV&V Review** None.
		Revision 1 IV&V Review Section 2.6 Resources provides information on funding, management direction, staffing levels and staff requirements needed to be part of the development team, and developer requirements/qualifications. Section 3.7 Deliverables discuses project closeout and the identification (and return) of remaining fund and NRC owned equipment.	**Revision 1 IV&V Review** None.
		Revision 2 IV&V Review Criteria satisfied.	**Revision 2 IV&V Review** None.
Does the Software	None specified.	**Revision 0 IV&V Review**	**Revision 0 IV&V Review**

Software Project Plan			
Criteria	**Source**	**Findings**	**Recommendations**
Project Plan map to the SVVP approach?		N/A (NOTE: IV&V will only examine test cases and observe developer testing per NRC sponsor direction)	None.
		Revision 1 IV&V Review This criteria not included in this review.	**Revision 1 IV&V Review** None.
		Revision 2 IV&V Review This criteria not included in this review.	**Revision 2 IV&V Review** None.
Does the Software Project Plan describe nonconformance reporting and corrective action processes (nonconformance detection and reporting)?	NUREG/BR-0167 Figure 5-1 and Section 3 of Figure 5-1 of the NUREG for PMP "outline".	**Revision 0 IV&V Review** Section 3.3 of the Project Plan addresses Nonconformance Reporting and Corrective Action. A discussion on *an impact assessment* is not discussed directly (but may be part of the MLSR and/or the SVVP). If it is the MLSR, for example, the paragraph should state as such. The SVVP, as stated earlier is incomplete and inadequate at this time. An excellent discussion on test processes and corrective actions on testing is very good.	**Revision 0 IV&V Review** An important "editorial" correction needs to be addressed. In the second paragraph, first sentence, it states that "corrective actions ***should be*** reported to the NRC. IV&V believes that corrective actions ***will be*** reported to NRC. Either they are reported or they are not. If there are instances in which they are not to be reported to NRC, the paragraph should state as such and provide examples when NRC would not be provided this information.
		Revision 1 IV&V Review Section 3.3 Nonconformance Reporting and Corrective Action of the Software Project Plan provide the information required by the NUREG.	**Revision 1 IV&V Review** None.
		Revision 2 IV&V Review Criteria satisfied.	**Revision 2 IV&V Review** None.
Is an impact assessment performed on nonconformance items and corrective actions identified?	NUREG/BR-0167 Section 7	**Revision 0 IV&V Review** As stated above, it is IV&V's position that an impact assessment is not directly addressed.	**Revision 0 IV&V Review** Stated above.
		Revision 1 IV&V Review Section 3.3 Nonconformance Reporting and Corrective Action of the Software Project Plan provide the information required by the NUREG.	**Revision 1 IV&V Review** None.
		Revision 2 IV&V Review Criteria satisfied.	**Revision 2 IV&V Review** None.
How are nonconformance items, their related reports, and corrective actions tracked (e.g., DBMS, Excel Spreadsheet, etc.)?	NUREG/BR-0167 Section 7	**Revision 0 IV&V Review** This information is reported as being inserted into the Change Request tracking system – **Is this the same as RCS?**	**Revision 0 IV&V Review** None.
		Revision 1 IV&V Review Section 3.3 Nonconformance Reporting and Corrective Action specify "*Testing- and QA-related nonconformances are reported through the SVVP and the Change Request tracking systems*."	**Revision 1 IV&V Review** None.

Software Project Plan			
Criteria	**Source**	**Findings**	**Recommendations**
		Revision 2 IV&V Review Criteria satisfied.	**Revision 2 IV&V Review** None.
Has the quality assessment approach and improvement approach been described?	NUREG/BR-0167 Section 5.2, Section 8	**Revision 0 IV&V Review** This is described in Section 3.4 of the plan. The section provides an excellent discussion on how the developers, etc. will implement a quality approach and process improvement strategy. This is implicitly stated as being in a forthcoming QA Plan. A good discussion on bug fixes is also discussed where the developer obtains information regarding the severity of the bug and actions taken for bug correction/workaround/future release.	**Revision 0 IV&V Review** Further discussion on bug reporting should be implemented. Bugs should be part of the anomaly reporting process, which includes recording the bug on an anomaly report/form (template), to "document" information and the actions taken for the bug "correction". Each form should be placed under configuration control. Metrics regarding these bug corrections (such as a trending report or a Pareto diagram) should be implemented to determine areas of the code, etc. where issues continually appear. For example, if bugs are found and corrected continually in one or two modules/objects, there is an indication that a module(s) is very complex and should be modified and tested to avoid the category of bug reoccurring.
		Revision 1 IV&V Review This is described in Section 3.5 of the plan. The section provides an excellent discussion on how the developers, etc. will implement a quality approach and process improvement strategy. This is implicitly stated as being in a forthcoming QA Plan. A good discussion on bug fixes is also discussed where the developer obtains information regarding the severity of the bug and actions taken for bug correction/workaround/future release.	**Revision 1 IV&V Review** However, further discussion on bug reporting should be implemented. Bugs should be part of the anomaly reporting process, which includes recording the bug on an anomaly report/form (template), to "document" information and the actions taken for the bug "correction". Each form should be placed under configuration control. Metrics regarding these bug corrections (such as a trending report or a Pareto diagram) should be implemented to determine areas of the code, etc. where issues continually appear. For example, if bugs are found and corrected continually in one or two modules/objects, there is an indication that a module(s) is very complex and should be modified and tested to avoid the category of bug reoccurring.
		Revision 2 IV&V Review Criteria satisfied.	**Revision 2 IV&V Review** None.
Are deliverables and dates due identified? (Also in the project schedule)?	Good Programming Practice	**Revision 0 IV&V Review** Section 2.4 provides the discussion on deliverables (documented in NRC Form 189 and Form 173). The anticipated schedule is also documented in a table at the end of the section.	**Revision 0 IV&V Review** None.
		Revision 1 IV&V Review Section 2.5 Scheduling and 3.7 Deliverables provides the discussion on deliverables	**Revision 1 IV&V Review** None.

Software Project Plan			
Criteria	**Source**	**Findings**	**Recommendations**
		(documented in NRC Form 189 and Form 173). The anticipated schedule is also documented in a table at the end of section 2.5.	
		Revision 2 IV&V Review Section 2.5 Scheduling and 3.7 Deliverables provides the discussion on deliverables (documented in NRC Form 189 and Form 173). The anticipated schedule is also documented in a table at the end of section 2.5. Refer to section 3.4 Peer Reviews and Code Walkthroughs, Table 1 Summary of Major Life Cycle Reviews and Audits. Criteria satisfied.	**Revision 2 IV&V Review** None.
Are standards used for documentation identified and adhered to?	NUREG/BR-0167 Section 5.2.1	**Revision 0 IV&V Review** Standards for documentation are stated that they will be compliant to INL internal procedures unless specifically stated to conform to an external standard, such as an IEEE standard. As most of the documents have yet to be developed or updated, (the QAPP, SVVP for example), IV&V cannot determine at this time if the "adherence" to the standards are correctly implemented.	**Revision 0 IV&V Review** **IV&V can neither pass nor fail** this criterion until provided the required documents. Please note, that IV&V has already stated that the SVVP, RTM, and Users/Training manuals need substantial improvement.
		Revision 1 IV&V Review Section 3.1 Implementing the Life Cycle Tasks of the Statement of Work last paragraph specifies "*QA-related documentation for the project should adhere to standards identified in NUREG/BR-0167, Software Quality Assurance Program and Guidelines." Technical documentation to be published as a NUREG/CR follows guidance in NUREG-0650, Revision 2, Preparing NUREG-Series Publications*."	**Revision 1 IV&V Review** As the documents have yet to be developed or updated, IV&V cannot determine at this time if the "adherence" to the standards are correctly implemented. **Therefore, IV&V can neither pass nor fail** this criterion until provided the developed/updated documents.
		Revision 2 IV&V Review Section 3.1 Implementing the Life Cycle Tasks of the Statement of Work last paragraph specifies "*QA-related documentation for the project should adhere to standards identified in NUREG/BR-0167, Software Quality Assurance Program and Guidelines." Technical documentation to be published as a NUREG/CR follows guidance in NUREG-0650, Revision 2, Preparing NUREG-Series Publications*." Standards required to be included within documentation are currently being	**Revision 2 IV&V Review** None.

Software Project Plan			
Criteria	**Source**	**Findings**	**Recommendations**
		implemented. Refer to section 3.4 Peer Reviews and Code Walkthroughs, Table 1 Summary of Major Life Cycle Reviews and Audits.	
Are coding conventions standards identified and adhered to?	NUREG/BR-0167 Section 5.2.1	**Revision 0 IV&V Review** As stated above, "the development group has provided a link to the CodeGear Object Pascal Style Guide".	**Revision 0 IV&V Review** Without peer reviews and especially code walkthroughs to assist in determining if the use of the coding standards is implemented appropriately, IV&V must fail this criterion. In addition, Section 5.2.1, Required Inputs to the Contract specifically states that the list of deliverables should contain not only the software end products but also presentation materials and minutes from formal reviews. It also states that identification of applicable standards must be identified, which include programming language standards, coding standards, and documentation standards.
		Revision 1 IV&V Review Section 2.6 Resources paragraph 5 specifies "*Developers of the SAPHIRE team need to be familiar with DELPHI © Version 7 IDE, Modula-2 IDE, DOS batch files and scripting, and use of the Microsoft Windows platforms to support the interface upgrade and the functional improvement development and testing effort*."	**Revision 1 IV&V Review** However, without peer reviews and especially code walkthroughs to assist in determining if the use of the coding standards is implemented appropriately, IV&V must fail this criterion. In addition, the NUREG/BR-0167 Section 5.2.1, Required Inputs to the Contract specifically states that the list of deliverables should contain not only the software end products but also presentation materials and minutes from formal reviews. It also states that identification of applicable standards must be identified, which include programming language standards, coding standards, and documentation standards.
		Revision 2 IV&V Review Section 2.6 Resources paragraph 5 specifies "*Developers of the SAPHIRE team need to be familiar with DELPHI © Version 7 IDE, Modula-2 IDE, DOS batch files and scripting, and use of the Microsoft Windows platforms to support the interface upgrade and the functional improvement development and testing effort*." In addition, the NUREG/BR-0167 Section 5.2.1, Required Inputs to the Contract specifically states that the list of deliverables should contain not only the software end products but also presentation materials and minutes from formal reviews. Refer to section 3.4 Peer Reviews and Code Walkthroughs, Table 1 Summary of Major Life Cycle Reviews and Audits. Criteria satisfied.	**Revision 2 IV&V Review** None.

Software Project Plan			
Criteria	**Source**	**Findings**	**Recommendations**
Are code and documentation inspections and reviews identified, recorded, and under CM Control?	None specified.	**Revision 0 IV&V Review** As stated above, code inspections via code walkthroughs and peer reviews are not occurring per NRC Sponsor request/requirement.	**Revision 0 IV&V Review** Presentation materials and minutes from these formal reviews are required by the NUREG. Documentation on how to use the code (such as the User's Guide and Workbook) are incomplete and incorrect (steps are absent).
		Revision 1 IV&V Review Code inspections via code walkthroughs and peer reviews are not occurring per NRC Sponsor request/requirement.	**Revision 1 IV&V Review** Presentation materials and minutes from these formal reviews are required by the NUREG.
		Revision 2 IV&V Review Refer to section 3.4 Peer Reviews and Code Walkthroughs, Table 1 Summary of Major Life Cycle Reviews and Audits. Criteria satisfied.	**Revision 2 IV&V Review** None.

Table 4-2 Project Tracking and Oversight

Project Tracking and Oversight			
Criteria	**Source**	**Findings**	**Recommendations**
Is monitoring, assessing, and reporting technical progress performed and actual results and performance tracked against the Software Project Plan?	NUREG/BR-0167 Section 5.3	**Revision 0 IV&V Review** Information on monitoring, assessing and reporting performance is discussed in Section 2.2 of the Project Plan.	**Revision 0 IV&V Review** None.
		Revision 1 IV&V Review Information on monitoring, assessing and reporting performance is discussed in Section 2.3 Tracking and Oversight Approach of the Software Project Plan.	**Revision 1 IV&V Review** None.
		Revision 2 IV&V Review Criteria satisfied.	**Revision 2 IV&V Review** None.
Is monitoring progress performed on an ongoing basis to maintain communications at all levels of the developer and sponsor organizations? Is there a record of this activity (reviews, reports, meetings, brainstorming sessions) and the information placed under configuration control?	NUREG/BR-0167 Section 5.3	**Revision 0 IV&V Review** Section 5.3 of the NUREG states "Implementation of planned verification and validation, **configuration management**, and quality assessment and implementation activities are part of the ordinary tracking and oversight functions". CM is not found in this section. However, it is discussed in Section 2.3.	**Revision 0 IV&V Review** None.
		Revision 1 IV&V Review Section 5.3 Project Tracking and Oversight of the NUREG states "Implementation of planned verification and validation, **configuration management**, and quality assessment and implementation activities are part of the ordinary tracking and oversight functions". Configuration Management is not discussed in section 2.3 Tracking and Oversight Approach. However, it is discussed in Section 2.7 Configuration Management.	**Revision 1 IV&V Review** None.
		Revision 2 IV&V Review Criteria satisfied.	**Revision 2 IV&V Review** None.
Are technical progress, costs, critical target computing resources, schedule, and risks tracked quantitatively?	NUREG/BR-0167 Section 5.3	**Revision 0 IV&V Review** Technical progress, costs and schedule variances, etc. are reported in Section 2.2 of the plan. The CV and SV identify schedule and costs quantitatively. Section 2.5 of the Project Plan states, "Personnel from the INL's Risk, Reliability, and NRC Programs Department shall be responsible **for risk assessment support** and for	**Revision 0 IV&V Review** None.

Project Tracking and Oversight			
Criteria	**Source**	**Findings**	**Recommendations**
		development and maintenance of the SAPHIRE software".	
		Revision 1 IV&V Review Technical progress, costs and schedule variances, etc. are reported in Section 2.3 Tracking and Oversight Approach of the plan. Section 2.6 Resources of the Project Plan states, "Personnel from the INL's Risk, Reliability, and NRC Programs Department shall be responsible **for risk assessment support** and for development and maintenance of the SAPHIRE software".	**Revision 1 IV&V Review** None.
		Revision 2 IV&V Review Criteria satisfied.	**Revision 2 IV&V Review** None.
Does the PM determine and report schedule, cost status of variances from the baseline plan? (Is there a Baseline Plan(s) and is it under CM Control?)	NUREG/BR-0167 Section 5.3	**Revision 0 IV&V Review** Baselines are discussed in Section 2.1 and also discussed in Section 2.2 as follows. "The task-oriented schedule and budget for each project is established by the PI in conjunction with the financial controls person. The PI will determine if there is a **need to re-baseline** the schedule and/or budget". Baselines are identified in Section 2.3 as follows. "Configuration Management and Change Control to monitor and uniquely identify baselines, changes that are requested, evaluated, approved, and tested, as well as backup and recovery actions".	**Revision 0 IV&V Review** None.
		Revision 1 IV&V Review Baselines are discussed in Section 2.1 Planning Approach and also discussed in Section 2.3 Tracking and Oversight Approach as follows: "The task-oriented schedule and budget for each project is established by the PI in conjunction with the financial controls person. The PI will determine if there is a **need to re-baseline** the schedule and/or budget". Baselines are identified in Section 2.4 Organization, Tasks, and Responsibilities as follows: "Configuration Management and Change Control to monitor and uniquely identify baselines, changes that are requested, evaluated, approved, and tested, as well as backup and recovery actions".	**Revision 1 IV&V Review** None.
		Revision 2 IV&V Review	**Revision 2 IV&V Review**

Project Tracking and Oversight			
Criteria	**Source**	**Findings**	**Recommendations**
		Criteria satisfied.	None.
Are corrective actions taken when actual results and performance taken if significant deviations occur between the Software Project Plan and current schedule, including but not limited to adding staff, extending work week, and or changing the skill mix?	NUREG/BR-0167 Section 5.3	**Revision 0 IV&V Review** This information is found in section 2.2 of the plan.	**Revision 0 IV&V Review** None.
		Revision 1 IV&V Review This information is found in section 2.3 Tacking and Oversight Approach of the Software Project plan.	**Revision 1 IV&V Review** None.
		Revision 2 IV&V Review Criteria satisfied.	**Revision 2 IV&V Review** None.

Table 4-3 Risk Management

Risk Management			
Criteria	**Source**	**Findings**	**Recommendations**
Is a Risk Management Plan established?	NUREG/BR-167, Section 5.8	**Revision 0 IV&V Review** Risk Management is addressed in section 2.2 of the Software Project Plan, Project Number: N6423, for U.S. Nuclear Regulatory Commission (NRC) Project: SAPHIRE 8, Document ID: INL/EXT-09-15853. Criteria satisfied.	**Revision 0 IV&V Review** It is the recommendation of IV&V that a Risk Management and Risk Mitigation plan be developed for the SAPHIRE 8 software development.
Does the Risk Management Plan identify, assess, document, and rank resources and schedule risks?	NUREG/BR-167, Section 5.8.1	**Revision 0 IV&V Review** An INL Proposal Risk and Evaluation Preparation System (PREPS) entry was created (PREPS ID: 0807-C.C-41-000454). Criteria satisfied.	**Revision 0 IV&V Review** None.
Has a Risk Mitigation Plan been developed (or incorporated into a Risk management Plan) and is it under CM Control?	NUREG/BR-167, Section 5.8.2	**Revision 0 IV&V Review** Risk mitigation activities are stipulated in the NRC Form 189, as deemed appropriate. Criteria satisfied.	**Revision 0 IV&V Review** None.

Table 4-4 Software Quality Assurance Plan

Software Quality Assurance Plan			
Criteria	**Source**	**Findings**	**Recommendations**
Software quality assurance is the planned and systematic pattern of all actions necessary to provide adequate confidence that a software product conforms to established technical requirements.	NUREG/BR-0167, Software Quality Assurance Program and Guidelines, section 1.2 Scope and Applicability.	**Revision 0 IV&V Review** Section 1.1 Project Background and Objectives first sentence states "*This Quality Assurance (QA) Plan documents the QA activities that will be managed by the INL related to JCN N6423*". JCN N6423 Revision 5, Date: 04/20/09, I. Task 9: Quality Assurance specifies that "*INL will support a variety of verification and validation (V&V) activities, including support of a NRC peer review, audits, testing, maintenance, and modifications of the SAPHIRE 8 software*" Section 1.2 Project Scope and Organization last paragraph states "*INL will follow NRC Management Directive 11.7 "Procedures for Placement and Monitoring of Work with the Department of Energy" related to software development. This directive suggests that "all software development, modification, or maintenance tasks shall follow general guidance provided in NUREG/BR-0167 "Software Quality Assurance Program and Guidance." SAPHIRE 8 will follow the requirements for Level 1 software defined in Section 1.2 of NUREG/BR-0167. The NRC will perform an audit of the software QA implementation once a year against the requirement of NUREG/BR-0167*". Criteria satisfied.	**Revision 0 IV&V Review** Minor corrections for the Software Quality Assurance Plan.
		Revision 1 IV&V Review Criteria satisfied.	**Revision 0 IV&V Review** None.

Table 4-5 Software Configuration Management Plan

Software Configuration Management Plan			
Criteria	**Source**	**Findings**	**Recommendations**
Does the Configuration Management approach/methodology identify, define and reference procedures used for establishing and maintaining project baselines?	NUREG/BR-0167 Sections 2.5, 6.2, 6.4	**Revision 0 IV&V Review** Section 1.2 Project Scope and Organization reference DOE Order 414.1C Quality Assurance, 10 CFR 830 Subpart A, Nuclear Safety Management, ASME NQA-1-2000 Quality Assurance Requirements for Nuclear Facility Applications, PDD-13610 Software Quality Assurance Program, LRD-13600 Software Quality Assurance, LWP-13620 Software Quality Assurance and NUREG/BR-0167 Software Quality Assurance Program and Guidelines. Section 1.2 Project Scope and Organization, last paragraph, last sentence states "*SAPHIRE 8 will follow the requirements for Level 1 software defined in Section 1.2 of NUREG/BR-0167*".	**Revision 0 IV&V Review** Suggest referring to NUREG-BR-0167 Software Quality Assurance Program and Guidelines, section 6.2 Baselines for reference to all required information to be included in baselines. Section 1.3 does not specifically address the items included in the baselines.
		Revision 1 IV&V Review Criteria satisfied.	**Revision 1 IV&V Review** None.
Does the Configuration Management approach/methodology identify, define and reference procedures used for establishing and performing change control?	NUREG/BR-0167 Section 6	**Revision 0 IV&V Review** Section 1.2 Project Scope and Organization reference DOE Order 414.1C Quality Assurance, 10 CFR 830 Subpart A, Nuclear Safety Management, ASME NQA-1-2000 Quality Assurance Requirements for Nuclear Facility Applications, PDD-13610 Software Quality Assurance Program, LRD-13600 Software Quality Assurance, LWP-13620 Software Quality Assurance and NUREG/BR-0167 Software Quality Assurance Program and Guidelines. Section 1.2 Project Scope and Organization, last paragraph, last sentence states "*SAPHIRE 8 will follow the requirements for Level 1 software defined in Section 1.2 of NUREG/BR-0167*".	**Revision 0 IV&V Review** Suggest referring to NUREG-BR-0167 Software Quality Assurance Program and Guidelines, section 6.3 Change Control for reference to all required information to be included in the change control procedure.
		Revision 1 IV&V Review Criteria satisfied.	**Revision 1 IV&V Review** None.
Does the Configuration Management approach/methodology identify, define and	NUREG/BR-0167 Section 6	**Revision 0 IV&V Review** Section 1.2 Project Scope and Organization reference DOE Order 414.1C Quality Assurance, 10 CFR 830 Subpart A, Nuclear Safety	**Revision 0 IV&V Review** None.

Software Configuration Management Plan			
Criteria	**Source**	**Findings**	**Recommendations**
reference procedures used for implementation and release of changes?		Management, ASME NQA-1-2000 Quality Assurance Requirements for Nuclear Facility Applications, PDD-13610 Software Quality Assurance Program, LRD-13600 Software Quality Assurance, LWP-13620 Software Quality Assurance and NUREG/BR-0167 Software Quality Assurance Program and Guidelines. Section 1.2 Project Scope and Organization, last paragraph, last sentence states "*SAPHIRE 8 will follow the requirements for Level 1 software defined in Section 1.2 of NUREG/BR-0167*".	
		Revision 1 IV&V Review Criteria satisfied.	**Revision 1 IV&V Review** None.
Does the Configuration Management approach/methodology identify, define and reference procedures used for code, access, and media controls?	NUREG/BR-0167 Section 6	**Revision 0 IV&V Review** Section 1.2 Project Scope and Organization reference DOE Order 414.1C Quality Assurance, 10 CFR 830 Subpart A, Nuclear Safety Management, ASME NQA-1-2000 Quality Assurance Requirements for Nuclear Facility Applications, PDD-13610 Software Quality Assurance Program, LRD-13600 Software Quality Assurance, LWP-13620 Software Quality Assurance and NUREG/BR-0167 Software Quality Assurance Program and Guidelines. Section 1.2 Project Scope and Organization, last paragraph, last sentence states "*SAPHIRE 8 will follow the requirements for Level 1 software defined in Section 1.2 of NUREG/BR-0167*".	**Revision 0 IV&V Review** Suggest referring to NUREG-BR-0167 Software Quality Assurance Program and Guidelines, section 6.6 Software, Access, and Media Control for reference to all required information to be included in the software, access, and media control procedure.
		Revision 1 IV&V Review Criteria satisfied.	**Revision 1 IV&V Review** None.
Does the Configuration Management approach/methodology identify, define and reference procedures for the use, access, and maintenance of the software development library?	NUREG/BR-0167 Section 6	**Revision 0 IV&V Review** Section 1.2 Project Scope and Organization reference NUREG/BR-0167 Software Quality Assurance Program and Guidelines.	**Revision 0 IV&V Review** None.
		Revision 1 IV&V Review Criteria satisfied.	**Revision 1 IV&V Review** None.
Are all nonconformance	NUREG/BR-0167	**Revision 0 IV&V Review**	**Revision 0 IV&V Review**

Software Configuration Management Plan			
Criteria	**Source**	**Findings**	**Recommendations**
items under CM Control?	Section 6 and 7	Section 1.3 Configuration Management Approach, paragraph 8 states "*Bug fixes and all supporting documentation are placed under configuration control*".	Suggest referring to NUREG-BR-0167 Software Quality Assurance Program and Guidelines, section 6.2 Baselines for reference to all required information to be included in baselines.
		Revision 1 IV&V Review Section 1.3 Configuration Management Approach, paragraph 8 states "*Bug fixes and all supporting documentation are placed under configuration control*". Criteria satisfied.	**Revision 1 IV&V Review** None.
Are the monthly progress reports under configuration management control?	NUREG/BR-0167 Section 6	**Revision 0 IV&V Review** Monthly progress reports currently are not in the SAPHIRE Revision Control System (RCS).	**Revision 0 IV&V Review** Suggest referring to NUREG-BR-0167 Software Quality Assurance Program and Guidelines, section 6.2 Baselines for reference to all required information to be included in baselines.
		Revision 1 IV&V Review Monthly progress reports are being added into the SAPHIRE Revision Control System (RCS). Criteria satisfied.	**Revision 1 IV&V Review** None.
Are peer reviews and structured walkthrough documents/completed forms under configuration control?	NUREG/BR-0167 Section 3.2.3	**Revision 0 IV&V Review** Code walkthroughs and Peer Reviews would assist in making this determination apparent but IV&V has not identified evidence that these requirements/reviews have been performed.	**Revision 0 IV&V Review** Suggest referring to NUREG-BR-0167 Software Quality Assurance Program and Guidelines, section 6.2 Baselines for reference to all required information to be included in baselines.
		Revision 1 IV&V Review Section 1.3 Configuration Management Approach, paragraph 6 states "*Quality assurance reviews configuration management and control processes to ensure that only authorized changes are mode to the software. All software modules that have been tested, documented, and approved for inclusion into the next release of the software are baselined*". Paragraph 7 states "*SAPHIRE uses a configuration management database as a control library for all information related to the development of software fixes, enhances, baselines, and subsequent releases. Processes are in place to uniquely identify all components, modules, documentation, error reports, test suites, and test results through the establishment of a configuration control tracking number*". Criteria satisfied.	**Revision 1 IV&V Review** None.

Software Configuration Management Plan			
Criteria	**Source**	**Findings**	**Recommendations**
Does the developer follow a written configuration management policy/methodology?	NUREG/BR-0167 Section 6.1	**Revision 0 IV&V Review** Software Configuration Management Plan, Document ID: INL/EXT-09-16696.	**Revision 0 IV&V Review** None.
		Revision 1 IV&V Review Software Configuration Management Plan, Document ID: INL/EXT-09-16696. Criteria satisfied.	**Revision 1 IV&V Review** None.
Are baseline documents for planning, managing and building the system (software) established and controlled (Explicitly identify project baselines for software products (source code, test cases, software specifications (standards & procedures) needed to establish & maintain stability of software activities?	NUREG/BR-0167 Section 6.2	**Revision 0 IV&V Review** This requirement is identified in section 1.2 Project Scope and Organization and section 1.3 Configuration Management Approach. Criteria satisfied.	**Revision 0 IV&V Review** Suggest referring to NUREG-BR-0167 Software Quality Assurance Program and Guidelines, section 6.2 Baselines for reference to all required information to be included in baselines.
		Revision 1 IV&V Review This requirement is identified in section 1.2 Project Scope and Organization and section 1.3 Configuration Management Approach. Criteria satisfied.	**Revision 1 IV&V Review** None.
Have a naming / labeling system that: uniquely identifies all project entities (documents, software elements, and test cases), changes by revision or version (and under CM Control), unique identification of configuration/version of revised software for use?	NUREG/BR-0167 Section 6.2	**Revision 0 IV&V Review** Section 1.3 Configuration Management Approach states "*SAPHIRE uses a configuration management database as a control library for all information related to the development of software fixes, enhances, baselines, and subsequent releases. Processes are in place to uniquely identify all components, modules, documentation, error reports, test suites, and test results through the establishment of a configuration control tracking number*".	**Revision 0 IV&V Review** Suggest referring to NUREG-BR-0167 Software Quality Assurance Program and Guidelines, section 6.2 Baselines for reference to all required information to be included in baselines.
		Revision 1 IV&V Review Section 1.3 Configuration Management Approach states "*SAPHIRE uses a configuration management database as a control library for all information related to the development of software fixes, enhances, baselines, and subsequent releases. Processes are in place to uniquely identify all components, modules, documentation, error reports, test suites, and test results through the establishment of a configuration control tracking number*".	**Revision 1 IV&V Review** None.

Software Configuration Management Plan			
Criteria	**Source**	**Findings**	**Recommendations**
		Criteria satisfied.	
Are baseline documents for planning, managing and building the system (software) established and controlled?	NUREG/BR-0167 Section 6.2	**Revision 0 IV&V Review** This requirement is identified in section 1.2 Project Scope and Organization and section 1.3 Configuration Management Approach.	**Revision 0 IV&V Review** Suggest referring to NUREG-BR-0167 Software Quality Assurance Program and Guidelines, section 6.2 Baselines for reference to all required information to be included in baselines.
		Revision 1 IV&V Review This requirement is identified in section 1.2 Project Scope and Organization and section 1.3 Configuration Management Approach. Criteria satisfied.	**Revision 1 IV&V Review** None.

Table 4-6 Software Requirements

Software Requirements			
Criteria	**Source**	**Findings**	**Recommendations**
Does the Requirements Document identify requirements that are uniquely identified, testable, and traceable through the software life cycle?	NUREG/BR-0167 Section 4.3	**Revision 0 IV&V Review** The requirements are not uniquely identified. Multiple requirements are listed in paragraphs. Testability and traceability of the requirements through the software life cycle cannot be achieved.	**Revision 0 IV&V Review** Uniquely identify the requirements as functional, performance, design constraints, attributes and external interface requirements.
		Revision 1 IV&V Review Section 2 Software Requirements provides requirements obtained from NRC Forms 189s Y6394 Revision 11, N6203 Revision 3, N6423 Revision 7, and Y6394 Revision 10. Section 3 Interface Requirements Specification provides requirements for the types of interfaces SAPHIRE 8 will provide. Sub-sections within section 2 Software Requirements and section 3 Interface Requirements Specification contain paragraphs specifying multiple requirements and single sentences containing a single requirement. Requirements are identifiable by the use of "will" and "shall" within the paragraphs and single sentences.	**Revision 1 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Requirements Revision 1 Document ID: INL/EXT-09-16789.
Does the Requirements Document address the functions that the software is to perform and only what is to be performed?	NUREG/BR-0167 Section 4.3.1, Software Engineering Practices	**Revision 0 IV&V Review** The requirements need to be uniquely identified as functional, performance, design constraints, attributes and external interface requirements.	**Revision 0 IV&V Review** Uniquely identify the requirements as functional, performance, design constraints, attributes and external interface requirements.
		Revision 1 IV&V Review Sub-sections within section 2 Software Requirements and section 3 Interface Requirements Specification contain paragraphs specifying multiple requirements and single sentences containing a single requirement. Requirements identified by the use of "will" and "shall" within the paragraphs and single sentences address the functions that the software is to perform.	**Revision 1 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Requirements Revision 1 Document ID: INL/EXT-09-16789.
Does the Requirements Document address time-related requirements of software operation such as speed, response time, and/or other performance	NUREG/BR-0167 Section 4.3.2	**Revision 0 IV&V Review** The requirements need to be uniquely identified as functional, performance, design constraints, attributes and external interface requirements.	**Revision 0 IV&V Review** Uniquely identify the requirements as functional, performance, design constraints, attributes and external interface requirements.
		Revision 1 IV&V Review Section 2.1 Graphical User Interface Requirements	**Revision 1 IV&V Review** Refer to the Independent Verification and Validation Of

Software Requirements			
Criteria	**Source**	**Findings**	**Recommendations**
requirements?		specifies "*The purpose of the upgraded interface is to create a series of Web-based, HTML-like screens with dropdown menus and form fields to facilitate user interaction. It will combine elements of both the old SAPHIRE and GEM tools in an attempt to improve usability by giving users access to most of the commonly used options and features of the tool set with a GUI.*" Section 2.1.2 Project Controls specifies "*The GUI will provide an enhanced environment for the management of a multiuser/multiproject environment.*" Section 2.1.3 Project Integration and Modification specifies "*Facilitate an increase in project quality by enforcing object restriction rights and tracking modifications.*" Section 2.5 Core Analysis Requirements specifies "*SAPHIRE will be able to perform (both quantification and reporting of results) standard risk/reliability analyses. SAPHIRE will be able to perform analyses for the Significance Determination Process (SDP). SAPHIRE will be able to perform analyses for Events and Condition Assessment (ECA) (formally known as Accident Sequence Precursor, ASP, analysis).*" Section 2.8 External Events Requirements specifies "*The application will extend the analysis capability to allow for external events modeling.*" Requirements identified by the use of "will" and "shall" within the paragraphs and single sentences address performance requirements of the software.	SAPHIRE 8 Software Requirements Revision 1 Document ID: INL/EXT-09-16789.
Does the Requirements Document address constraints imposed on implementation activities, including but not limited to hardware platform and	NUREG/BR-0167 Section 4.3.3	**Revision 0 IV&V Review** The requirements need to be uniquely identified as functional, performance, design constraints, attributes and external interface requirements.	**Revision 0 IV&V Review** Uniquely identify the requirements as functional, performance, design constraints, attributes and external interface requirements.
		Revision 1 IV&V Review Section 2.2 Application Program Interface (API) Requirements, section 2.4.1 Model Creation and	**Revision 1 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Requirements Revision 1 Document

Software Requirements			
Criteria	**Source**	**Findings**	**Recommendations**
programming language?		Maintenance, section 2.4.6 Sequence Object, section 2.5 Core Analysis Requirements, section 2.5.7 User-Defined Model Type, section 3.2 Application Program Interface Requirements and section 3.10 Operating System Interface Requirements address design constraint requirements of the software.	ID: INL/EXT-09-16789.
Does the Requirements Document address attributes of the software, such as portability, access controls, property of an object, element, or file?	NUREG/BR-0167 Section 4.3.4 – Best Practices	**Revision 0 IV&V Review** The requirements need to be uniquely identified as functional, performance, design constraints, attributes and external interface requirements.	**Revision 0 IV&V Review** Uniquely identify the requirements as functional, performance, design constraints, attributes and external interface requirements.
		Revision 1 IV&V Review Sub-sections within section 2 Software Requirements and section 3 Interface Requirements Specification address attributes of the software.	**Revision 1 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Requirements Revision 1 Document ID: INL/EXT-09-16789.
Does the Requirements Document identify external interfaces – interactions/communications with people, hardware, and other software? NOTE: Interfaces may be identified in a separate document, e.g., an Interface Requirements Specification.	NUREG/BR-0167 Section 4.3.5	**Revision 0 IV&V Review** The requirements need to be uniquely identified as functional, performance, design constraints, attributes and external interface requirements.	**Revision 0 IV&V Review** Uniquely identify the requirements as functional, performance, design constraints, attributes and external interface requirements.
		Revision 1 IV&V Review Section 3 Interface Requirements Specification addresses the interface requirements of the software.	**Revision 1 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Requirements Revision 1 Document ID: INL/EXT-09-16789.
Does the Requirements Document identify internal interfaces – interactions/communications which exist between separate software components and provide a programmatic mechanism by which these components can communicate? NOTE: Interfaces may be identified in a separate document, e.g., an Interface Requirements	NUREG/BR-0167 Section 2.2, Section 3.2.2.1 – Section 3.2.4.1 - Software Best Practices	**Revision 0 IV&V Review** The requirements need to be uniquely identified as functional, performance, design constraints, attributes and external interface requirements.	**Revision 0 IV&V Review** Uniquely identify the requirements as functional, performance, design constraints, attributes and external interface requirements.
		Revision 1 IV&V Review Section 3 Interface Requirements Specification addresses the interface requirements of the software.	**Revision 1 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Requirements Revision 1 Document ID: INL/EXT-09-16789.

Software Requirements			
Criteria	**Source**	**Findings**	**Recommendations**
Specification.			
Does the Requirements Document identify assumptions, constraints, or dependencies that the requirements are based upon?	NUREG/BR-0167 Section 4.3, Software Best Practices	**Revision 0 IV&V Review** The requirements need to be uniquely identified as functional, performance, design constraints, attributes and external interface requirements.	**Revision 0 IV&V Review** Uniquely identify the requirements as functional, performance, design constraints, attributes and external interface requirements.
		Revision 1 IV&V Review Section 2 Software Requirements and section 2.1 Graphical User Interface Requirements refer to the Nuclear Regulatory Commission (NRC) Form 189s that the requirements are based upon.	**Revision 1 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Requirements Revision 1 Document ID: INL/EXT-09-16789.
Is each requirement uniquely identified and requirements baseline under CM control?	NUREG/BR-0167 Section 6.2	**Revision 0 IV&V Review** The requirements need to be uniquely identified as functional, performance, design constraints, attributes and external interface requirements.	**Revision 0 IV&V Review** Uniquely identify the requirements as functional, performance, design constraints, attributes and external interface requirements.
		Revision 1 IV&V Review Sub-sections within section 2 Software Requirements and section 3 Interface Requirements Specification contain paragraphs specifying multiple requirements and single sentences containing a single requirement. Requirements are identifiable by the use of "will" and "shall" within the paragraphs and single sentences. In order for the requirements to be testable and traceable through the software life cycle the individual requirements need to be uniquely identified. Refer to Criteria 1. The requirements as identified in the SAPHIRE Version 8 Software Verification and Validation Plan – Volume 1 (INL/EXT-05-00821) are baselined using the revision control system (RCS) described in the Software Configuration Management Plan (INL/EXT-09-16696).	**Revision 1 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Requirements Revision 1 Document ID: INL/EXT-09-16789.
Are the requirements verifiable (clarity increases verifiability)? NOTE: A requirement is verifiable if some method can be devised for objectively demonstrating that the software implements it.	NUREG/BR-0167 Section 3.2.1.5	**Revision 0 IV&V Review** The requirements matrix is incomplete and does not show the relationship of software requirements to the software architecture down to the unit level and to the tests used to verify the requirements.	**Revision 0 IV&V Review** Uniquely identify the requirements as functional, performance, design constraints, attributes and external interface requirements.
		Revision 1 IV&V Review Sub-sections within section 2 Software Requirements and section 3 Interface Requirements Specification contain paragraphs	**Revision 1 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Requirements Revision 1 Document ID: INL/EXT-09-16789.

Software Requirements			
Criteria	**Source**	**Findings**	**Recommendations**
		specifying multiple requirements and single sentences containing a single requirement. Requirements are identifiable by the use of "will" and "shall" within the paragraphs and single sentences.	
Does each statement of a requirement contain one and only one requirement? Are all requirements identified uniquely and unambiguous? (Functional, Performance, Design Constraints, Attribute, Interfaces). Do requirements state WHAT and not HOW they are implemented? Note: Interface requirements may be included in the SRS if not in a separate document.	NUREG/BR-0167 Section 3.2.1.5	**Revision 0 IV&V Review** The requirements are not uniquely identified. Multiple requirements are listed in paragraphs. Testability and traceability of the requirements through the software life cycle cannot be achieved.	**Revision 0 IV&V Review** The requirements need to be uniquely identified as functional, performance, design constraints, attributes and external interface requirements.
		Revision 1 IV&V Review Sub-sections within section 2 Software Requirements and section 3 Interface Requirements Specification contain paragraphs specifying multiple requirements and single sentences containing a single requirement. Requirements are identifiable by the use of "will" and "shall" within the paragraphs and single sentences.	**Revision 1 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Requirements Revision 1 Document ID: INL/EXT-09-16789.
Is there a Requirements Traceability Matrix?	NUREG/BR-0167 Section 3.2.1.5	**Revision 0 IV&V Review** The requirements matrix is incomplete and does not show the relationship of software requirements to the software architecture down to the unit level and to the tests used to verify the requirements.	**Revision 0 IV&V Review** The requirements need to be uniquely identified as functional, performance, design constraints, attributes and external interface requirements.
		Revision 1 IV&V Review Refer to SAPHIRE Version 8 Software Verification and Validation Plan – Volume II (INL/EXT-05-00821) appendix D.	**Revision 1 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Requirements Revision 1 Document ID: INL/EXT-09-16789.
Does the Requirements Traceability Matrix (RTM) provide the preliminary trace of Functional Requirements (e.g., FR-01), Performance Requirements (e.g., PR-01), Design Constraint Requirements (e.g.,	NUREG/BR-0167 Section 3.2.1.5	**Revision 0 IV&V Review** The requirements matrix is incomplete and does not show the relationship of software requirements to the software architecture down to the unit level and to the tests used to verify the requirements.	**Revision 0 IV&V Review** The requirements need to be uniquely identified as functional, performance, design constraints, attributes and external interface requirements.
		Revision 1 IV&V Review The requirements as listed in the SAPHIRE Version 8 Software Verification and Validation Plan – Volume II (INL/EXT-05-00821) appendix	**Revision 1 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Requirements Revision 1 Document ID: INL/EXT-09-16789.

Software Requirements			
Criteria	**Source**	**Findings**	**Recommendations**
DCR-01), Attribute Requirements (e.g., AR-01), and Interface Requirements (e.g., IR-01) down to the unit level and do test cases map to requirements?		D Requirements Traceability Matrix (RTM) are R1 thru R74. In order for the requirements to be testable and traceable through the software life cycle the individual requirements need to be uniquely identified. The RTM does not list design components that map to requirements. The test cases as listed in the RTM are incomplete ("NA", "None", "To be determined").	
Are all requirements testable? (If it is not testable, then it is not a requirement)	NUREG/BR-0167 Section 1.7, Table 1-1, Section 2.1, Section 2.5.2, Table 3-1, Section 3.2.2.3	**Revision 0 IV&V Review** The requirements matrix is incomplete and does not show the relationship of software requirements to the software architecture down to the unit level and to the tests used to verify the requirements.	**Revision 0 IV&V Review** The requirements need to be uniquely identified as functional, performance, design constraints, attributes and external interface requirements.
		Revision 1 IV&V Review Some of the requirements as listed in the RTM do not map to a test case ("NA" and "None").	**Revision 1 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Requirements Revision 1 Document ID: INL/EXT-09-16789.
Is the RTM under Configuration Management and Change Control? NOTE: The RTM is a living document and should be baselined at the end of each life-cycle phase or when changes to requirements occur within a life-cycle phase after it has been baselined.	NUREG/BR-0167 Table 1-1, Section 6, Section 6.2	**Revision 0 IV&V Review** The Requirements Traceability Matrix is included as Appendix D within the SAPHIRE Version 8 Software Verification and Validation Plan Volume II.	**Revision 0 IV&V Review** None.
		Revision 1 IV&V Review The Requirements Traceability Matrix in the SAPHIRE Version 8 Software Verification and Validation Plan – Volume II (INL/EXT-05-00821) appendix D is baselined using the revision control system (RCS) described in the Software Configuration Management Plan (INL/EXT-09-16696).	**Revision 1 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Requirements Revision 1 Document ID: INL/EXT-09-16789.
Does the Requirements Document identify the purpose and scope?	NUREG/BR-0167 Section 2.2, 4.3	**Revision 0 IV&V Review** The requirements are included in section 2 Software Requirements and section 3 Interface Requirements Specification within the SAPHIRE Version 8 Software Verification and Validation Plan Volume I. There is no section addressing purpose or scope. There is no Software Requirements Documentation.	**Revision 0 IV&V Review** Provide sections addressing purpose and scope in the requirements documentation.
		Revision 1 IV&V Review The required information is provided in section 1	**Revision 1 IV&V Review** Refer to the Independent Verification and Validation Of

Software Requirements			
Criteria	**Source**	**Findings**	**Recommendations**
		Introduction and Overview and section 2 Software Requirements.	SAPHIRE 8 Software Requirements Revision 1 Document ID: INL/EXT-09-16789.
Does the Requirements Document identify what the products will and will not do?	Software Engineering Practices	**Revision 0 IV&V Review** The requirements are included in section 2 Software Requirements and section 3 Interface Requirements Specification within the SAPHIRE Version 8 Software Verification and Validation Plan Volume I. There is no Software Requirements Documentation.	**Revision 0 IV&V Review** Identify what the product will and will not do.
		Revision 1 IV&V Review This information is provided in section 1.4 SAPHIRE Features, Table 1.4 Salient features of SAPHIRE and relevant version numbers.	**Revision 1 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Requirements Revision 1 Document ID: INL/EXT-09-16789.
Does the Requirements Document describe the objectives and goals?	NUREG/BR-0167 Section 5.2.1	**Revision 0 IV&V Review** The requirements are included in section 2 Software Requirements and section 3 Interface Requirements Specification within the SAPHIRE Version 8 Software Verification and Validation Plan Volume I. There is no section addressing objectives and goals. There is no Software Requirements Documentation.	**Revision 0 IV&V Review** Provide sections addressing the objectives and goals in the requirements documentation.
		Revision 1 IV&V Review The required information is provided in section 1 Introduction and Overview.	**Revision 1 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Requirements Revision 1 Document ID: INL/EXT-09-16789..
Does the Requirements Document describe any constraints on memory or other system constraints?	Software Engineering Practices	**Revision 0 IV&V Review** The requirements are not uniquely identified. Multiple requirements are listed in paragraphs. Testability and traceability of the requirements through the software life cycle cannot be achieved. The requirements need to be uniquely identified as functional, performance, design constraints, attributes and external interface requirements.	**Revision 0 IV&V Review** The requirements need to be uniquely identified as functional, performance, design constraints, attributes and external interface requirements.
		Revision 1 IV&V Review Section 2.2 Application Program Interface (API) Requirements, section 2.4.1 Model Creation and Maintenance, section 2.4.6 Sequence Object, section 2.5 Core Analysis Requirements, section 2.5.7 User-Defined Model Type, section 3.2 Application Program Interface Requirements and section 3.10 Operating System Interface Requirements address design constraint	**Revision 1 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Requirements Revision 1 Document ID: INL/EXT-09-16789.

Software Requirements			
Criteria	**Source**	**Findings**	**Recommendations**
		requirements of the software.	
Does the Requirements Document describe backup and recovery operations, if applicable?	Software Engineering Practices	**Revision 0 IV&V Review** The requirements are included in section 2 Software Requirements and section 3 Interface Requirements Specification within the SAPHIRE Version 8 Software Verification and Validation Plan Volume I. There is no section addressing backup and recovery operations. There is no Software Requirements Documentation.	**Revision 0 IV&V Review** Provide a section addressing backup and recovery operations in the requirements documentation.
		Revision 1 IV&V Review Section 2.2 Application Program Interface (API) Requirements specifies "*The API interface to the database will provide database operations to perform searches, inputs, edit, and delete data. There will be the capability to load data into the database and to extract data from the database into a flat file format, such as a spreadsheet or delimited text file*".	**Revision 1 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Requirements Revision 1 Document ID: INL/EXT-09-16789.
Does the Requirements Document describe assumptions? (Assumptions can lead into Risks)	Software Engineering Practices	**Revision 0 IV&V Review** The requirements are included in section 2 Software Requirements and section 3 Interface Requirements Specification within the SAPHIRE Version 8 Software Verification and Validation Plan Volume I. There is no section addressing assumptions. There is no Software Requirements Documentation.	**Revision 0 IV&V Review** Provide a section addressing assumptions in the requirements documentation.
		Revision 1 IV&V Review Assumptions are addressed in the SAPHIRE Version 8 Software Verification and Validation Plan – Volume 1 (INL/EXT-05-00821) section 4 Design Specification.	**Revision 1 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Requirements Revision 1 Document ID: INL/EXT-09-16789.

Table 4-7 Software Design and Interface Design

Software Design and Interface Design			
Criteria	**Source**	**Findings**	**Recommendations**
Does the Software Design Specification (SDS) present the structure of the software such that it can be translated into code?	NUREG/BR-0167 Section 4.4	**Revision 0 IV&V Review** Major elements of the software as they relate to the requirements are missing. Sections describing the theoretical basis, physical model, mathematical model, control flow, data flow, control logic, and data structure are not present.	**Revision 0 IV&V Review** Complete the major elements of the software design as they relate to the requirements.
		Revision 1 IV&V Review Section 4.1.2 Project controls does not contain design information. Section 4.1.5 Project-Wide Search Design specifies "*This functionality is currently in the concept stage of design.*" These two sections need to provide software design information. Section 4.1.8 External Events Design does not contain design information leading into the design information presented within subsections 4.1.8.1 thru 4.1.8.5. Section 4.7 Phase Mission Design does not contain design information leading into the design information presented with subsections 4.7.1 thru 4.7.4.2. Section 4.4.5 End State Object Design specifies "*End state objects are currently under development*", then the paragraph following goes into the End State Object Design. Section 4.5.9 General Analysis Design specifies "*This analysis is currently in the development stage of design*" then goes into the General Analysis Design. The consistency of detail between design components varies. For example refer to section 4.1.1 Access to Top Level Objects Design and section 4.5.8 ECA Analysis Design.	**Revision 1 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Design and Interface Design Revision 1 Document ID: INL/EXT-09-17069.
Does the SDS provide a description of the major elements/components of the software as related to	NUREG/BR-0167 Section 4.4	**Revision 0 IV&V Review** The software design specification contains design specification for requirements that are not uniquely identified in the software requirements	**Revision 0 IV&V Review** Complete the major elements of the software design as they relate to the requirements.

Software Design and Interface Design			
Criteria	**Source**	**Findings**	**Recommendations**
the requirements in the SRS?		documentation and is missing software design specification for requirements that are in the software requirements documentation.	
		Revision 1 IV&V Review Section 4.1.2 Project controls does not contain design information. Section 4.1.5 Project-Wide Search Design specifies "*This functionality is currently in the concept stage of design.*" These two sections need to provide software design information. The Requirements Traceability Matrix (RTM) as presented in the SAPHIRE Version 8 Software Verification and Validation Plan – Volume II, Appendix D Requirements Traceability Matrix, (INL/EXT-05-00821) is incomplete and currently does not show the traceability between software design components and software requirements. The design components are not uniquely identified.	**Revision 1 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Design and Interface Design Revision 1 Document ID: INL/EXT-09-17069.
Does the SDS provide a technical description in terms of the theoretical basis?	NUREG/BR-0167 Section 4.4	**Revision 0 IV&V Review** Sections describing the theoretical basis, physical model, mathematical model, control flow, data flow, control logic, and data structure are not present.	**Revision 0 IV&V Review** Provide a technical description in terms of the theoretical basis.
		Revision 1 IV&V Review Refer to section 1.1 System Description.	**Revision 1 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Design and Interface Design Revision 1 Document ID: INL/EXT-09-17069.
Does the SDS provide a technical description in terms of the mathematical model?	NUREG/BR-0167 Section 4.4	**Revision 0 IV&V Review** Sections describing the theoretical basis, physical model, mathematical model, control flow, data flow, control logic, and data structure are not present.	**Revision 0 IV&V Review** Provide a technical description in terms of the mathematical model.
		Revision 1 IV&V Review Refer to sections 4.5 Core Analysis Design, 4.7 Phase Mission Design, 4.8 Common Cause Failure Module Design, 4.10 Level 2 Design.	**Revision 1 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Design and Interface Design Revision 1 Document ID: INL/EXT-09-17069.
Does the SDS provide a technical description of the data flow(s) and data	NUREG/BR-0167 Section 4.4	**Revision 0 IV&V Review** Sections describing the theoretical basis, physical model, mathematical model, control flow, data	**Revision 0 IV&V Review** Provide technical descriptions of the data flow(s) and data structure(s).

Software Design and Interface Design			
Criteria	**Source**	**Findings**	**Recommendations**
structure(s)?		flow, control logic, and data structure are not present.	
		Revision 1 IV&V Review Refer to sections 4.1.8.1 General Model Type Information, section 4.3.1 General SAGE-ST Tool Description, section 4.4.6 Sequence Object Design, section 4.6 Embedded Macro Design, section 4.7.1 General Phase Information, section 4.9.1 General Model Type Information, SAPHIRE Version 8 Software Verification and Validation Plan – Volume II, Appendix F Database Schema for SAPHIRE 8, (INL/EXT-05-00821).	**Revision 1 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Design and Interface Design Revision 1 Document ID: INL/EXT-09-17069.
Does the SDS provide the defined range of input values?	NUREG/BR-0167 Section 3.2.4.1 (boundary conditions)	**Revision 0 IV&V Review** Various discussions of inputs are found throughout section 4 Design Specification. A section providing the defined range of input values is not present.	**Revision 0 IV&V Review** Provide the defined range of input values.
		Revision 1 IV&V Review Various discussions of inputs are found throughout section 4 Design Specification. Refer to section 4.1.6 User Selectable Constants Design, section 4.1.8 External Events Design, section 4.4 Core Modeling Design "*The input screens will be dynamic and display only relevant information based on previous user selection and input.*", section 4.5 Core Analysis Design, 4.7 Phase Mission Design, 4.8 Common Cause Failure Module Design, 4.9 External Events Design, section 4.10 Level 2 Design, section 4.11 SDP Workspace Design, section 4.12 Events and Condition Assessment Workspace Design.	**Revision 1 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Design and Interface Design Revision 1 Document ID: INL/EXT-09-17069.
Does the SDS provide the defined range of output values?	NUREG/BR-0167 Section 3.2.4.1 (boundary conditions)	**Revision 0 IV&V Review** Various discussions of outputs are found throughout section 4 Design Specification. A section providing the defined range of output values is not present.	**Revision 0 IV&V Review** Provide the defined range of output values.
		Revision 1 IV&V Review Various discussions of outputs are found throughout section 4 Design Specification. Refer to section 4.1.6 User Selectable Constants	**Revision 1 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Design and Interface Design Revision 1 Document ID: INL/EXT-09-17069.

Software Design and Interface Design			
Criteria	**Source**	**Findings**	**Recommendations**
		Design, section 4.5 Core Analysis Design.	
Has the "Test Plan" and "Test Suite" for validating the software (by the development team) been addressed?	NUREG/BR-0167 Appendix B	**Revision 0 IV&V Review** Section 4.6 Embedded Macro Design references the previously used Microsoft Visual Test suite, but no reference to the hardware platform used for testing. Section 5 Test Specification lists the features to be tested and features not tested. No reference is made to address the actual Test Plan and Test Suite for validating the software in section 4 Design Specification.	**Revision 0 IV&V Review** Provide information addressing the Test Plan and Test Suite for validating the software.
		Revision 1 IV&V Review Refer to section 4.6 Embedded Macro Design. The SAPHIRE Version 8 Software Verification and Validation Plan – Volume II (INL/EXT-05-00821), sections 6 Test Specification, 7 Test Methodologies, 8 Test Phases and 9 Development and Test Environment address these criteria.	**Revision 1 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Design and Interface Design Revision 1 Document ID: INL/EXT-09-17069.
Has the RTM been updated to map the design components back to the defined requirements and are the design components/requirements mapped to test cases?	NUREG/BR-0167 Section 4.3	**Revision 0 IV&V Review** The Requirements Traceability Matrix is incomplete. Section numbers specified in the RTM do not match section numbers within section 4 Design Specification. There are no individual test cases mapped to requirements and design components.	**Revision 0 IV&V Review** Update the RTM to map design components back to the defined requirements and test cases.
		Revision 1 IV&V Review The Requirements Traceability Matrix (RTM) as presented in the SAPHIRE Version 8 Software Verification and Validation Plan – Volume II, Appendix D Requirements Traceability Matrix, (INL/EXT-05-00821) is incomplete and currently does not show the traceability between software design components and software requirements. The RTM does not list design components that map to requirements. The test cases as listed in the RTM are incomplete ("NA", "None", "To be determined").	**Revision 1 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Design and Interface Design Revision 1 Document ID: INL/EXT-09-17069.
Has the acceptance criteria for specifying how to determine the validity of the software provided, given the results of the test cases?	NUREG/BR-0167 Section 2.6	**Revision 0 IV&V Review** Section 6.3 Test Data and section 7.3 Sources of Data refer to acceptance criteria in general for all tests. Specific acceptance criteria given the results of each test case are not found.	**Revision 0 IV&V Review** Specify how to determine the validity of the software provided, given the results of the test cases.
		Revision 1 IV&V Review	**Revision 1 IV&V Review**

Software Design and Interface Design			
Criteria	**Source**	**Findings**	**Recommendations**
		The following sections presented in the SAPHIRE Version 8 Software Verification and Validation Plan – Volume II (INL/EXT-05-00821) specifies how to determine the validity of the software given the results of the test cases. Section 7.1.1.2 PRA Elements Embodied within SAPHIRE 8.0 specifies "*The success criteria are a specification of the compliment of equipment that must successfully operate to achieve functional success for each branch point or top event. This specification is developed analytically. The success criteria are used to define the boundary conditions for the failure modeling embodied within the corresponding fault tree.*" Section 7.2.1 Test Descriptions provides test results verification criteria. Section 3.4 Test Data specifies "*The test acceptance criteria ranged from a single value (e.g., total core damage frequency) to hundreds of similar values (e.g., core damage frequency from individual accident sequences) to a set of dissimilar values (e.g., different importance measures for fault trees, moments, and percentiles from uncertainty sampling). In all cases, though, knowledgeable PRA personnel or statisticians at INL obtained and verified the results.*" Section 8.3 Sources of Data specifies "*For each test, criteria are developed to determine if SAPHIRE accomplished a task. This generation of acceptance criteria results in a significant amount of information, since a test may use multiple PRA models. For example, the first test (Test-01) is performed using 82 different databases. Also, where applicable, the test evaluated the different mechanisms in SAPHIRE to accomplish the same task. An example of this aspect is the ability to generate end state cut sets using either the predefined end state categories (on the event tree) or using the end state partition rules.*"	Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Design and Interface Design Revision 1 Document ID: INL/EXT-09-17069.

Software Design and Interface Design			
Criteria	**Source**	**Findings**	**Recommendations**
		Section 8.4 Entrance and Exit Criteria specifies "*The entrance criteria for testing are to obtain the stored test repository and associated project databases from the revision control system. The test scripts will be exercised as noted in the script. The exit criteria for testing are to check the suite test output results file for any failed tests. Note that one test has been designed to always fail and is used as a "false positive" results to ensure functionality of the designed comparison against the QA benchmarked results.*"	
Are the test case identifiers unique/unambiguous?	NUREG/BR-0167 Section 6.2, 2.6.2	**Revision 0 IV&V Review** Test case identifiers are Test-01 through Test-66.	**Revision 0 IV&V Review** None.
		Revision 1 IV&V Review Test case identifiers are listed in the SAPHIRE Version 8 Software Verification and Validation Plan – Volume II (INL/EXT-05-00821), section 7.2.1 Test Descriptions.	**Revision 1 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Design and Interface Design Revision 1 Document ID: INL/EXT-09-17069.
Has a data dictionary been developed?	Software Engineering Practices	**Revision 0 IV&V Review** Develop the Data Dictionary defining items computed in the code. What they are and what they do.	**Revision 0 IV&V Review** Define in the Data Dictionary items computed in the code, what they are and what they do.
		Revision 1 IV&V Review The Data Dictionary has been developed. The Data Dictionary contains database table names, descriptions of the database tables and data types, data lengths and key information. The Data Dictionary does not contain information that defines items computed in the code, what they are and what they do. Define in the Data Dictionary items computed in the code, what they are and what they do.	**Revision 1 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Design and Interface Design Revision 1 Document ID: INL/EXT-09-17069.
If the SRS is found to require an update, has the SRS been updated, information represented correctly, completely, and accurately in the SRS?	NUREG/BR-0167 Section 4.3, Section 6	**Revision 0 IV&V Review** Refer to document Independent Verification and Validation Of SAPHIRE 8 Software Requirements Project Number: N6423 U.S. Nuclear Regulatory Commission, Document ID: INL/EXT-09-16789.	**Revision 0 IV&V Review** Refer to document Independent Verification and Validation Of SAPHIRE 8 Software Requirements Project Number: N6423 U.S. Nuclear Regulatory Commission, Document ID: INL/EXT-09-16789.
		Revision 1 IV&V Review Refer to document Independent Verification and Validation Of SAPHIRE 8 Software Requirements Project Number: N6423 U.S. Nuclear Regulatory	**Revision 1 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Design and Interface Design Revision 1 Document ID: INL/EXT-09-17069.

Software Design and Interface Design			
Criteria	**Source**	**Findings**	**Recommendations**
		Commission, Document ID: INL/EXT-09-16789 Revision 1.	
Have all documents, including revised documents from the Requirements phase, been placed under Configuration Control and were Configuration Control procedures been performed completely and accurately?	NUREG/BR-0167 Section 6	**Revision 0 IV&V Review** The requirements are included in section 2 Software Requirements and section 3 Interface Requirements Specification, the design is in section 4 Design Specification and section 5 Test Specification is within the SAPHIRE Version 8 Software Verification and Validation Plan Volume I. Section 6 Test Methodologies is within the SAPHIRE Version 8 Software Verification and Validation Plan Volume II.	**Revision 0 IV&V Review** None.
		Revision 1 IV&V Review SAPHIRE Version 8 Software Verification and Validation Plan Volume I (INL/EXT-05-00821) and SAPHIRE Version 8 Software Verification and Validation Plan Volume II (INL/EXT-05-00821) are baselined using the revision control system (RCS) described in the Software Configuration Management Plan (INL/EXT-09-16696).	**Revision 1 IV&V Review** None.
Have Peer Reviews, Software Requirements Reviews, Preliminary Design Reviews, Critical Design Reviews and Qualification Readiness Reviews been performed, with recorded results (usually via checklist or pre-approved form), and placed under configuration control? NOTE: IV&V activities require attendance at all major life-cycle reviews and audits.	NUREG/BR-0167 Section 3.1 and 3.2.2, 3.2.3	**Revision 0 IV&V Review** Peer reviews are not occurring per NRC Sponsor request/requirement.	**Revision 0 IV&V Review** Code walkthroughs and Peer Reviews would assist in making this determination apparent but IV&V has not identified evidence that these requirements/reviews have been performed (they are not under Configuration Control). IV&V has been directed to attend these reviews but it does not appear that these reviews are being performed.
		Revision 1 IV&V Review Previous reviews, SAPHIRE 8 Build Alpha Preliminary Design Review April 25, 2006, SAPHIRE 8 Design Review from Audit August 9, 2007, Design Review Comments On SDP Interface NRC April 23 2008, SAPHIRE 8.0.3.31 Design Review Modifications to Cut Set Viewer April 24, 2008, Design Review From Audit December 3, 2008, current code reviews using the SAPHIRE Version 8 Software Verification and Validation Plan – Volume II (INL/EXT-05-00821), Appendix C Coding Standards are baselined using the revision control system (RCS) described in the Software Configuration	**Revision 1 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Design and Interface Design Revision 1 Document ID: INL/EXT-09-17069.

Software Design and Interface Design			
Criteria	**Source**	**Findings**	**Recommendations**
		Management Plan (INL/EXT-09-16696).	

Table 4-8 System Test Plan

System Test Plan			
Criteria	**Source**	**Findings**	**Recommendations**
Has a System Test Plan been initiated?	NUREG/BR-0167 Section 4.9.1	**Revision 0 IV&V Review** Refer to the SAPHIRE Version 8 System Test Plan Document ID: INL/EXT-09-16455. Criteria satisfied.	**Revision 0 IV&V Review** None.
Does the System Test Plan identify WHAT test activities will be performed?	Appendix B, Glossary (Test Plan)	**Revision 0 IV&V Review** Section 1.2 Beta Testing states "*Beta testing is following a beta test plan*." Section 3 Independent Verification and Validation (IV&V) states "*For the high level areas, the IV&V team will be reviewing and testing as described in the NUREG/BR-0167 and IEEE STD 101202004…*". Section 4 Software Acceptance Test Plan states "*The Software Acceptance Test Plan documents the acceptance tests that the INL will use to demonstrate that SAPHIRE 8 is ready for official release*." Criteria satisfied.	**Revision 0 IV&V Review** None.
Does the System Test Plan identify the resources, team responsibilities, and techniques to plan, develop, and implement test activities through the life-cycle, and identify testing techniques and test phases?	NUREG/BR-0167 Section 5.2.4	**Revision 0 IV&V Review** Section 1.1 Introduction, paragraph 2 states "*The SAPHIRE System Test Plan (STP) plan is structured around NUREG/BR-0167, Software Quality Assurance Program and Guidelines, (February 1993)*." The criterion is also satisfied in section 1.2 Beta Testing, section 3 Independent Verification and Validation (IV&V), section 4 Software Acceptance Test Plan and Life cycle Phase listed in Table 1 IV&V Tasks Based on NUREG/BR-0167. Criteria satisfied.	**Revision 0 IV&V Review** None.

Table 4-9 Software Acceptance Test Plan

Software Acceptance Test Plan			
Criteria	**Source**	**Findings**	**Recommendations**
Does the test plan exercise or evaluate the software product or part of the software product by manual or automated means to verify that it satisfies specified requirements or to identify differences between expected and actual results?	NUREG/BR-0167 Section 3.2.4	**Revision 0 IV&V Review** Section 2 Testing Approach specifies "The test approach used for SAPHIRE Version 8 will be based upon the test approach for previous releases of the SAPHIRE tool. Taking into consideration lessons learned from the *SV&V efforts, where applicable, actual tests and test specifications from the older testing were used in the SV&V*. Additional tests were developed specifically for the newer SV&V process, primarily due to the fact that the test could be automated. This au*tomation aspect of testing allows the testing team to rerun a battery of calculations as many times as they wish, regardless of the complexity of the test*." Section 2.3 User-Interface Testing specifies "The software development team is investigating a way to test the user interface with a updated scripting technology. This testing approach would allow the team to build scripts with a tool that can simulate user keystrokes and actions. This approach would allow INL to perform automated testing on the user interface and allow INL to do memory leak checking on repetitive user activities without devoting a user to do it." Section 3.2 Plant Models Available In SAPHIRE 8.0 specifies "Originally, the set of written procedures developed for manually testing the ten lead plant models were obtained. These procedures were translated into an automated test script, initially for the Byron (BYRN) and Peach Bottom (PBOT) models. Once these were completed, the automated test scripts for the other lead plant models were easily developed by changing only the inputs and the result tables associated with the script. These changes were subsequently checked to ensure that the proper analysis steps were being applied."	**Revision 0 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Acceptance Test Plan Document ID: INL/EXT-10-18081.

Software Acceptance Test Plan			
Criteria	**Source**	**Findings**	**Recommendations**
		Section 3.6 Requirements Validation specifies "*The entire automated test suite is performed on the application. The test scenarios validate requirements at the system level. A PRA Analyst reviews test data collected from the test scenarios to ensure consistency with predicted results.*"	
Is each software unit being separately tested?	NUREG/BR-0167 Section 3.2.4	**Revision 0 IV&V Review** Section 3.6 Requirements Validation specifies "*Additionally, prototype testing, unit testing and integration testing will be performed on the areas of code affected by the interface upgrade. Prototype testing is the testing of a new feature to see if it has been implemented correctly and if the design of that feature was adequate. This would be done to give the developer a confirmation of that the feature as designed meets the needs of the user. Unit testing is the testing of individual functional units of the code. The main difference between unit testing and prototype testing is that the prototype testing helps set the requirements while unit testing ensures that the unit meets the requirements.* *Integration testing is the testing of the entire code. It is mainly the testing of how all the individual units work together to ensure that the units interact properly and according to requirements.*"	**Revision 0 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Acceptance Test Plan Document ID: INL/EXT-10-18081.
Is integration testing being carried out?	NUREG/BR-0167 Section 3.2.4	**Revision 0 IV&V Review** Section 3.6 Requirements Validation specifies "*Additionally, prototype testing, unit testing and integration testing will be performed on the areas of code affected by the interface upgrade. Prototype testing is the testing of a new feature to see if it has been implemented correctly and if the design of that feature was adequate. This would be done to give the developer a confirmation of that the feature as designed meets the needs of the user. Unit testing is the testing of individual functional units of the code. The main difference between unit testing and prototype testing is that the prototype testing helps set the requirements while unit testing ensures that the unit meets the*	**Revision 0 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Acceptance Test Plan Document ID: INL/EXT-10-18081.

Software Acceptance Test Plan			
Criteria	**Source**	**Findings**	**Recommendations**
		requirements. *Integration testing is the testing of the entire code. It is mainly the testing of how all the individual units work together to ensure that the units interact properly and according to requirements.*"	
Are the test descriptions within the test plan sponsor-approved?	NUREG/BR-0167 Section 3.2.4.3	**Revision 0 IV&V Review** Refer to the REVISION LOG page 1. Multiple updates have been made based upon NRC comments.	**Revision 0 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Acceptance Test Plan Document ID: INL/EXT-10-18081.
Does the test plan require test witnesses?	NUREG/BR-0167 Section 3.2.4.3	**Revision 0 IV&V Review** Section 4.2 Participants specifies "*A member of the software development team starts the test run and examines the test results. A member of the SV&V team should be present at the start of the test and when the software team member checks the overall result of the test run.*"	**Revision 0 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Acceptance Test Plan Document ID: INL/EXT-10-18081.
Does the test plan require a record of all nonconformances?	NUREG/BR-0167 Section 3.2.4.3	**Revision 0 IV&V Review** Section 1.2 Project Scope and Organization specifies "*The organizational structure of the SAPHIRE software development team influences and controls the software quality. Roles and responsibilities within the organizational structure provide the development team with the freedom, flexibility and objectivity to evaluate and monitor the software quality as well as verify problem resolutions. This structure enables the development team to tailor the maintenance and development activities, techniques, and methodologies for problem identification, reporting and resolution, testing, records retention, and configuration management.*"	**Revision 0 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Acceptance Test Plan Document ID: INL/EXT-10-18081.
Does the test plan require a test report?	NUREG/BR-0167 Section 3.2.4.3	**Revision 0 IV&V Review** Section 3.5 Test Documents specifies "*All product documentation is in accordance with Customer procedures documented in the NRC Form 189, Revision 7.*" NRC Form 189, JCN Y6394, Revision 7, Section 8 Reporting Requirements and Schedule, Section A Technical Reports, third bullet "*The testing and validation efforts and results*".	**Revision 0 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Acceptance Test Plan Document ID: INL/EXT-10-18081.
Does the test plan provide regression	NUREG/BR-0167 Section 3.2.4.3	**Revision 0 IV&V Review** Section 2.2 Features Not Tested specifies	**Revision 0 IV&V Review** Refer to the Independent Verification and Validation Of

Software Acceptance Test Plan			
Criteria	**Source**	**Findings**	**Recommendations**
testing to ensure that changes did not introduce errors into previously accepted software?		"*However, if a modification is made to SAPHIRE, for example, to update the recovery rule algorithm, the existing test suite will ensure the modification did not change test results through regression testing. But the test suite does test the most commonly used mechanisms of performing tasks in SAPHIRE.*"	SAPHIRE 8 Software Acceptance Test Plan Document ID: INL/EXT-10-18081.
Does the test plan prescribe the approach to be taken for intended testing activities?	NUREG/BR-0167 Appendix B	**Revision 0 IV&V Review** Section 2 Testing Approach provides the information required.	**Revision 0 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Acceptance Test Plan Document ID: INL/EXT-10-18081.
Does the test plan identify the items to be tested?	NUREG/BR-0167 Appendix B	**Revision 0 IV&V Review** Section 2.1 Features to be tested provides the information required.	**Revision 0 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Acceptance Test Plan Document ID: INL/EXT-10-18081.
Does the test plan identify the requirements being tested?	NUREG/BR-0167 Appendix B	**Revision 0 IV&V Review** Section 4.5 Requirements specifies "*The requirements validated are listed at the beginning of each test macro script.*"	**Revision 0 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Acceptance Test Plan Document ID: INL/EXT-10-18081.
Does the test plan identify the testing to be performed?	NUREG/BR-0167 Appendix B	**Revision 0 IV&V Review** Section 3.3.1 Descriptions identifies the testing to be performed.	**Revision 0 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Acceptance Test Plan Document ID: INL/EXT-10-18081.
Does the test plan identify the test schedules?	NUREG/BR-0167 Appendix B	**Revision 0 IV&V Review** Section 6 Schedule specifies "*See NRC Form 189, Revision 7, for Job Code Y6394, Maintain and Support SAPHIRE Code and Library of PRA document for detailed schedule activities.*"	**Revision 0 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Acceptance Test Plan Document ID: INL/EXT-10-18081.
Does the test plan identify the personnel requirements?	NUREG/BR-0167 Appendix B	**Revision 0 IV&V Review** Section 5.3 Staffing and Training specifies "*Test performers and test developers of the team need to be familiar with the SAPHIRE 8 macro language, DOS batch files and scripting, and use of the Microsoft Windows platforms to support the testing effort.*"	**Revision 0 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Acceptance Test Plan Document ID: INL/EXT-10-18081.
Does the test plan identify the reporting requirements?	NUREG/BR-0167 Appendix B	**Revision 0 IV&V Review** Section 3.5 Test Documents specifies "*All product documentation is in accordance with Customer procedures documented in the NRC Form 189, Revision 7.*"	**Revision 0 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Acceptance Test Plan Document ID: INL/EXT-10-18081.
Does the test plan identify the evaluation	NUREG/BR-0167 Appendix B	**Revision 0 IV&V Review** Section 3.1.1.2 PRA Elements Embodied within	**Revision 0 IV&V Review** Refer to the Independent Verification and Validation Of

Software Acceptance Test Plan			
Criteria	**Source**	**Findings**	**Recommendations**
criteria?		SAPHIRE 8.0 specifies "*The success criteria are a specification of the compliment of equipment that must successfully operate to achieve functional success for each branch point or top event. This specification is developed analytically. The success criteria are used to define the boundary conditions for the failure modeling embodied within the corresponding fault tree.*" Section 3.3.1 Test Descriptions provides test results verification criteria. Section 3.4 Test Data specifies "*The test acceptance criteria ranged from a single value (e.g., total core damage frequency) to hundreds of similar values (e.g., core damage frequency from individual accident sequences) to a set of dissimilar values (e.g., different importance measures for fault trees, moments, and percentiles from uncertainty sampling). In all cases, though, knowledgeable PRA personnel or statisticians at INL obtained and verified the results.*" Section 4.3 Sources of Data specifies "*For each test, criteria are developed to determine if SAPHIRE accomplished a task. This generation of acceptance criteria results in a significant amount of information, since a test may use multiple PRA models. For example, the first test (Test-01) is performed using 82 different databases. Also, where applicable, the test evaluated the different mechanisms in SAPHIRE to accomplish the same task. An example of this aspect is the ability to generate end state cut sets using either the predefined end state categories (on the event tree) or using the end state partition rules.*" Section 4.4 Entrance and Exit Criteria specifies "*The entrance criteria for testing are to obtain the stored test repository and associated project databases from the revision control system. The test scripts will be exercised as noted in the script.* *The exit criteria for testing are to check the suite test output results file for any failed tests. Note that*	SAPHIRE 8 Software Acceptance Test Plan Document ID: INL/EXT-10-18081.

Software Acceptance Test Plan			
Criteria	**Source**	**Findings**	**Recommendations**
		one test has been designed to always fail and is used as a "false positive" results to ensure functionality of the designed comparison against the QA benchmarked results."	
Does the test plan identify any risks requiring contingency planning?	NUREG/BR-0167 Appendix B	**Revision 0 IV&V Review** Section 1.2 Project Scope and Organization provide the quality level designator that identifies the relative risk associated with the failure of items or activities. "*For the SAPHIRE 8 development project, the INL-derived QA program (LWP-13620) quality level has been set at Quality Level 3.*" "***Quality Level 3*** *software is software whose failure creates "low" risk. This software requires a low degree of rigor during the software life cycle.*"	**Revision 0 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Software Acceptance Test Plan Document ID: INL/EXT-10-18081.

Table 4-10 Volume 3 Users' Guide

Volume 3 Users' Guide			
Criteria	**Source**	**Findings**	**Recommendations**
Is the User Manual complete, including: A description of User's interaction with the software, description of required training necessary to use the software, input and output specifications and formats with sample cases, limitations of the software, anticipated errors and user response to errors, error messages with workarounds (when applicable), information about user support?	NUREG/BR-0167 Section 4.7	**Revision 0 IV&V Review** The information presented within the Volume 3 Users' Guide provides a complete description of the user's interaction with the software, limitations and input and output specifications showing formats with sample cases. References to the description of required training necessary to use the software, anticipated errors and user response to errors, error messages with workarounds and information about user support were not found.	**Revision 0 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Volume 3 Users' Guide Document ID: INL/EXT-10-18028.
Does the User Manual provide instructions on how to install, setup, and access the application?	NUREG/BR-0167 Section 2.6	**Revision 0 IV&V Review** Installation instructions are provided in section 1.4 Installation of SAPHIRE along with un-installation instructions in section 1.5 Un-installation of SAPHIRE. Setup instructions are given in section 1.6 SAPHIRE Project Settings and the sub-sections in section 1.7 SAPHIRE User Settings. Specific instructions for accessing the SAPHIRE 8 application were not found. The ABSTRACT states "*This reference guide will introduce the SAPHIRE Version 8.0 software. A brief discussion of the purpose and history of the software is included along with general information such as installation instructions,* ***starting and stopping*** *the program, and some pointers on how to get around inside the program. Next, database concepts and structure are discussed. Following that discussion are nine sections, one for each of the menu options on the SAPHIRE main menu, wherein the purpose and general capabilities for each option are furnished. Next, the capabilities and limitations of the software are provided.*" The following	**Revision 0 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Volume 3 Users' Guide Document ID: INL/EXT-10-18028.

Volume 3 Users' Guide			
Criteria	**Source**	**Findings**	**Recommendations**
		information in section 1.2 Overview of SAPHIRE Users' Guide "*When starting SAPHIRE, the main screen displays will be shown as they appear on the video display (**Error! Reference source not found.**)*", and section 2.1 Opening a Project "*If there is not a current project available or a second session of SAPHIRE is started*" were found, but specific instructions for starting SAPHIRE 8 were not found.	
Does the User Manual provide a complete, consistent, correct, and adequate coverage of software functionality and is it presented in a "logical" and hierarchical order?	NUREG/BR-0167 Section 2.2, Section 4.3	**Revision 0 IV&V Review** The information presented within the Volume 3 Users' Guide provides a complete, consistent, correct, and adequate coverage of software functionality and is presented in a logical and hierarchical order.	**Revision 0 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Volume 3 Users' Guide Document ID: INL/EXT-10-18028.
Does the User Manual provide screen shots, reports, examples etc. to provide end users' with typical/example outputs (for reference, help, etc.)?	NUREG/BR-0167 Section 4.7	**Revision 0 IV&V Review** Multiple screen shots, reports and examples are provided within the Volume 3 Users' Guide for reference.	**Revision 0 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Volume 3 Users' Guide Document ID: INL/EXT-10-18028.
Does the User Manual provide instructions on accessing on-line help features (including User Support)?	NUREG/BR-0167 Section 4.7	**Revision 0 IV&V Review** The Volume 3 Users' Guide does not provide instructions for accessing the on-line help features or User Support. Information is provided on page v within the FOREWORD section referencing the seven volumes that address the use and capabilities of SAPHIRE Version 8. "*This NUREG-series report comprises seven volumes, which address use and capabilities of SAPHIRE Version 8. Volume 1, "Overview/Summary," gives an overview of the functions available in SAPHIRE and presents general instructions for using the software. Volume 2, "Technical Reference," discusses the theoretical background behind the SAPHIRE functions. Volume 3, "SAPHIRE Users Guide," provides installation instructions and a step-by-step approach to using the program's features. Volume 4, "SAPHIRE Tutorial," provides an example of the overall process of constructing a*	**Revision 0 IV&V Review** Refer to the Independent Verification and Validation Of SAPHIRE 8 Volume 3 Users' Guide Document ID: INL/EXT-10-18028.

Volume 3 Users' Guide			
Criteria	**Source**	**Findings**	**Recommendations**
		PRA database. Volume 5, "SAPHIRE Workspace Reference Guide," discusses the use of analysis Workspaces. Volume 6, "SAPHIRE Quality Assurance," discusses QA methods and tests. Lastly, Volume 7, "SAPHIRE Data Loading," assists the user in entering PRA data into SAPHIRE using the built-in MAR-D ASCII-text file data transfer process."	

Attachment 5: Project Best Practices

The SAPHIRE team is improving the software development process by conducting Independent Verification and Validation activities to provide a process to support the Nuclear Regulatory Commission in ensuring a high-quality software development process and product through a formal process.

The SAPHIRE Independent Verification and Validation activities are being conducted by a team that is both technically and managerially separate from the organization responsible for developing the product. The verification process ensures that the products and processes of each major activity of the life cycle meet the standards for the products and the objectives of that major activity. The validation process demonstrates that the software meets its requirements. Testing is the process of detecting errors and verifying performance.

The SAPHIRE product is implementing and following the requirements for Level 1 software defined in Section 1.2 of NUREG/BR-0167 Software Quality Assurance Program and Guidelines, technical application software used in a safety decision.

The Nuclear Regulatory Commission will perform an audit of the software Quality Assurance implementation once a year against the requirements of NUREG/BR-0167 Software Quality Assurance Program and Guidelines.

SAPHIRE configuration management for version control, source code and documentation uses the Revision Control System to maintain the integrity of the software and its documentation. The Idaho National Laboratory software developers use version control for both the formally released SAPHIRE versions, as well as for source code. For each formal release of the software, the developers perform an acceptance test: the software must pass a suite of automated tests prior to official release. Independent verification and validation tests and test observations are also being performed as given in the Independent Verification and Validation Plan (INL/EXT-09-15649) to support the first general release version of SAPHIRE 8.

The organization, tasks, roles and responsibilities within the SAPHIRE team are defined. The organizational structure of the SAPHIRE software development team influences and controls the software quality. Roles and responsibilities within the organizational structure provide the development team with the freedom, flexibility and objectivity to evaluate and monitor the software quality as well as verify problem resolutions. This structure enables the development team to tailor the maintenance and development activities, techniques, and methodologies for problem identification, reporting and resolution, testing, records retention, and configuration management.

Peer reviews and Code Walkthroughs are being implemented. As part of the SAPHIRE 8 development, the team will perform and document, as appropriate, periodic peer reviews and code walkthroughs, including reviews of preliminary and critical designs proposals.

SAPHIRE has a defined quality assessment and improvement approach. Product quality is a key component of SAPHIRE. The SAPHIRE Quality Assurance processes documented in the report provides the basis for setting quality objectives, progress, and the necessary framework for quality improvements.

Attachment 6: Project Lessons Learned

Ensure that all software requirements are documented. The requirements form the basis for the software plans, products, and activities. Ensure that the documented requirements define the response of the software to anticipated classes of input data (including erroneous data) and provide the information and detail necessary to design the software (e.g., mathematical models, equations, data requirements). Because requirements inevitably change as a project evolves, manage the requirements throughout the development and maintenance efforts in accordance with well defined change control procedures

Ensure that all software requirements are uniquely defined as functional, performance, design constraints, attributes and external interface.

Ensure that all software requirements are testable. If a software requirement is not testable, then it is not a software requirement.

Conduct the Software Requirements Review at the end of the requirements definition to assure the intent, completeness, verifiability, consistency and technical feasibility of the requirements.

Ensure that all software design components are documented and meet the requirements defined in the software requirements documentation.

Ensure that all software design components are uniquely defined and specify the overall structure of the software so that it can be translated into code.

Conduct the Preliminary Design Review when the preliminary design (software architecture) has been designed to assure that the preliminary design is complete (meets all the requirements), verifiable (through testing or other means), consistent, and technically feasible.

Conduct the Critical Design Review when the design is complete to assure that the design is complete (meets all the requirements and meets design completion criteria), verifiable (through testing or other means), consistent, and technically feasible.

Ensure that the Requirements Traceability Matrix shows all software requirements are mapped to design components and test cases.

Conduct formal peer inspections in order to find errors.

Ensure that the documentation is maintained.

Attachment 7: CodeHealer Analysis

Table 7-1 provides an overview of the basic constructs used in the SAPHIRE version 8 source code using the source code analysis and verification tool *CodeHealer for Delphi* © Version 2.5.0. Any and all extra characters after the terminating "end." of a program, unit or project file are ignored, and any extra lines are always treated as blank lines, regardless of what they contain. It is possible for the total number of lines to be greater than the sum of the number of blank lines, the number of code lines and the number of comment lines if one or more lines contain a number of spaces or tab characters and nothing else, since these lines do not fit in any of the counted categories.

The majority of the metrics values are self explanatory from their name, such as the number of characters, lines, units or other basic item, so are not defined further here. Certain metrics values, however, justify further explanation, and these are listed below.

Note that because the metric values are displayed on a module basis, the **Branches**, **Loops** and **Cyclomatic complexity** metrics values are calculated and shown as an **average** of the values for each function, procedure and (class) method in the module, rather than as a **total** for the module.

Branches – This metric value is the average number of branches per function or procedure that occur within the source code of the selected items. A branch in the source code is an "**if**", "**goto**", "**try .. except**" statement or a case item or "**else**" value of a "**case**" statement, and represents a point where the flow of control may take one of two alternative routes. The number of branches within a function, procedure or module is (historically) considered as a very basic indicator of its complexity.

Loops – This metric value is the total number of loops that occur within the source code of the selected items. A loop in the source code is a "**for**", "**repeat**" or "**while**" statement, and represents a point where the flow of control may take one of two alternative routes on more than one occasion. The number of loops within a function, procedure or module is (historically) considered as a very basic indicator of its complexity.

Cyclomatic Complexity – This metric value was introduced by Thomas McCabe in 1976, and it measures the number of possible paths through a source code item. It is widely considered a broad measure of soundness and confidence for a program, and also gives an indication of the minimum number of test cases that are necessary to properly test each item of the program. The cyclomatic complexity of a module is calculated as the average of the cyclomatic complexity values of each function, procedure and (class) method of the module. Table 7-2 provides the individual SAPHIRE Version 8 source code files Cyclomatic Complexity. The cyclomatic complexity of a function, procedure or (class) method is calculated as:

1 + **Branches** + **Loops** + Number of logical "**and**" and "**or**" operations within conditional expressions where **Branches** and **Loops** are calculated as defined above.

The Carnegie Mellon Software Engineering Institute definition of Cyclomatic Complexity can be viewed at "*CMU – Cyclomatic Complexity*", and part of that definition is the following suggested set of threshold values that may be used to assess the risk associated with modifying a module:

Complexity	**Risk evaluation for the module or program**
1 – 10	Relatively simple, without much risk
11 – 20	More complex, moderate risk
21 – 50	Complex, high risk
Greater than 50	Untestable (very high risk)

To access the file contents shown in Table 7-1, refer to file "*SAPHIRE8-Metrics-100405.pdf*" included on the CD as an addendum to this report. To access the file:

1. Open Internet Explorer.
2. Select "Open" from the "File" menu.
3. The "Open" window will be displayed.
4. Select the "Browse…" button from the "Open" window.
5. The "Windows Internet Explorer" window will be displayed.
6. Navigate to the "*SAPHIRE8-Metrics-100405.pdf*" file located on the CD.
7. Select the "*SAPHIRE8-Metrics-100405.pdf*" file on the CD.
8. Select the "Open" button from the "Windows Internet Explorer" window.
9. The "Windows Internet Explorer" window will close.
10. Select the "OK" button from the "Open" window.

Table 7-1 Source Code Metrics for CodeHealer Project SAPHIRE Version 8

Metric Value	Total
Source Files	1,291
Programs	6
Libraries	12
Packages	1
Units	1,272
Forms	405
Main Used Units	1,428
Used Units (not unique)	20,981
Characters	53,035,946
Lines	1,846,865
Blank Lines	371,863
Branches (average)	2
Loops (average)	1
Cyclomatic Complexity (average)	**4**
Commented Code Lines	41,869
Pure Code Lines	1,182,202
Code Lines	1,224,071
Significant Comment Lines	242,243
Blank Comment Lines	7,711
Comment Lines	249,954
Total Comments (%)	19%
Significant Comments (%)	19%
Classes	1,775
Interfaces	27
Objects	0
Properties	5,346
Constructors	1,295
Destructors	736
Functions	12,439
Procedures	32,047
Initializations	84
Finalizations	35
Keywords	796,973
Directives	65,281
Identifiers	2,168,392
Hex Integers	8,665
Integers	174,790
Labels	2
Reals	11,735
String Constants	75,985

Table 7-2 Individual SAPHIRE Version 8 Source Code File Cyclomatic Complexity

File Name	File Path	Cyclomatic Complexity
AboutUnit	C:\Saphire 8\Debug\source\schemaObjects\	1
AdjListPanel	C:\Saphire 8\Debug\source\DelphiSource\	6
AnalysisPointETObject.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	4
AnalysisPointFTCSPathObject.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	7
AnalysisPointFTObject.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	6
AnalysisPointObject.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	2
AnalyzeGeneral.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
AnalyzeSDP.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
API_AnalysisType.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	2
API_Assess.pas	C:\Saphire 8\Debug\source\DelphiSource\	0
API_Assess.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	1
API_BlockDiagram.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	0
API_Cat.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	1
API_Category.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	1
API_ChgSet.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	2
API_CompareProject.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	1
API_Constants.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	1
API_DefSolve.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	1
API_EndState.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	1
API_ESCat.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	1
API_EvCat.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	1
API_EvCmpLib.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	2
API_Event.pas	C:\Saphire 8\Debug\source\DelphiSource\	0
API_Event.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	2
API_EventSet.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	1
API_EventTree.pas	C:\Saphire 8\Debug\source\DelphiSource\	0
API_EventTree.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	2
API_Extract.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	2
API_Gate.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	1
API_Gather.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	1
API_Generate.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	1
API_Histogram.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	1
API_Importance.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	0
API_Load.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	1
API_Logic.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	1
API_MergeProjects.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	1
API_Partition.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	0
API_Phase.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	1
API_Project.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	2
API_Quantify.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	0
API_RaspCCF.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	1
API_Recover.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	0
API_ReportCust.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	1
API_Reports7.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	4
API_Risk.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	2
API_RiskErr.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	0
API_RiskMacro.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	1
API_RulesCode.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	2
API_Sequence.pas	C:\Saphire 8\Debug\source\DelphiSource\	0
API_Sequence.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	1
API_Simulation.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	1
API_Slice.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	1
API_System.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	2
API_TreeRead.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	1

File Name	File Path	Cyclomatic Complexity
API_Uncertainty.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	1
API_Update.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	0
API_WorkSpace.pas	C:\Saphire 8\Debug\source\DelphiSource\	1
API_WorkSpace.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	1
APIX_XOverMain.pas	C:\Saphire 8\Debug\source\DelphiSource\RiskApi\	3
ApplicableTypes.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
ApplicableTypes.pas	C:\Saphire 8\Debug\source\DelphiSource_ProjObjects\	3
ASCIIX.pas	C:\Saphire 8\Debug\source\	0
AscRptLib.pas	C:\Saphire 8\Debug\source\	6
AutoFT.pas	C:\Saphire 8\Debug\source\DelphiSource\BddItems\	***14***
AuxSpec.pas	C:\Saphire 8\Debug\source\	0
BaseDef.pas	C:\Saphire 8\Debug\source\DelphiSource\PlugIns\	1
BaseDefs.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
BasicFieldClass.pas	C:\Saphire 8\Debug\source\	2
BasicRelationClass.pas	C:\Saphire 8\Debug\source\	2
BasicSchemaClass.pas	C:\Saphire 8\Debug\source\	2
BENodeEditor.pas	C:\Saphire 8\Debug\source\DelphiSource\	***13***
BENodeEditor.pas	C:\Saphire 8\Debug\source\DelphiSource\EventEditing\	5
BEObject.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
BEObject.pas	C:\Saphire 8\Debug\source\DelphiSource_ProjObjects\	4
BEProbability.pas	C:\Saphire 8\Debug\source\DelphiSource\	***14***
BEQuick.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
BEQuick.pas	C:\Saphire 8\Debug\source\DelphiSource_ProjObjects\	3
BESelectList.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
BinLib.pas	C:\Saphire 8\Debug\source\	3
BitLib.pas	C:\Saphire 8\Debug\source\	2
BitMapFont.pas	C:\Saphire 8\Debug\source\	5
BitSetObj.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
BlkEdit.pas	C:\Saphire 8\Debug\source\	3
BlockDataLib.pas	C:\Saphire 8\Debug\source\	4
BlockIO.pas	C:\Saphire 8\Debug\source\	8
BMPLib.pas	C:\Saphire 8\Debug\source\	9
BookmarksObj.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
Btree.pas	C:\Saphire 8\Debug\source\	6
BtreeBuf.pas	C:\Saphire 8\Debug\source\	7
BtrList.pas	C:\Saphire 8\Debug\source\	4
BtrListClass.pas	C:\Saphire 8\Debug\source\	2
BtrStack.pas	C:\Saphire 8\Debug\source\	4
BufIO.pas	C:\Saphire 8\Debug\source\	6
Cache.pas	C:\Saphire 8\Debug\source\	6
CatAPI.pas	C:\Saphire 8\Debug\source\DelphiSource\	0
CategoryObj.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
CategoryObj.pas	C:\Saphire 8\Debug\source\DelphiSource_ProjObjects\	3
CatLib.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
CCFData.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
CCFEvLib.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
CCFRAlpha.pas	C:\Saphire 8\Debug\source\DelphiSource\RaspCCF\	4
CCFRBase.pas	C:\Saphire 8\Debug\source\DelphiSource\EventEditing\	4
CCFRBeta.pas	C:\Saphire 8\Debug\source\DelphiSource\RaspCCF\	3
CCFRCalc.pas	C:\Saphire 8\Debug\source\DelphiSource\RaspCCF\	1
CCFRCommon.pas	C:\Saphire 8\Debug\source\DelphiSource\RaspCCF\	2
CCFRData.pas	C:\Saphire 8\Debug\source\DelphiSource\RaspCCF\	4
CCFRDebug.pas	C:\Saphire 8\Debug\source\DelphiSource\RaspCCF\	3
CCFRDLL.dpr	C:\Saphire 8\Debug\source\DelphiSource\RaspCCF\	2
CCFRInterface.pas	C:\Saphire 8\Debug\source\DelphiSource\RaspCCF\	1
CCFRLib.pas	C:\Saphire 8\Debug\source\DelphiSource\RaspCCF\	2

File Name	File Path	Cyclomatic Complexity
CCFRMGL.pas	C:\Saphire 8\Debug\source\DelphiSource\RaspCCF\	4
CCFRObj.pas	C:\Saphire 8\Debug\source\DelphiSource\EventEditing\	4
CCFROutput.pas	C:\Saphire 8\Debug\source\DelphiSource\RaspCCF\	3
CCFRReport.pas	C:\Saphire 8\Debug\source\DelphiSource\RaspCCF\	2
CCFRStag.pas	C:\Saphire 8\Debug\source\DelphiSource\RaspCCF\	4
CCFRUtil.pas	C:\Saphire 8\Debug\source\DelphiSource\RaspCCF\	5
CCFRVBE.pas	C:\Saphire 8\Debug\source\DelphiSource\RaspCCF\	2
CFStag.pas	C:\Saphire 8\Debug\source\DelphiSource\PlugIns\	2
CCLib.pas	C:\Saphire 8\Debug\source\	2
CCProcs.pas	C:\Saphire 8\Debug\source\	***15***
CFGLib.pas	C:\Saphire 8\Debug\source\	6
CGMWin.pas	C:\Saphire 8\Debug\source\	10
ChangeSet.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
ChangeSet.pas	C:\Saphire 8\Debug\source\DelphiSource_ProjObjects\	4
CheckLib.pas	C:\Saphire 8\Debug\source\	1
chgset.pas	C:\Saphire 8\Debug\source\DelphiSource\	0
ChgSetNodeEditor.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
ChgSetNodeEditor.pas	C:\Saphire 8\Debug\source\DelphiSource\EventEditing\	3
ClassCngTreeNode.pas	C:\Saphire 8\Debug\source\DelphiSource\EventEditing\	6
ClipBoard.pas	C:\Saphire 8\Debug\source\	3
CmndLine.pas	C:\Saphire 8\Debug\source\	7
CodeGenCommon.pas	C:\Saphire 8\Debug\source\	6
CodeGenerator.pas	C:\Saphire 8\Debug\source\	3
CodeGenerator.pas	C:\Saphire 8\Debug\source\schemaObjects\	3
CodeLib.pas	C:\Saphire 8\Debug\source\	***13***
CodeMerg.pas	C:\Saphire 8\Debug\source\	***11***
Coder.pas	C:\Saphire 8\Debug\source\	3
CompareBE.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
CompareCS.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
CompareDflt.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
CompareES.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
CompareET.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
CompareFT.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
CompareGT.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
CompareHtml.pas	C:\Saphire 8\Debug\source\DelphiSource\	9
Compress.pas	C:\Saphire 8\Debug\source\	6
Conversions.pas	C:\Saphire 8\Debug\source\	6
Convert.pas	C:\Saphire 8\Debug\source\	4
ConvertReal.pas	C:\Saphire 8\Debug\source\	***11***
Crypto.pas	C:\Saphire 8\Debug\source\	***13***
CtrlBttn.pas	C:\Saphire 8\Debug\source\	2
CtrlCBox.pas	C:\Saphire 8\Debug\source\	2
CtrlComb.pas	C:\Saphire 8\Debug\source\	2
CtrlEdit.pas	C:\Saphire 8\Debug\source\	2
CtrlGrid.pas	C:\Saphire 8\Debug\source\	3
CtrlList.pas	C:\Saphire 8\Debug\source\	3
CtrlLV.pas	C:\Saphire 8\Debug\source\	2
CtrlRBtn.pas	C:\Saphire 8\Debug\source\	2
CtrlRich.pas	C:\Saphire 8\Debug\source\	3
CtrlSBar.pas	C:\Saphire 8\Debug\source\	2
CtrlSppt.pas	C:\Saphire 8\Debug\source\	3
CtrlStat.pas	C:\Saphire 8\Debug\source\	1
CtrlTree.pas	C:\Saphire 8\Debug\source\	3
CtrlWin.pas	C:\Saphire 8\Debug\source\	2
CustCntl.pas	C:\Saphire 8\Debug\source\	0
CustRptLib.pas	C:\Saphire 8\Debug\source\DelphiSource\	***37***

File Name	File Path	Cyclomatic Complexity
DataPack.pas	C:\Saphire 8\Debug\source\hfdll\	0
DBLoad.pas	C:\Saphire 8\Debug\source\	9
DBMerge.pas	C:\Saphire 8\Debug\source\	6
DCompile.pas	C:\Saphire 8\Debug\source\	10
DDAccess.pas	C:\Saphire 8\Debug\source\	9
DDUniversal.pas	C:\Saphire 8\Debug\source\	4
DesignOperation.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	1
Dialog.pas	C:\Saphire 8\Debug\source\	2
Disklib.pas	C:\Saphire 8\Debug\source\	4
Display.pas	C:\Saphire 8\Debug\source\	5
DisplayW.pas	C:\Saphire 8\Debug\source\	7
dlgConfirmReplace.pas	C:\Saphire 8\Debug\source\DelphiSource\RulesEditor\	2
dlgReplaceText.pas	C:\Saphire 8\Debug\source\DelphiSource\RulesEditor\	3
DlgSageSTMain.pas	C:\Saphire 8\Debug\source\	0
dlgSearchText.pas	C:\Saphire 8\Debug\source\DelphiSource\RulesEditor\	2
DMCat.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
DMRegExpMatching.pas	C:\Saphire 8\Debug\source\DelphiSource\	1
DosLib.pas	C:\Saphire 8\Debug\source\	4
DTstGen.pas	C:\Saphire 8\Debug\source\DelphiSource\BddItems\HashTableLib\	3
DWLib.pas	C:\Saphire 8\Debug\source\	4
DWSpec.pas	C:\Saphire 8\Debug\source\	0
EditAnalysisPoint.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	3
EditETAnalysisPoint.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	3
EditEvent.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	3
EditEventEndstate.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	3
EditEventEndstateCol.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	2
EditEventTree.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	3
EditFaultTreeObject.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	6
EditLib.pas	C:\Saphire 8\Debug\source\	6
EditRBlockObject.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
EnvironmentX.pas	C:\Saphire 8\Debug\source\	4
ErrorLog.pas	C:\Saphire 8\Debug\source\	7
ESCatEdit.pas	C:\Saphire 8\Debug\source\DelphiSource\	5
ETGroupObj.pas	C:\Saphire 8\Debug\source\DelphiSource_ProjObjects\	3
ETObject.pas	C:\Saphire 8\Debug\source\DelphiSource_ProjObjects\	3
EventEndObject.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	3
EventIns.pas	C:\Saphire 8\Debug\source\	6
EventObject.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	2
EventScheduler.pas	C:\Saphire 8\Debug\source\DelphiSource\	9
EventSetObj.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
EventTreeObject.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	5
EventView1.pas	C:\Saphire 8\Debug\source\DelphiSource\	0
EvProbList.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
EvTCatObj.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
ExcelOut.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
Exec.pas	C:\Saphire 8\Debug\source\	1
ExpOpt.pas	C:\Saphire 8\Debug\source\	8
ExStorageX.pas	C:\Saphire 8\Debug\source\	4
EZDSLCTS.PAS	C:\Saphire 8\Debug\source\DelphiSource\BddItems\HashTableLib\	0
FastMM4.pas	C:\Saphire 8\Debug\source\fastmm\	6
FastMM4Messages.pas	C:\Saphire 8\Debug\source\fastmm\	0
FaultTreeObject.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	5
FileEdit.pas	C:\Saphire 8\Debug\source\	3
FileFunc.pas	C:\Saphire 8\Debug\source\	6
FileQuery.pas	C:\Saphire 8\Debug\source\	2
Files.pas	C:\Saphire 8\Debug\source\	4

File Name	File Path	Cyclomatic Complexity
FilesOp.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
FileUtil.pas	C:\Saphire 8\Debug\source\	7
FilterFunctions.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
FixLib.pas	C:\Saphire 8\Debug\source\	9
FlagLib.pas	C:\Saphire 8\Debug\source\	4
FldFlags.pas	C:\Saphire 8\Debug\source\	8
Fonts.pas	C:\Saphire 8\Debug\source\	4
Form_BDD_FT_Solve.pas	C:\Saphire 8\Debug\source\DelphiSource\BddItems\	3
Form_ErrorLog.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
Form_Histograms.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
Form_SeqProperties.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
FormAccidentMatrix.pas	C:\Saphire 8\Debug\source\DelphiSource\	5
FormAnalysisType.pas	C:\Saphire 8\Debug\source\DelphiSource\	5
FormAnalysisTypeEdit.pas	C:\Saphire 8\Debug\source\DelphiSource\	1
FormASP.pas	C:\Saphire 8\Debug\source\DelphiSource\	7
FormASP1.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
FormASP2.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
FormASP3.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
FormBE.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
FormBEData.pas	C:\Saphire 8\Debug\source\hfdll\	5
FormBEDataEdit.pas	C:\Saphire 8\Debug\source\DelphiSource\EventEditing\	5
FormBookmarkAdd.pas	C:\Saphire 8\Debug\source\DelphiSource\	1
FormCategories.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
FormCategoryEdit.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
FormChangeBE.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
FormChangeSet.pas	C:\Saphire 8\Debug\source\DelphiSource\EventEditing\	3
FormChangeSetEdit.pas	C:\Saphire 8\Debug\source\DelphiSource\EventEditing\	2
FormChk.pas	C:\Saphire 8\Debug\source\	1
FormCompareDBs.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
FormCustomPrint.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	5
FormCustReportList.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
FormCustRptEdit.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
FormCutSetViewer.pas	C:\Saphire 8\Debug\source\DelphiSource\	5
FormCutsetViewerES.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
FormCutSetViewerET.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
FormCutSetViewerFT.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
FormDesignEdtBase.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	2
FormDocManager.pas	C:\Saphire 8\Debug\source\DelphiSource\	6
FormEditBookmarks.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
FormEditETGroups.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
FormEditEventGroups.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
FormEndStateEdit.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
FormESCategory.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
FormET.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
FormETEditor.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	4
FormETGraphicalDisp.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	6
FormETGraphicOnly.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	2
FormExtractProject.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
FormFlagSetEdit.pas	C:\Saphire 8\Debug\source\DelphiSource\EventEditing\	2
FormFlagSets.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
FormFT.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
FormFTCSGraphicalDisp.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	3
FormFTCSPathViewer.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	1
FormFTEditor.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	3
FormFTGraphicalDisp.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	5
FormFTGraphicOnly.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	2

File Name	File Path	Cyclomatic Complexity
FormGenAn.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
FormGenAn1.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
FormGenAn2.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
FormGenAn3.pas	C:\Saphire 8\Debug\source\DelphiSource\	9
FormGenAn4.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
FormGraphicalDispBase.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	4
FormHistogramEdit.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
FormHistograms.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
FormImpExp.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
FormImport.pas	C:\Saphire 8\Debug\source\DelphiSource\	1
FormImportanceM.pas	C:\Saphire 8\Debug\source\DelphiSource\	5
FormLib.pas	C:\Saphire 8\Debug\source\	7
FormLink.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
FormLinkProgress.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
FormLinkResults.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
FormLoadExtProb.pas	C:\Saphire 8\Debug\source\DelphiSource\ImportExport\	2
FormLoadExtract.pas	C:\Saphire 8\Debug\source\DelphiSource\	***15***
FormLoadExtractProbs.pas	C:\Saphire 8\Debug\source\DelphiSource\	1
FormMacroManager.pas	C:\Saphire 8\Debug\source\DelphiSource\	5
FormMacroRunner.pas	C:\Saphire 8\Debug\source\DelphiSource\	***19***
FormMain.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
FormMinMax.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
FormModelDataEdit.pas	C:\Saphire 8\Debug\source\DelphiSource\EventEditing\	3
FormModelDataTab.pas	C:\Saphire 8\Debug\source\DelphiSource\EventEditing\	3
FormModelType.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
FormModelTypeEdit.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
FormNameDesc.pas	C:\Saphire 8\Debug\source\DelphiSource\	0
FormNewItemData.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	1
FormNewProject.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
FormPhase.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
FormPhaseEdit.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
FormPID.pas	C:\Saphire 8\Debug\source\DelphiSource\	1
FormProjCheck.pas	C:\Saphire 8\Debug\source\DelphiSource\	7
FormProjectUpdate.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
FormPublish.pas	C:\Saphire 8\Debug\source\DelphiSource\	5
FormPublish2.pas	C:\Saphire 8\Debug\source\DelphiSource\	7
FormQuickEditEventES.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	2
FormQuickEditEventESCol.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	2
FormQuickEditEventTree.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	2
FormQuickEditFaultTree.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	2
FormQuickEditTopEvent.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	2
FormQuickSearch.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	1
FormRaspCmpd.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
FormRebuildUpgrade.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
FormResultsViewer.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
FormResultsViewer.pas	C:\Saphire 8\Debug\source\DelphiSource\ResultsViewer\	3
FormResultsViewerES.pas	C:\Saphire 8\Debug\source\DelphiSource\ResultsViewer\	3
FormResultsViewerET.pas	C:\Saphire 8\Debug\source\DelphiSource\ResultsViewer\	4
FormResultsViewerFT.pas	C:\Saphire 8\Debug\source\DelphiSource\ResultsViewer\	2
FormRuleEdETLink.pas	C:\Saphire 8\Debug\source\DelphiSource\RulesEditor\	2
FormRuleEdETPart.pas	C:\Saphire 8\Debug\source\DelphiSource\RulesEditor\	1
FormRuleEdETRec.pas	C:\Saphire 8\Debug\source\DelphiSource\RulesEditor\	1
FormRuleEdFTRec.pas	C:\Saphire 8\Debug\source\DelphiSource\RulesEditor\	1
FormRuleEdProjETRec.pas	C:\Saphire 8\Debug\source\DelphiSource\RulesEditor\	1
FormRuleEdProjFTRec.pas	C:\Saphire 8\Debug\source\DelphiSource\RulesEditor\	1
FormRuleEdProjPart.pas	C:\Saphire 8\Debug\source\DelphiSource\RulesEditor\	1

File Name	File Path	Cyclomatic Complexity
FormRuleEdSlice.pas	C:\Saphire 8\Debug\source\DelphiSource\RulesEditor\	1
FormRuleEdSQPart.pas	C:\Saphire 8\Debug\source\DelphiSource\RulesEditor\	1
FormRuleEdSQRec.pas	C:\Saphire 8\Debug\source\DelphiSource\RulesEditor\	1
FormSampleOps.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
FormSaveWorkspace.pas	C:\Saphire 8\Debug\source\DelphiSource\	1
FormSDP.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
FormSDP1.pas	C:\Saphire 8\Debug\source\DelphiSource\	5
FormSDP2.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
FormSDP3.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
FormSDP4.pas	C:\Saphire 8\Debug\source\DelphiSource\	5
FormSDPAdvancedRpt.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
FormSDPLerfFactors.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
FormSearch.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
FormSearchAdv.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
FormSetChangesBase.pas	C:\Saphire 8\Debug\source\DelphiSource\EventEditing\	4
FormSimulation.pas	C:\Saphire 8\Debug\source\DelphiSource\	5
FormSimulationEdit.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
FormSimulationEvent.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
FormSimulationName.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
FormSimulationState.pas	C:\Saphire 8\Debug\source\DelphiSource\	5
FormSimulationTrigger.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
FormSliceBy.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
FormSolveResults.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
FormSolveSettings.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
FormStartup.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
FormStepManager.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
FormTemplate.pas	C:\Saphire 8\Debug\source\DelphiSource\	6
FormToolBar.pas	C:\Saphire 8\Debug\source\DelphiSource\	1
FormUncertainty.pas	C:\Saphire 8\Debug\source\DelphiSource\	6
FormUserSetting.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
FormViewHtml.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
FormViewPdf.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
FormWarnSPAR.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
FormWManager.pas	C:\Saphire 8\Debug\source\DelphiSource\	5
FormWorkspace.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
FormXReference.pas	C:\Saphire 8\Debug\source\DelphiSource\	9
FrameDuration.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
FrameETGraphicalDisp.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	6
FrameFTCSGraphicalDisp.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	3
FrameFTGraphicalDisp.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	5
FrameGraphicalDispBase.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	4
FrameHdrModelInfo.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
FrameHdrProjectInfo.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
FrameNotes.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
frmRulesEditor.pas	C:\Saphire 8\Debug\source\DelphiSource\RulesEditor\	3
FTObject.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
FTObject.pas	C:\Saphire 8\Debug\source\DelphiSource_ProjObjects\	3
FX.pas	C:\Saphire 8\Debug\source\	8
GateObj.pas	C:\Saphire 8\Debug\source\DelphiSource_ProjObjects\	3
GdiPrint.pas	C:\Saphire 8\Debug\source\	10
GdiUtil.pas	C:\Saphire 8\Debug\source\	1
GdiView.pas	C:\Saphire 8\Debug\source\	9
GemH.pas	C:\Saphire 8\Debug\source\DelphiSource\	0
GenAn_Editors.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
GenAnSupport.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
GIFImage.pas	C:\Saphire 8\Debug\source\DelphiSource\	4

File Name	File Path	Cyclomatic Complexity
GrafDef.pas	C:\Saphire 8\Debug\source\	0
Graph2D.pas	C:\Saphire 8\Debug\source\	6
GraphicalModelObj.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	4
GroupData.pas	C:\Saphire 8\Debug\source\	6
HashLib.pas	C:\Saphire 8\Debug\source\	5
HashTable.pas	C:\Saphire 8\Debug\source\DelphiSource\BddItems\HashTableLib\	4
HelpLib.pas	C:\Saphire 8\Debug\source\	1
HelpTopics.pas	C:\Saphire 8\Debug\source\DelphiSource\	***51***
HRADef.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
HRADLL.dpr	C:\Saphire 8\Debug\source\hfdll\	5
HTML.pas	C:\Saphire 8\Debug\source\	7
HtmlHelp.pas	C:\Saphire 8\Debug\source\	2
HyperTxt.pas	C:\Saphire 8\Debug\source\	10
ImportCSPathDataObj.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	2
ImportETDataObject.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	4
ImportExpBE.pas	C:\Saphire 8\Debug\source\DelphiSource\ImportExport\	6
ImportFTDataObj.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	4
InBios.pas	C:\Saphire 8\Debug\source\	3
InfoLib.pas	C:\Saphire 8\Debug\source\	6
IniDefs.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
Inputs.pas	C:\Saphire 8\Debug\source\	8
IOUniversal.pas	C:\Saphire 8\Debug\source\	3
LangMap.pas	C:\Saphire 8\Debug\source\	4
LibSequence.pas	C:\Saphire 8\Debug\source\	6
LinkList.pas	C:\Saphire 8\Debug\source\	3
LinkObject.pas	C:\Saphire 8\Debug\source\	6
LinksEd.pas	C:\Saphire 8\Debug\source\	4
ListObj.pas	C:\Saphire 8\Debug\source\	7
Literal.pas	C:\Saphire 8\Debug\source\DelphiSource\PlugIns\	1
LitTypes.pas	C:\Saphire 8\Debug\source\DelphiSource\PlugIns\	0
Logger.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
LogLib.pas	C:\Saphire 8\Debug\source\	9
LowLongX.pas	C:\Saphire 8\Debug\source\	4
MainForm.pas	C:\Saphire 8\Debug\source\schemaObjects\	3
Manager.pas	C:\Saphire 8\Debug\source\	4
MathL.pas	C:\Saphire 8\Debug\source\	4
MathLib.pas	C:\Saphire 8\Debug\source\	2
MaxFiles.pas	C:\Saphire 8\Debug\source\	2
MBlkEdit.pas	C:\Saphire 8\Debug\source\	3
MEditLib.pas	C:\Saphire 8\Debug\source\	7
MemCheck.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
MenuLib.pas	C:\Saphire 8\Debug\source\	7
MergeAPI.pas	C:\Saphire 8\Debug\source\DelphiSource\	0
MMTools.pas	C:\Saphire 8\Debug\source\	2
ModelData.pas	C:\Saphire 8\Debug\source\DelphiSource\	7
ModelData.pas	C:\Saphire 8\Debug\source\DelphiSource_ProjObjects\	4
ModelDataCSTreeNode.pas	C:\Saphire 8\Debug\source\DelphiSource\EventEditing\	3
ModelDataDefs.pas	C:\Saphire 8\Debug\source\DelphiSource_ProjObjects\	***23***
ModelDataTreeNode.pas	C:\Saphire 8\Debug\source\DelphiSource\EventEditing\	6
ModelLib.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
ModelTypeObj.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
ModSys.pas	C:\Saphire 8\Debug\source\	1
MoveLib.pas	C:\Saphire 8\Debug\source\	2
MSageLib.pas	C:\Saphire 8\Debug\source\	7
MsgChk.pas	C:\Saphire 8\Debug\source\	1
MsgWrap.pas	C:\Saphire 8\Debug\source\	2

File Name	File Path	Cyclomatic Complexity
MultSage.pas	C:\Saphire 8\Debug\source\	5
MultUser.pas	C:\Saphire 8\Debug\source\	3
MusicLib.pas	C:\Saphire 8\Debug\source\	10
MynerDFM.pas	C:\Saphire 8\Debug\source\DelphiSource\PlugIns\	2
NewFormFT.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
NewProject.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
NewSets.pas	C:\Saphire 8\Debug\source\	3
NodePropertyForm.pas	C:\Saphire 8\Debug\source\DelphiSource\	0
NumberIO.pas	C:\Saphire 8\Debug\source\	2
ObjCalendar.pas	C:\Saphire 8\Debug\source\	7
ObjCommon.pas	C:\Saphire 8\Debug\source\	1
ObjDef.pas	C:\Saphire 8\Debug\source\	1
ObjDefault.pas	C:\Saphire 8\Debug\source\	1
ObjDialog.pas	C:\Saphire 8\Debug\source\	4
ObjEMail.pas	C:\Saphire 8\Debug\source\	7
ObjExec.pas	C:\Saphire 8\Debug\source\	4
ObjExExe.pas	C:\Saphire 8\Debug\source\	3
ObjExit.pas	C:\Saphire 8\Debug\source\	2
ObjFtp.pas	C:\Saphire 8\Debug\source\	5
ObjJustOne.pas	C:\Saphire 8\Debug\source\	3
ObjLib.pas	C:\Saphire 8\Debug\source\	5
ObjMenu.pas	C:\Saphire 8\Debug\source\	8
ObjMessage.pas	C:\Saphire 8\Debug\source\	4
ObjPool.pas	C:\Saphire 8\Debug\source\	4
ObjPropSheet.pas	C:\Saphire 8\Debug\source\	5
ObjSage.pas	C:\Saphire 8\Debug\source\	2
ObjSequence.pas	C:\Saphire 8\Debug\source\	2
ObjSplash.pas	C:\Saphire 8\Debug\source\	4
ObjWindow.pas	C:\Saphire 8\Debug\source\	2
Parser.pas	C:\Saphire 8\Debug\source\DelphiSource\RulesEditor\	***19***
ParseRtf.pas	C:\Saphire 8\Debug\source\DelphiSource\	9
PCXImage.pas	C:\Saphire 8\Debug\source\	1
PidDir2Xml.pas	C:\Saphire 8\Debug\source\DelphiSource\	6
PlugCCFStag.dpr	C:\Saphire 8\Debug\source\DelphiSource\PlugIns\	2
PlugCCFUtil.pas	C:\Saphire 8\Debug\source\DelphiSource\PlugIns\	***20***
PlugDef.pas	C:\Saphire 8\Debug\source\DelphiSource\PlugIns\	0
PlugDFM.dpr	C:\Saphire 8\Debug\source\DelphiSource\PlugIns\	2
PntrDev.pas	C:\Saphire 8\Debug\source\	1
Pool.pas	C:\Saphire 8\Debug\source\	6
Profile.pas	C:\Saphire 8\Debug\source\	4
ProgCmnd.pas	C:\Saphire 8\Debug\source\	4
ProgramX.pas	C:\Saphire 8\Debug\source\	2
ProjChanges.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
Project_Object.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
Publish.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
Qualify.pas	C:\Saphire 8\Debug\source\	9
QueryAux.pas	C:\Saphire 8\Debug\source\	9
QueryLib.pas	C:\Saphire 8\Debug\source\	9
QuickBE.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
QuickEditObj.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	6
RANCACHE.pas	C:\Saphire 8\Debug\source\	6
Random.pas	C:\Saphire 8\Debug\source\	2
RaspCCFObj.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
RConversions.pas	C:\Saphire 8\Debug\source\	7
ReliabilityBlockObject.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
RelLock.pas	C:\Saphire 8\Debug\source\	5

File Name	File Path	Cyclomatic Complexity
Reports.pas	C:\Saphire 8\Debug\source\	5
ResDir.pas	C:\Saphire 8\Debug\source\	4
ResLib.pas	C:\Saphire 8\Debug\source\	***12***
Resource.pas	C:\Saphire 8\Debug\source\	5
RptCutSets.pas	C:\Saphire 8\Debug\source\DelphiSource\	5
RptGraphics.pas	C:\Saphire 8\Debug\source\DelphiSource\	5
RptGroups.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
RptImportance.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
RptObjs.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
RptTemplate.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
RTF.pas	C:\Saphire 8\Debug\source\	***11***
RulesItem.pas	C:\Saphire 8\Debug\source\DelphiSource\RulesEditor\	4
RulesSchema.pas	C:\Saphire 8\Debug\source\DelphiSource\RulesEditor\	1
RulesUtil.pas	C:\Saphire 8\Debug\source\DelphiSource\	14
RunProgX.pas	C:\Saphire 8\Debug\source\	4
Sage.pas	C:\Saphire 8\Debug\source\	4
SageBttn.pas	C:\Saphire 8\Debug\source\	10
SageCBox.pas	C:\Saphire 8\Debug\source\	***11***
SageCC.pas	C:\Saphire 8\Debug\source\	0
SageComb.pas	C:\Saphire 8\Debug\source\	14
SageDialogs.pas	C:\Saphire 8\Debug\source\	9
SageDyn.pas	C:\Saphire 8\Debug\source\	7
SageEdit.pas	C:\Saphire 8\Debug\source\	***16***
SageErrs.pas	C:\Saphire 8\Debug\source\	2
SageFinal.pas	C:\Saphire 8\Debug\source\	1
SageGrid.pas	C:\Saphire 8\Debug\source\	9
SageInit.pas	C:\Saphire 8\Debug\source\	1
SageKey.pas	C:\Saphire 8\Debug\source\	7
SageLib.pas	C:\Saphire 8\Debug\source\	7
SageList.pas	C:\Saphire 8\Debug\source\	9
SageLV.pas	C:\Saphire 8\Debug\source\	6
SageMask.pas	C:\Saphire 8\Debug\source\	***11***
SageMenu.pas	C:\Saphire 8\Debug\source\	7
SageOpt.pas	C:\Saphire 8\Debug\source\	***11***
SageRBtn.pas	C:\Saphire 8\Debug\source\	10
SageRich.pas	C:\Saphire 8\Debug\source\	***11***
SageRisk2.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
SageRiskUtil.pas	C:\Saphire 8\Debug\source\DelphiSource\	5
SageSBar.pas	C:\Saphire 8\Debug\source\	7
SageSpec.pas	C:\Saphire 8\Debug\source\	2
SageSplash.pas	C:\Saphire 8\Debug\source\	2
SageST.dpr	C:\Saphire 8\Debug\source\	1
SageStat.pas	C:\Saphire 8\Debug\source\	8
SageSTDataSet.pas	C:\Saphire 8\Debug\source\	3
SageSTObject.pas	C:\Saphire 8\Debug\source\	2
SageSTPackage.dpk	C:\Saphire 8\Debug\source\	0
SageSTSchemaObjects.dpr	C:\Saphire 8\Debug\source\schemaObjects\	1
SageTerm.pas	C:\Saphire 8\Debug\source\	4
SageTree.pas	C:\Saphire 8\Debug\source\	***14***
SaphCache.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
SaphDataM.pas	C:\Saphire 8\Debug\source\DelphiSource\	0
SAPHIRE.dpr	C:\Saphire 8\Debug\source\DelphiSource\	5
SAPHIRE_Project.dpr	C:\Saphire 8\Debug\source\DelphiSource\	9
SAPHIRE8.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
SaphireAnalysis.pas	C:\Saphire 8\Debug\source\DelphiSource\	5
saphmacro.pas	C:\Saphire 8\Debug\source\DelphiSource\	***24***

File Name	File Path	Cyclomatic Complexity
SaphSet.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
ScanLib.pas	C:\Saphire 8\Debug\source\	1
Scroll.pas	C:\Saphire 8\Debug\source\	9
SDP_Editors.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
SDP_Insights.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
SDPReports.pas	C:\Saphire 8\Debug\source\DelphiSource\	5
SearchObj.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
SecurLib.pas	C:\Saphire 8\Debug\source\	3
Select.pas	C:\Saphire 8\Debug\source\	2
SelectModel.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
Semaphore.pas	C:\Saphire 8\Debug\source\	4
SetLib.pas	C:\Saphire 8\Debug\source\	3
SGK.pas	C:\Saphire 8\Debug\source\	5
SGKDevice.pas	C:\Saphire 8\Debug\source\	0
SGKDriver.pas	C:\Saphire 8\Debug\source\	3
SGKErrors.pas	C:\Saphire 8\Debug\source\	2
SGKFill.pas	C:\Saphire 8\Debug\source\	***11***
SgkFinal.pas	C:\Saphire 8\Debug\source\	1
SGKFont.pas	C:\Saphire 8\Debug\source\	6
SGKGraphics.pas	C:\Saphire 8\Debug\source\	4
SGKInBios.pas	C:\Saphire 8\Debug\source\	3
SgkInit.pas	C:\Saphire 8\Debug\source\	1
SGKInputs.pas	C:\Saphire 8\Debug\source\	8
SGKLine.pas	C:\Saphire 8\Debug\source\	8
SGKMarker.pas	C:\Saphire 8\Debug\source\	2
SGKPCX.pas	C:\Saphire 8\Debug\source\	1
SGKSupport.pas	C:\Saphire 8\Debug\source\	1
SGKUtil.pas	C:\Saphire 8\Debug\source\	5
SGKWin.pas	C:\Saphire 8\Debug\source\	4
SGMenu.pas	C:\Saphire 8\Debug\source\	7
Simulation_Main.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
SimulationBaseObject.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
SimulationEdit_Main.pas	C:\Saphire 8\Debug\source\DelphiSource\	5
SimulationObject.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
SortLibX.pas	C:\Saphire 8\Debug\source\	4
SortList.pas	C:\Saphire 8\Debug\source\	8
SortMrg.pas	C:\Saphire 8\Debug\source\	6
Soundex.pas	C:\Saphire 8\Debug\source\	***11***
Sounds.pas	C:\Saphire 8\Debug\source\	3
SPARH.pas	C:\Saphire 8\Debug\source\DelphiSource\	7
SPARH.pas	C:\Saphire 8\Debug\source\hfdll\	7
SparRpt.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
SPDLib.pas	C:\Saphire 8\Debug\source\	6
SplashScreenForm.pas	C:\Saphire 8\Debug\source\DelphiSource\	1
SqCanvas.pas	C:\Saphire 8\Debug\source\	8
SqCheck.pas	C:\Saphire 8\Debug\source\	5
SqDef.pas	C:\Saphire 8\Debug\source\	0
SqEdDef.pas	C:\Saphire 8\Debug\source\	0
SqEdit.pas	C:\Saphire 8\Debug\source\	6
SqExec.pas	C:\Saphire 8\Debug\source\	6
SqGShow.pas	C:\Saphire 8\Debug\source\	3
SqGSmbl.pas	C:\Saphire 8\Debug\source\	4
SqGTop.pas	C:\Saphire 8\Debug\source\	1
SqGUtil.pas	C:\Saphire 8\Debug\source\	3
SQLAct.pas	C:\Saphire 8\Debug\source\	***25***
SQLCheck.pas	C:\Saphire 8\Debug\source\	6

File Name	File Path	Cyclomatic Complexity
SQLExec.pas	C:\Saphire 8\Debug\source\	4
SqLinks.pas	C:\Saphire 8\Debug\source\	4
SQLParse.pas	C:\Saphire 8\Debug\source\	***19***
SQLRun.pas	C:\Saphire 8\Debug\source\	8
SQLScan.pas	C:\Saphire 8\Debug\source\	5
SQLUtil.pas	C:\Saphire 8\Debug\source\	6
SqOccur.pas	C:\Saphire 8\Debug\source\	5
SqUtil.pas	C:\Saphire 8\Debug\source\	4
STBackup.pas	C:\Saphire 8\Debug\source\	3
STCustomDataSet.pas	C:\Saphire 8\Debug\source\	2
STNative.pas	C:\Saphire 8\Debug\source\	3
StorageX.pas	C:\Saphire 8\Debug\source\	2
STRegistry.pas	C:\Saphire 8\Debug\source\	3
STResourceObjects.pas	C:\Saphire 8\Debug\source\	4
StringGridLib.pas	C:\Saphire 8\Debug\source\	5
StringsX.pas	C:\Saphire 8\Debug\source\	4
StrokeFont.pas	C:\Saphire 8\Debug\source\	5
STSecurity.pas	C:\Saphire 8\Debug\source\	9
SubUnorderedBDD.pas	C:\Saphire 8\Debug\source\DelphiSource\BddItems\	4
SuperIO.pas	C:\Saphire 8\Debug\source\	7
Supermsk.pas	C:\Saphire 8\Debug\source\DelphiSource\	***18***
SymParse.pas	C:\Saphire 8\Debug\source\	6
SynEdit.pas	C:\Saphire 8\Debug\source\DelphiSource\RulesEditor\	6
SynHighlighterMacMan.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
SynHighlighterSaphL.pas	C:\Saphire 8\Debug\source\DelphiSource\RulesEditor\	3
SynHighlighterSaphP.pas	C:\Saphire 8\Debug\source\DelphiSource\RulesEditor\	3
SynHighlighterSaphR.pas	C:\Saphire 8\Debug\source\DelphiSource\RulesEditor\	3
SynHighlighterSaphS.pas	C:\Saphire 8\Debug\source\DelphiSource\RulesEditor\	3
TermX.pas	C:\Saphire 8\Debug\source\	4
TextBase.pas	C:\Saphire 8\Debug\source\	10
TextDB.pas	C:\Saphire 8\Debug\source\	5
TextEd2.pas	C:\Saphire 8\Debug\source\	***12***
TextEdit.pas	C:\Saphire 8\Debug\source\	6
TextShow.pas	C:\Saphire 8\Debug\source\	10
TextX.pas	C:\Saphire 8\Debug\source\	4
ThorAdj.pas	C:\Saphire 8\Debug\source\	***12***
ThorBld.pas	C:\Saphire 8\Debug\source\	9
ThorEdit.pas	C:\Saphire 8\Debug\source\	***11***
ThorForm.pas	C:\Saphire 8\Debug\source\	7
ThorGraf.pas	C:\Saphire 8\Debug\source\	7
ThorLib.pas	C:\Saphire 8\Debug\source\	9
ThorLibX.pas	C:\Saphire 8\Debug\source\	8
ThorLoad.pas	C:\Saphire 8\Debug\source\	8
ThorPort.pas	C:\Saphire 8\Debug\source\	3
ThorSer.pas	C:\Saphire 8\Debug\source\	6
ThorShow.pas	C:\Saphire 8\Debug\source\	8
ThorSpec.pas	C:\Saphire 8\Debug\source\	1
ThorUtil.pas	C:\Saphire 8\Debug\source\	1
TimeDate.pas	C:\Saphire 8\Debug\source\	4
TimeLib.pas	C:\Saphire 8\Debug\source\	5
TimeReal.pas	C:\Saphire 8\Debug\source\	3
TokenLib.pas	C:\Saphire 8\Debug\source\	3
Toolbar.pas	C:\Saphire 8\Debug\source\	10
TPCVideo.pas	C:\Saphire 8\Debug\source\	5
Trackit.pas	C:\Saphire 8\Debug\source\	3
Transact.pas	C:\Saphire 8\Debug\source\	6

File Name	File Path	Cyclomatic Complexity
TreeRiskAssessment.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	3
TrueTypeFont.pas	C:\Saphire 8\Debug\source\	3
TxtBLib.pas	C:\Saphire 8\Debug\source\	9
UI_Utils.pas	C:\Saphire 8\Debug\source\DelphiSource\	9
Uncertainty.pas	C:\Saphire 8\Debug\source\DelphiSource\	0
UncertAreaChart.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
UniqueID.pas	C:\Saphire 8\Debug\source\DelphiSource\GraphicalEditing\	2
Unit1.pas	C:\Saphire 8\Debug\source\DelphiSource\	1
dummyone.pas (Unit2)	C:\Saphire 8\Debug\source\DelphiSource\	0
dummy3.pas (Unit3)	C:\Saphire 8\Debug\source\DelphiSource\	0
UnorderedBDD.pas	C:\Saphire 8\Debug\source\DelphiSource\BddItems\	3
UpdLib.pas	C:\Saphire 8\Debug\source\	4
UpgradeCats.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
UpgradeETLogic.pas	C:\Saphire 8\Debug\source\DelphiSource\	***13***
Variates.pas	C:\Saphire 8\Debug\source\DelphiSource\	3
VirtualNodeEditor.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
VRPT.pas	C:\Saphire 8\Debug\source\	0
VRptLib.pas	C:\Saphire 8\Debug\source\	***13***
VSTreeStateObj.pas	C:\Saphire 8\Debug\source\DelphiSource\	10
VTEditors.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
WebSiteLib.pas	C:\Saphire 8\Debug\source\DelphiSource\	4
WEditLib.pas	C:\Saphire 8\Debug\source\	***11***
WinAux.pas	C:\Saphire 8\Debug\source\	3
WinDevice.pas	C:\Saphire 8\Debug\source\	4
Window.pas	C:\Saphire 8\Debug\source\	2
WinDriver.pas	C:\Saphire 8\Debug\source\	5
WinExec.pas	C:\Saphire 8\Debug\source\	6
WinHelp.pas	C:\Saphire 8\Debug\source\	9
WinKey.pas	C:\Saphire 8\Debug\source\	***31***
WinPrint.pas	C:\Saphire 8\Debug\source\	5
WinRebuild.pas	C:\Saphire 8\Debug\source\	9
WinReports.pas	C:\Saphire 8\Debug\source\	9
WinRpUtil.pas	C:\Saphire 8\Debug\source\	9
WinSpec.pas	C:\Saphire 8\Debug\source\	0
WinText.pas	C:\Saphire 8\Debug\source\	6
WinTools.pas	C:\Saphire 8\Debug\source\	3
WorkspaceUtils.pas	C:\Saphire 8\Debug\source\DelphiSource\	5
WorkspaceUtils.pas	C:\Saphire 8\Debug\source\DelphiSource\	5
WriteHTML.pas	C:\Saphire 8\Debug\source\DelphiSource\	2
XmlDataGenerator.pas	C:\Saphire 8\Debug\source\	2
XmlSchemaGenerator.pas	C:\Saphire 8\Debug\source\	2

Figure 7-2 provides the SAPHIRE Version 8 Project Analysis using the Audits and Checks category options provided in Figure 7-3 and Figure 7-4. The analysis parses all source files into an internal tree to ensure that all symbols are available to be cross referenced and validated. The analysis results provide information on the following:

- Parsing errors
- Delphi directive names used as identifiers
- Delphi keywords used as identifiers
- Identifiers hiding others of the same name at a higher scope
- "if" statements followed by an empty statement
- Type assignment incompatibilities
- Undefined function return values
- Uninitialized variables
- Unreferenced global identifiers
- Unreferenced local identifiers
- Unused assigned values

The following provide the definitions for the messages as a result of the analysis:

A1001 Audit result message – The <item> is declared as deprecated.

A1002 Audit result message – The identifier <id> is also a Delphi directive.

A1003 Audit result message – The <item> is declared as experimental.

A1004 Audit result message – The <item> hides the <item> of the same name declared on line <n> of <filename>.

A1005 Audit result message – The identifier <id> is also a Delphi Keyword.

A1006 Audit result message – The <item> is declared as library dependent.

A1007 Audit result message – The <item> is declared as platform dependent.

C1001 Check result message – The array index expression can be outside the bounds of the array.

C1002 Check result message – The destination of the assignment is a constant so should not be modified.

C1003 Check result message – The "if" statement is followed by an empty statement.

C1004 Check result message – The constant expression is outside the range of valid values.

C1005 Check result message – The type <type> and <type> are not compatible.

C1006 Check result message – The return value of <function> is undefined in one or more code paths through its implementation.

C1007 Check result message – The <item> has not been assigned a value in one or more code paths.

C1008 Check result message – The source code at or before <item> is unreachable.

C1009 Check result message – The global <item> is declared but is never referenced.

C1010 Check result message – The local <item> is declared but is never referenced.

C1011 Check result message – The value assigned to <id> is never used.

To access the file contents shown in Figure 7-1, refer to file "*SAPHIRE8-Analysis-100405.pdf*" included on the CD as an addendum to this report. To access the file:

1. Open Internet Explorer.
2. Select "Open" from the "File" menu.
3. The "Open" window will be displayed.
4. Select the "Browse…" button from the "Open" window.
5. The "Windows Internet Explorer" window will be displayed.
6. Navigate to the "*SAPHIRE8-Analysis-100405.pdf*" file located on the CD.
7. Select the "*SAPHIRE8-Analysis-100405.pdf*" file on the CD.
8. Select the "Open" button from the "Windows Internet Explorer" window.
9. The "Windows Internet Explorer" window will close.
10. Select the "OK" button from the "Open" window.

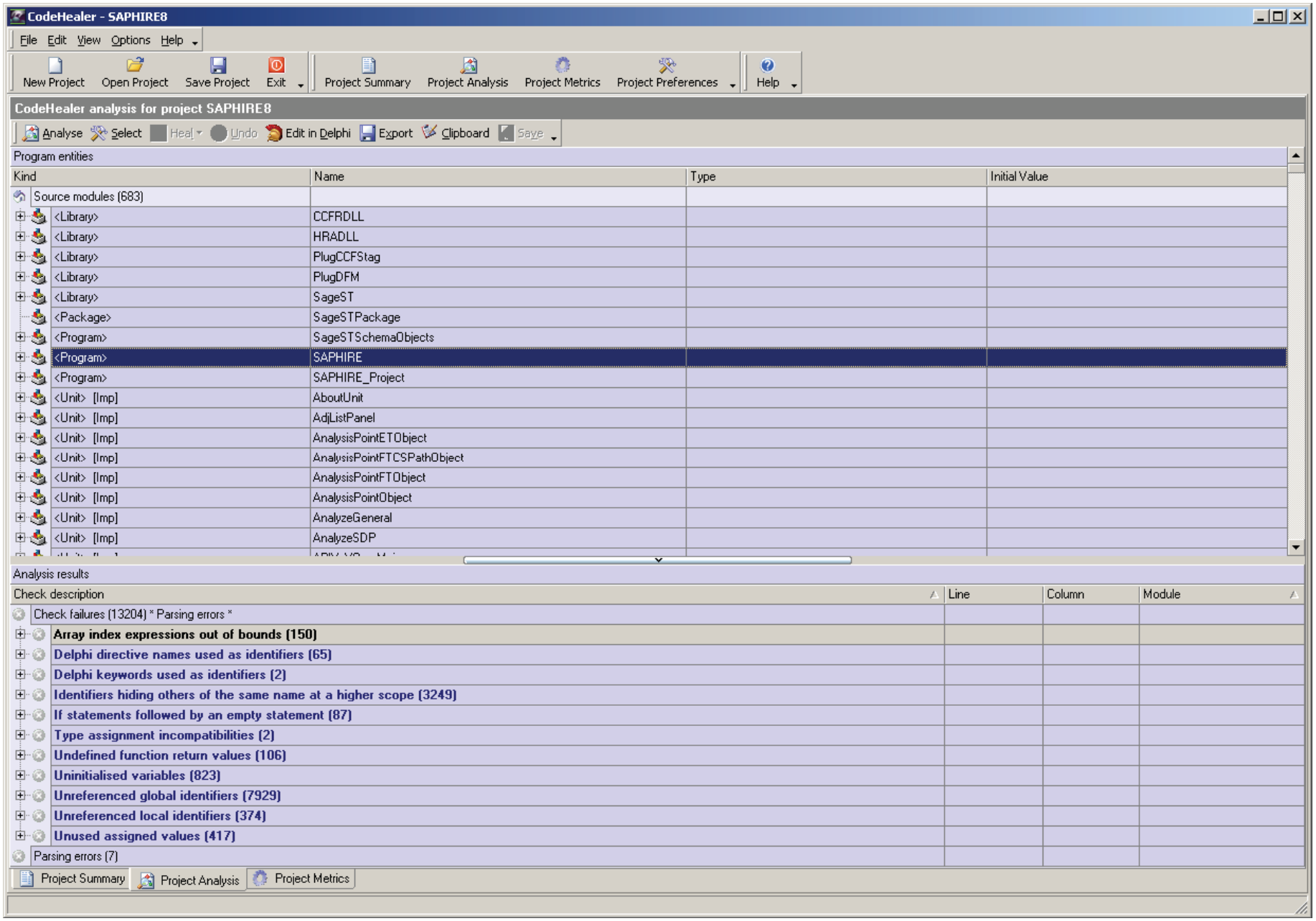


Figure 7-1 Source Code Analysis for CodeHealer Project SAPHIRE Version 8

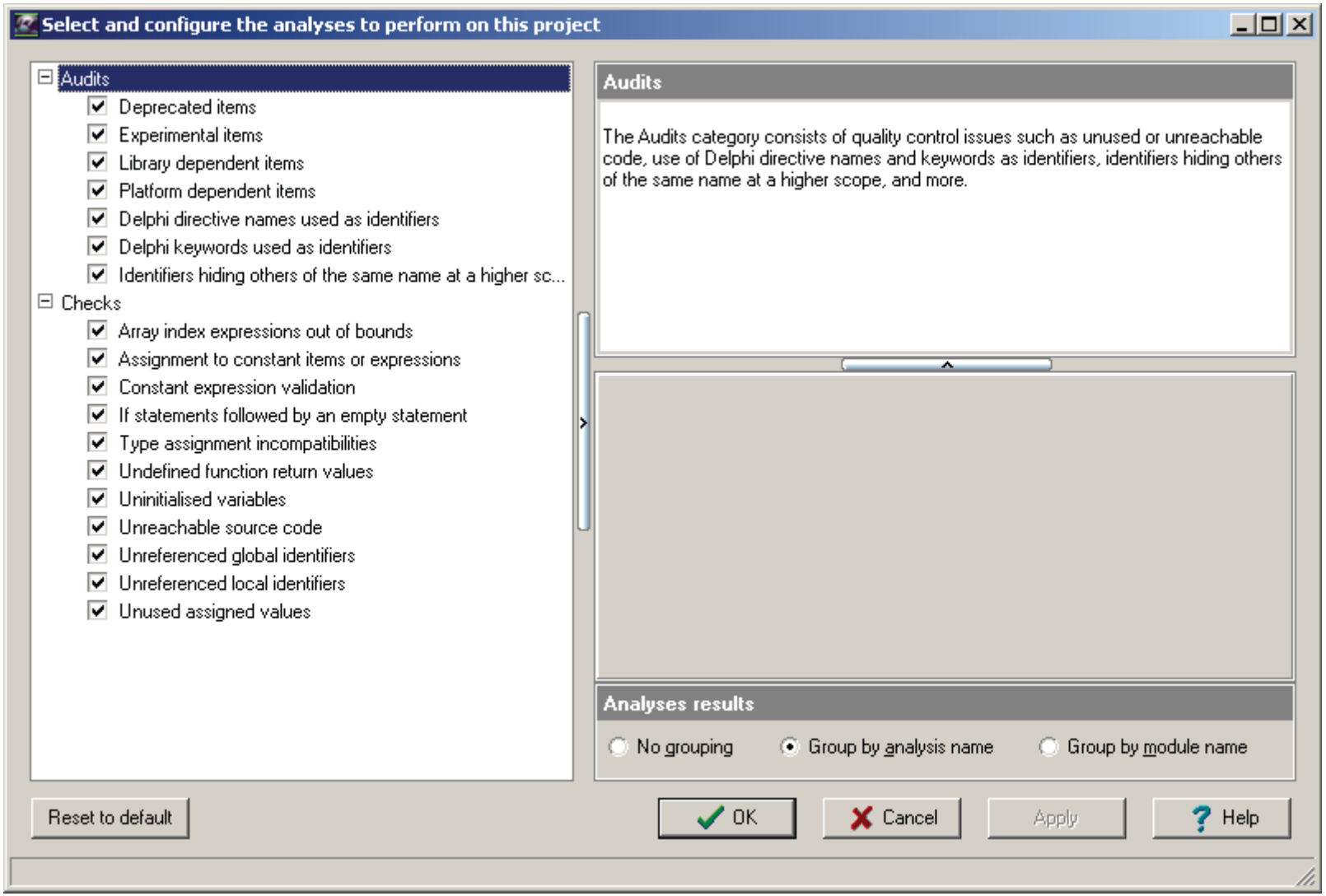


Figure 7-2 Audits Category Settings for CodeHealer Project SAPHIRE Version 8 Analysis

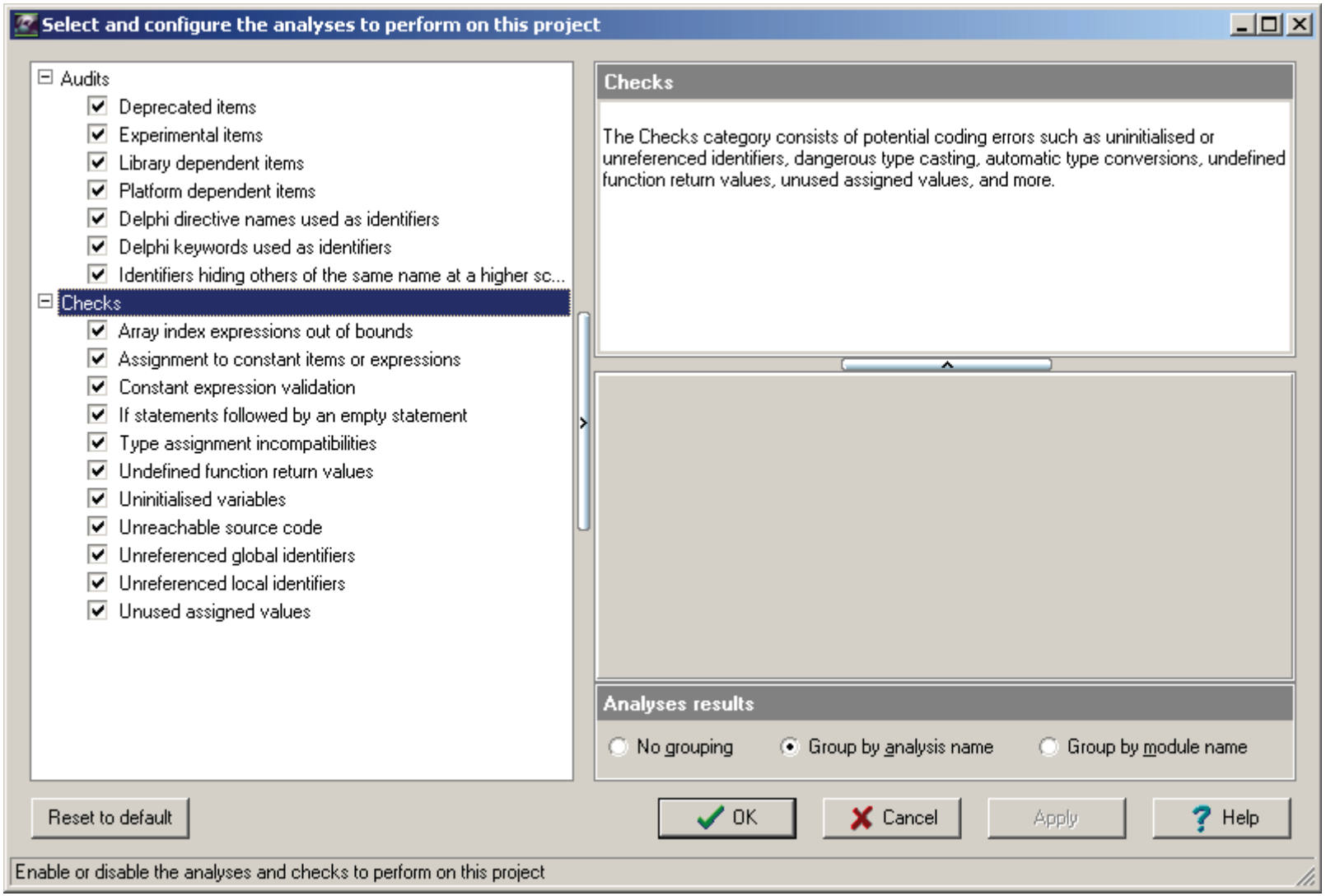


Figure 7-3 Checks Category Settings for CodeHealer Project SAPHIRE Version 8 Analysis

Attachment 8: Coverage Validator

Figure 8-1, Figure 8-2 and Figure 8-3 provides the coverage summary for the SAPHIRE version 8 source code using the source code coverage analyzer *Coverage Validator* © Version 4.10. The coverage summary for a Significance Determination Process analysis (Figure 8-1), Events and Condition Assessment analysis (Figure 8-2) and a General analysis (Figure 8-3) have been provided.

The figures show various coverage statistics with percentages where appropriate. No unit testing has been performed. The statistics displayed are:

- Number of files
- Number of visited files
- Number of unvisited files
- Number of 100% visited files

- Number of functions
- Number of visited functions
- Number of unvisited functions
- Number of 100% visited functions

- Number of branches
- Number of visited branches
- Number of unvisited branches
- Number of functions containing branches
- Number of 100% branch functions

- Number of lines
- Number of visited lines
- Number of unvisited lines
- Number of lines that could not be hooked
- Number of visits to lines

- Number of unit tests
- Number of successful unit tests
- Number of unsuccessful unit tests
- Number of unit test failures
- Number of unit test errors

To access the file contents shown in Figure 8-1, refer to file "*CoverageValidatorSDPSummaryReport.html*" included on the CD as an addendum to this report. To access the file:

1. Open Internet Explorer.
2. Select "Open" from the "File" menu.
3. The "Open" window will be displayed.
4. Select the "Browse…" button from the "Open" window.
5. The "Windows Internet Explorer" window will be displayed.
6. Navigate to the "*CoverageValidatorSDPSummaryReport.html*" file located on the CD.
7. Select the "*CoverageValidatorSDPSummaryReport.html*" file on the CD.

8. Select the “Open” button from the “Windows Internet Explorer” window.
9. The “Windows Internet Explorer” window will close.
10. Select the “OK” button from the “Open” window.

To access the file contents shown in Figure 8-2, refer to file “*CoverageValidatorECASummaryReport.html*” included on the CD as an addendum to this report. To access the file:

1. Open Internet Explorer.
2. Select “Open” from the “File” menu.
3. The “Open” window will be displayed.
4. Select the “Browse…” button from the “Open” window.
5. The “Windows Internet Explorer” window will be displayed.
6. Navigate to the “*CoverageValidatorECASummaryReport.html*” file located on the CD.
7. Select the “*CoverageValidatorECASummaryReport.html*” file on the CD.
8. Select the “Open” button from the “Windows Internet Explorer” window.
9. The “Windows Internet Explorer” window will close.
10. Select the “OK” button from the “Open” window.

To access the file contents shown in Figure 8-3, refer to file “*CoverageValidatorGeneralAnalysisSummaryReport.html*” included on the CD as an addendum to this report. To access the file:

1. Open Internet Explorer.
2. Select “Open” from the “File” menu.
3. The “Open” window will be displayed.
4. Select the “Browse…” button from the “Open” window.
5. The “Windows Internet Explorer” window will be displayed.
6. Navigate to the “*CoverageValidatorECASummaryReport.html*” file located on the CD.
7. Select the “*CoverageValidatorECASummaryReport.html*” file on the CD.
8. Select the “Open” button from the “Windows Internet Explorer” window.
9. The “Windows Internet Explorer” window will close.
10. Select the “OK” button from the “Open” window.

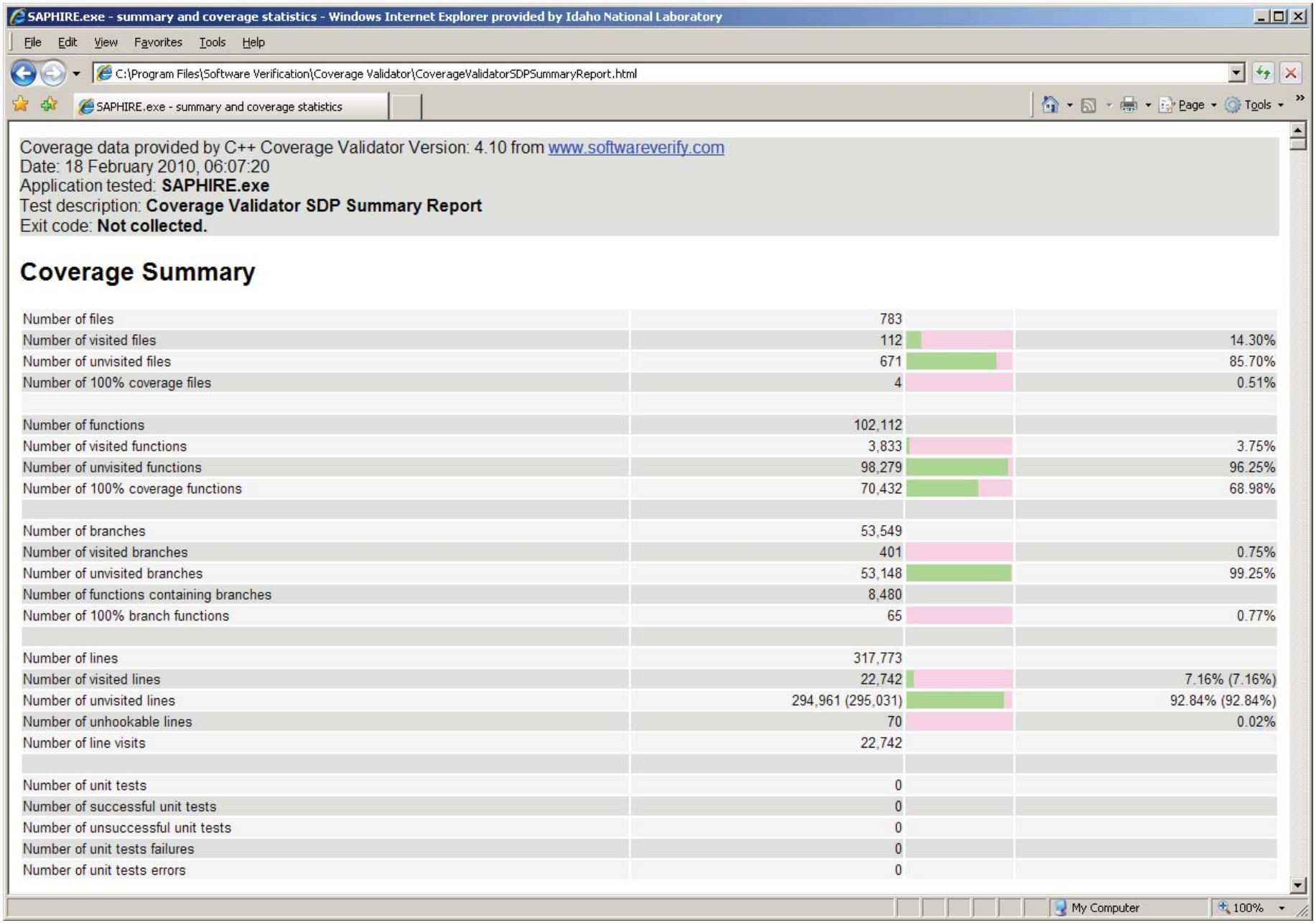


Figure 8-1 Coverage Validator SDP Summary Report

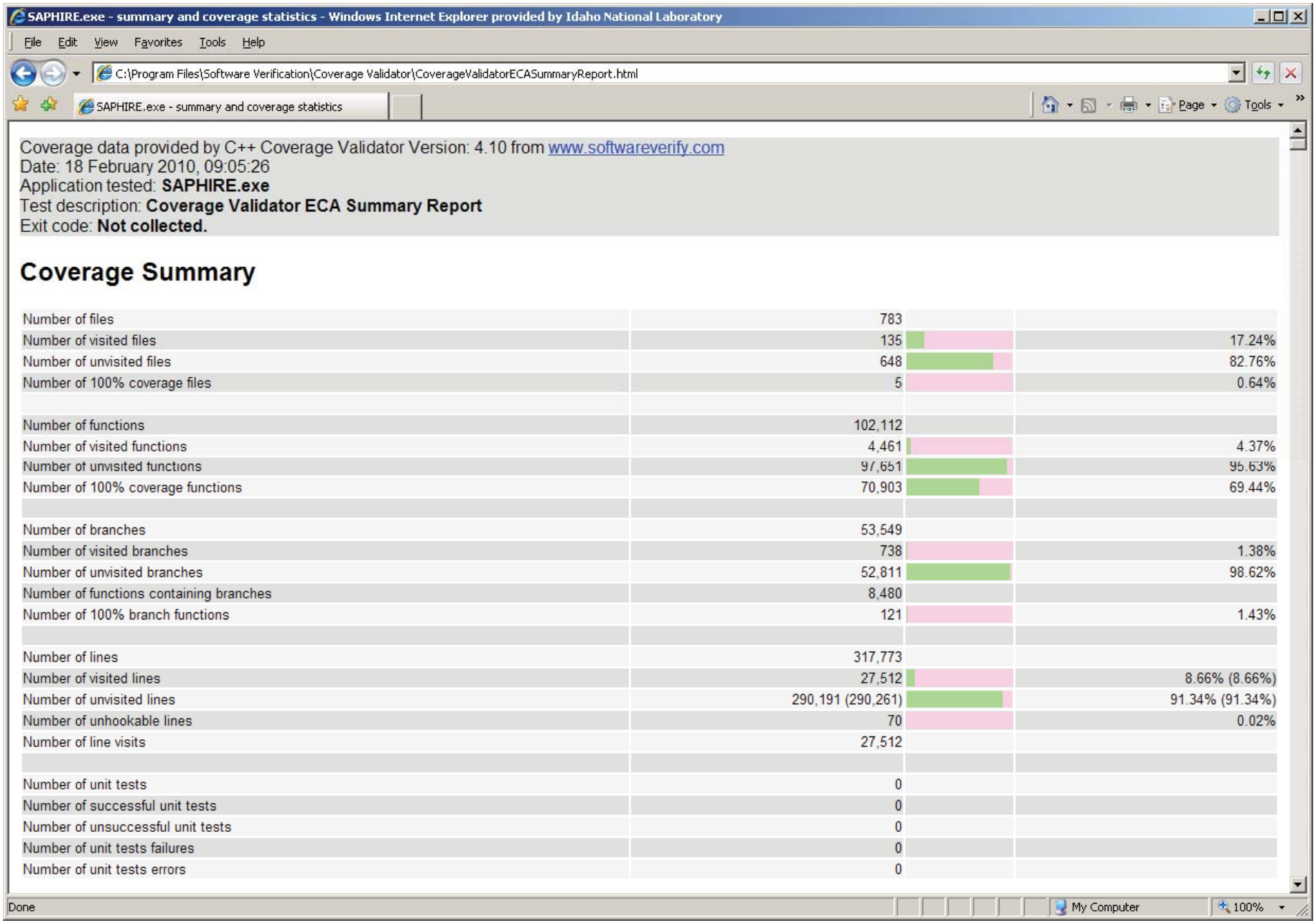


Figure 8-2 Coverage Validator ECA Summary Report

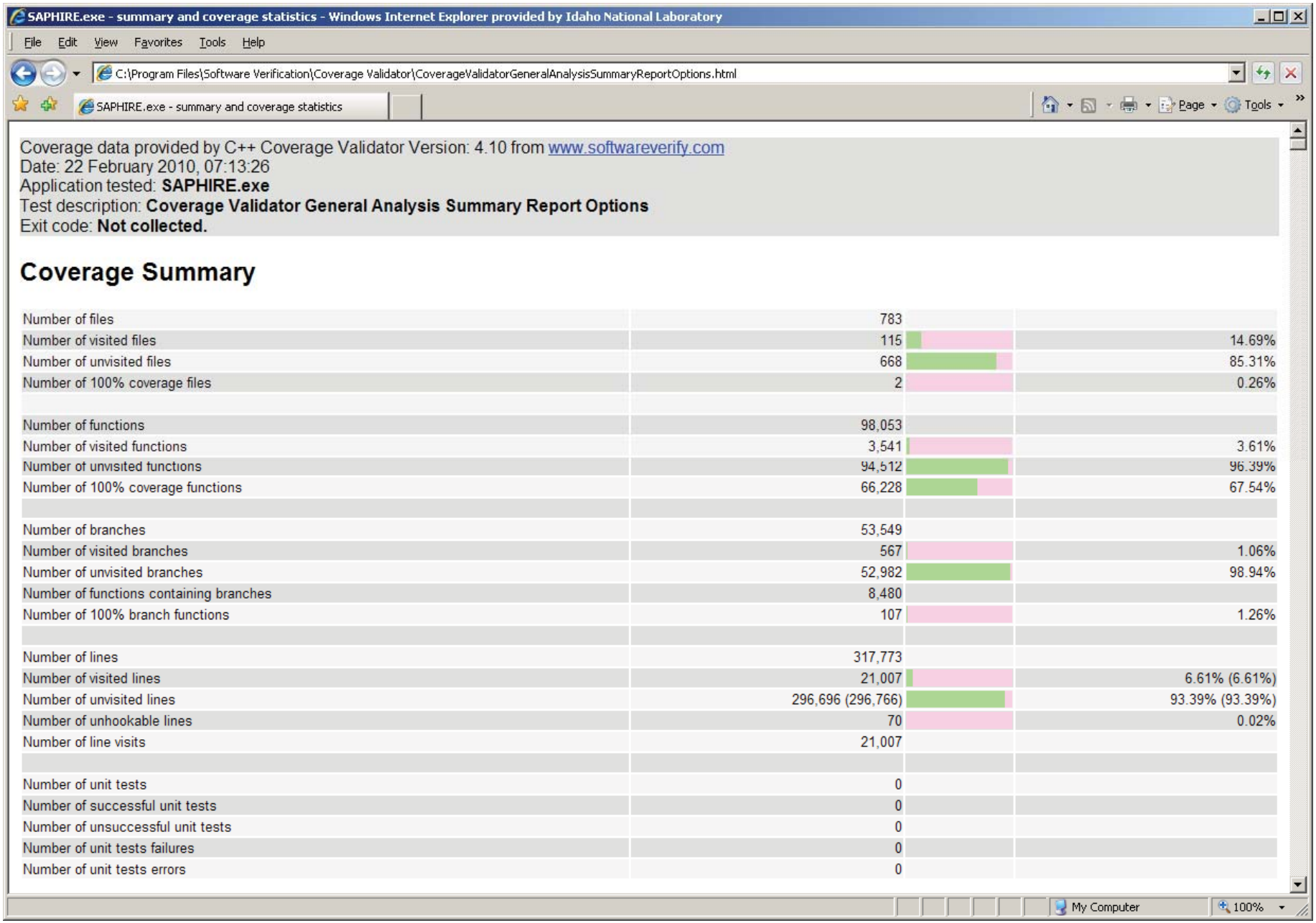


Figure 8-3 Coverage Validator General Analysis Summary Report

Attachment 9: Memory Validator

Figure 8-4 provides the results for memory leak and handle leak detection for the SAPHIRE version 8 source code using the memory and resource leak detector *Memory Validator* © Version 4.86. The option "*Check pointers and handles on DWORD boundaries. Fastest option. This will find less pointers and handles, but also find less FALSE positives*" was selected for the results provided.

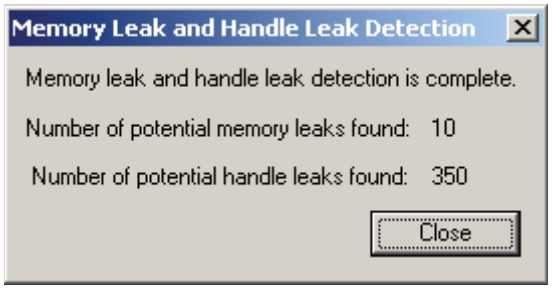


Figure 8-4 Memory Validator Memory Leak and Handle Leak Detection

Figure 8-5 and Figure 8-6 provide partial results of the report of Allocated Memory for a Significance Determination Process analysis. The information reports all memory and resource allocations that have not been deallocated and any information about damaged memory.

Figure 8-7 provides the results of the Virtual Memory report providing a partial textual representation of the memory in the SAPHIRE version 8 program. The textual display shows the allocation state of each memory page in the program as a textual description. The information displayed includes Win32 Heaps, CRT heaps, DLLs, Memory mapped files and thread stacks. For each virtual memory area, the address, size, type and description of the area are displayed.

Figure 8-8 provides the results of the Objects Report that corresponds to the objects tab shown in Figure 8-9. The objects tab displays a visual representation of all the objects in the SAPHIRE version 8 program. Examining the object statistics provides an insight into the number of allocations the SAPHIRE Version 8 software is making and the allocation size frequency of those allocations.

To access the file contents shown in Figure 8-5 and Figure 8-6, refer to file "*MemoryValidatorSDPMemoryDetailed.html*" included on the CD as an addendum to this report. To access the file:

1. Open Internet Explorer.
2. Select "Open" from the "File" menu.
3. The "Open" window will be displayed.
4. Select the "Browse…" button from the "Open" window.
5. The "Windows Internet Explorer" window will be displayed.
6. Navigate to the "*MemoryValidatorSDPMemoryDetailed.html*" file located on the CD.
7. Select the "*MemoryValidatorSDPMemoryDetailed.html*" file on the CD.
8. Select the "Open" button from the "Windows Internet Explorer" window.
9. The "Windows Internet Explorer" window will close.
10. Select the "OK" button from the "Open" window.

To access the file contents shown in Figure 8-7, refer to file "*VirtualMemoryDataExportReport.html*" included on the CD as an addendum to this report. To access the file:

1. Open Internet Explorer.
2. Select "Open" from the "File" menu.
3. The "Open" window will be displayed.
4. Select the "Browse…" button from the "Open" window.
5. The "Windows Internet Explorer" window will be displayed.
6. Navigate to the "*VirtualMemoryDataExportReport.html*" file located on the CD.
7. Select the "*VirtualMemoryDataExportReport.html*" file on the CD.
8. Select the "Open" button from the "Windows Internet Explorer" window.
9. The "Windows Internet Explorer" window will close.
10. Select the "OK" button from the "Open" window.

To access the file contents shown in Figure 8-8, refer to file "*MemoryValidatorDSPObjectsReport.html*" included on the CD as an addendum to this report. To access the file:

1. Open Internet Explorer.
2. Select "Open" from the "File" menu.
3. The "Open" window will be displayed.
4. Select the "Browse…" button from the "Open" window.
5. The "Windows Internet Explorer" window will be displayed.
6. Navigate to the "*MemoryValidatorDSPObjectsReport.html*" file located on the CD.
7. Select the "*MemoryValidatorDSPObjectsReport.html*" file on the CD.
8. Select the "Open" button from the "Windows Internet Explorer" window.
9. The "Windows Internet Explorer" window will close.
10. Select the "OK" button from the "Open" window.

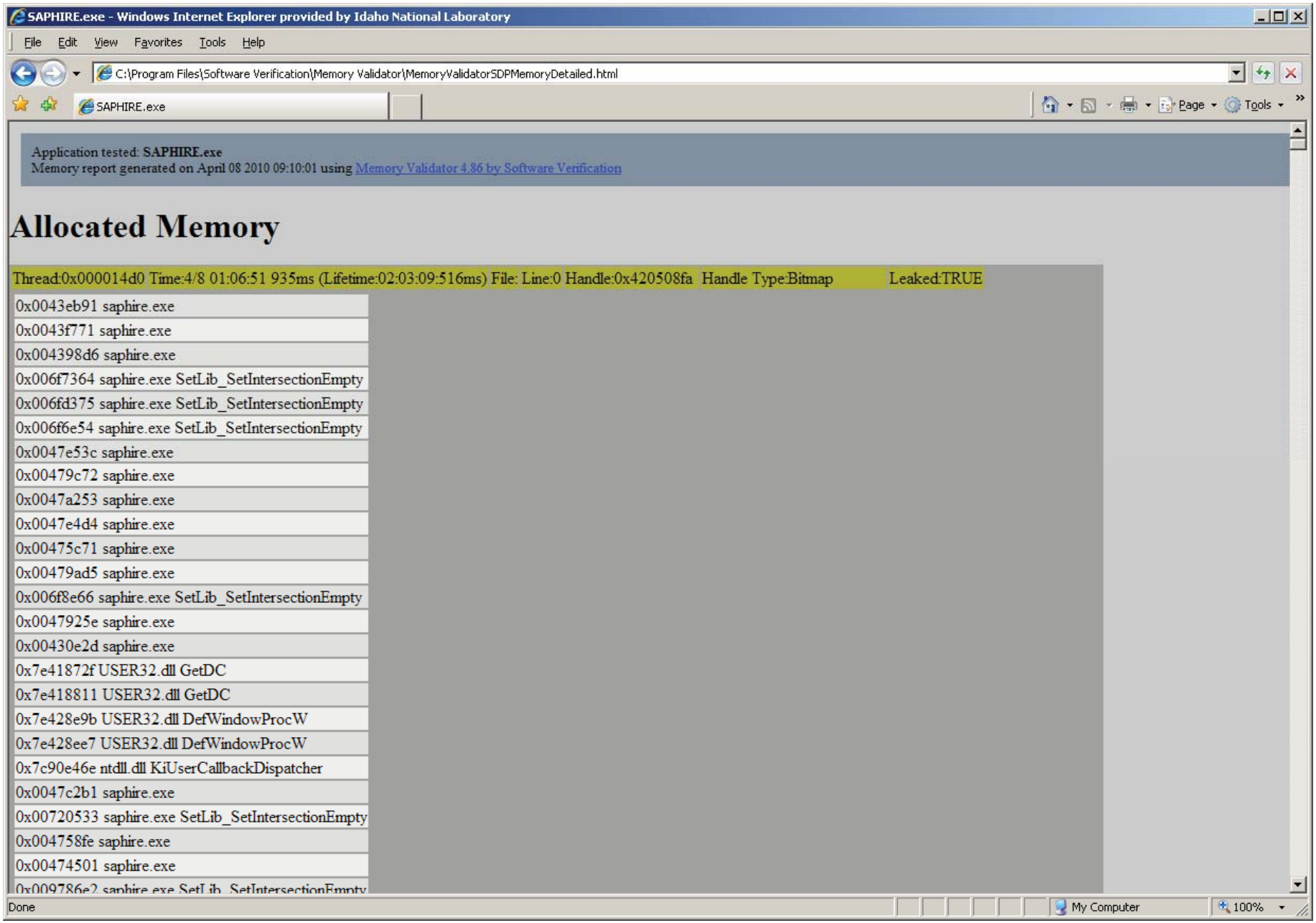


Figure 8-5 Memory Validator Memory Report - Top

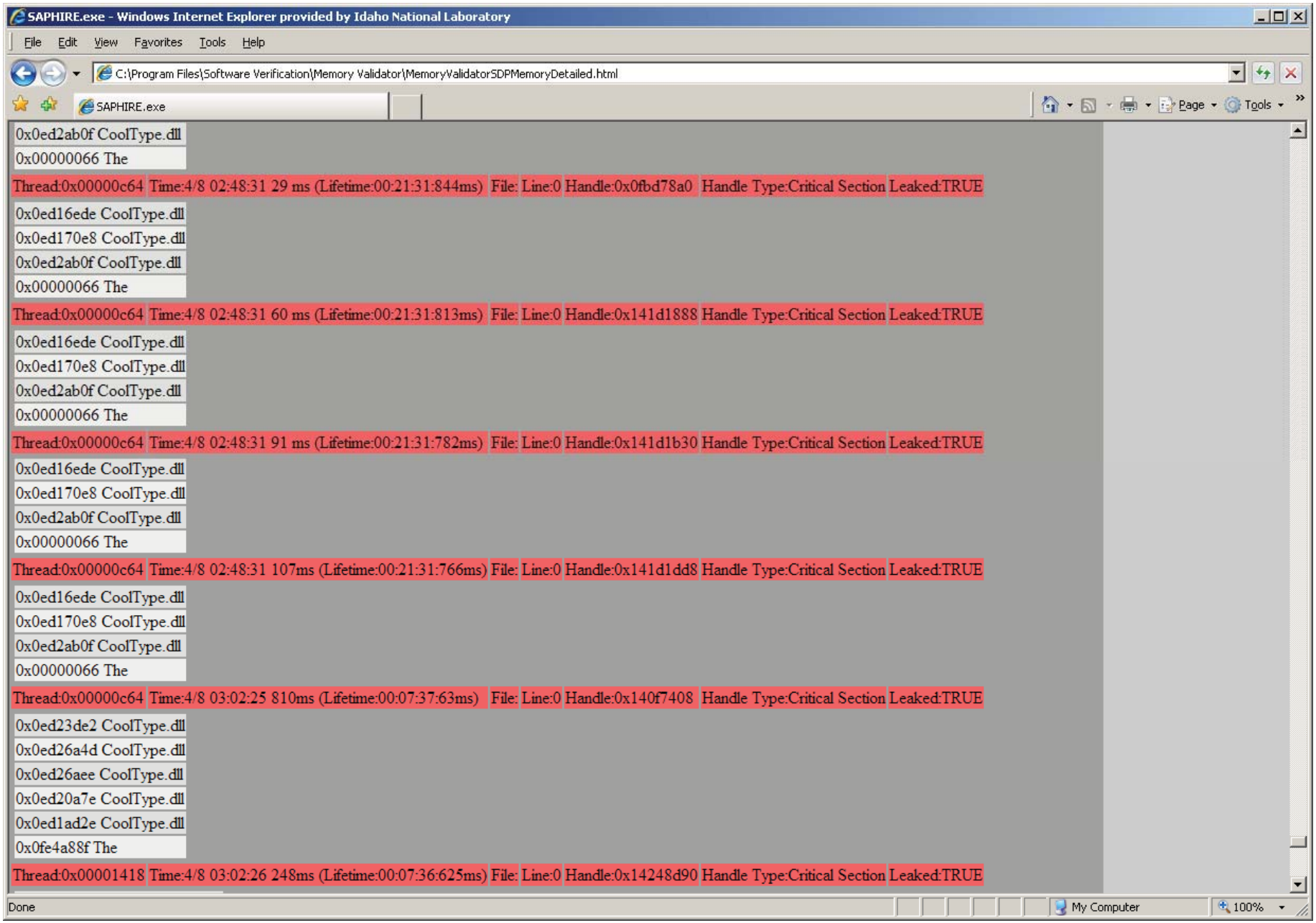
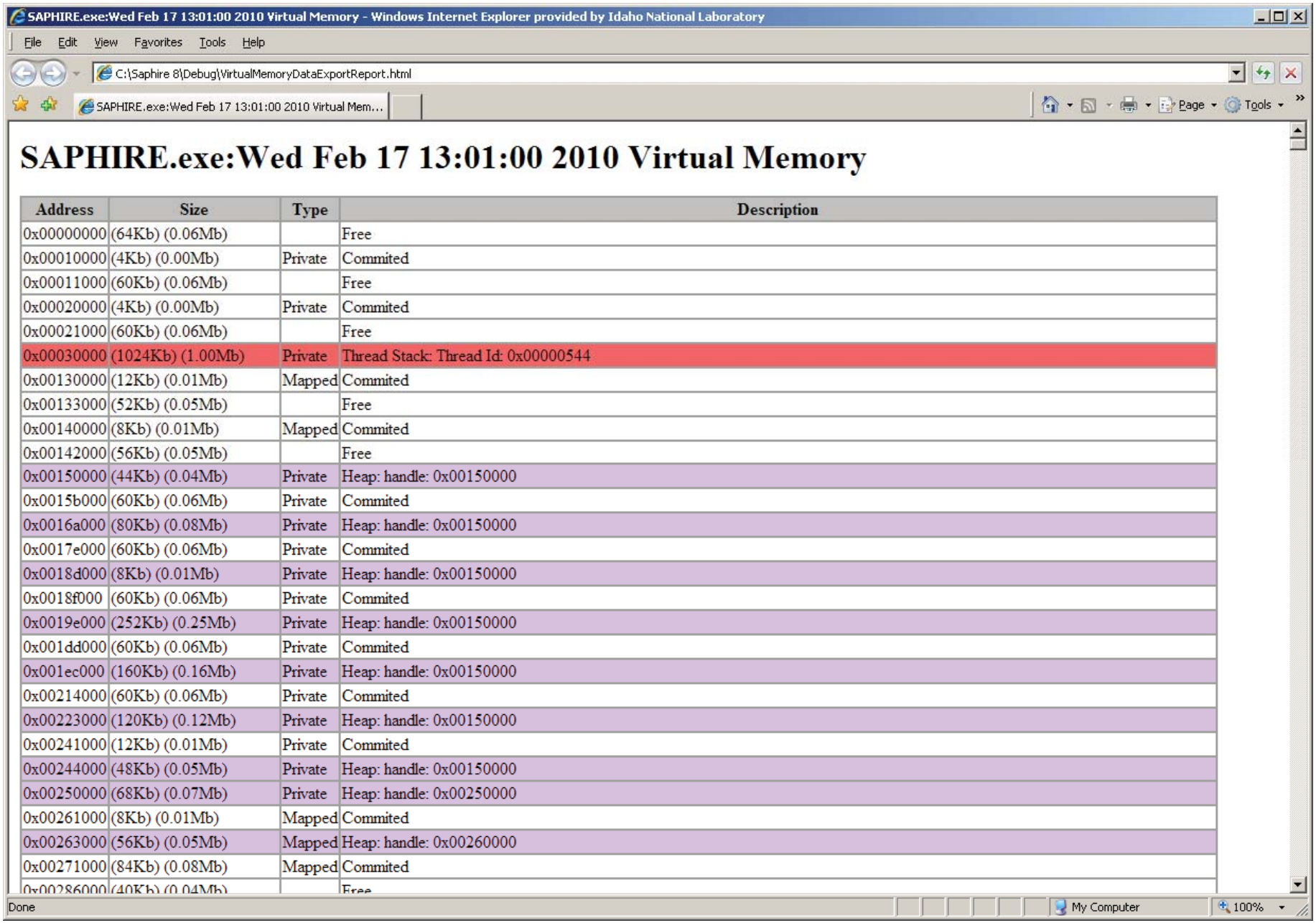


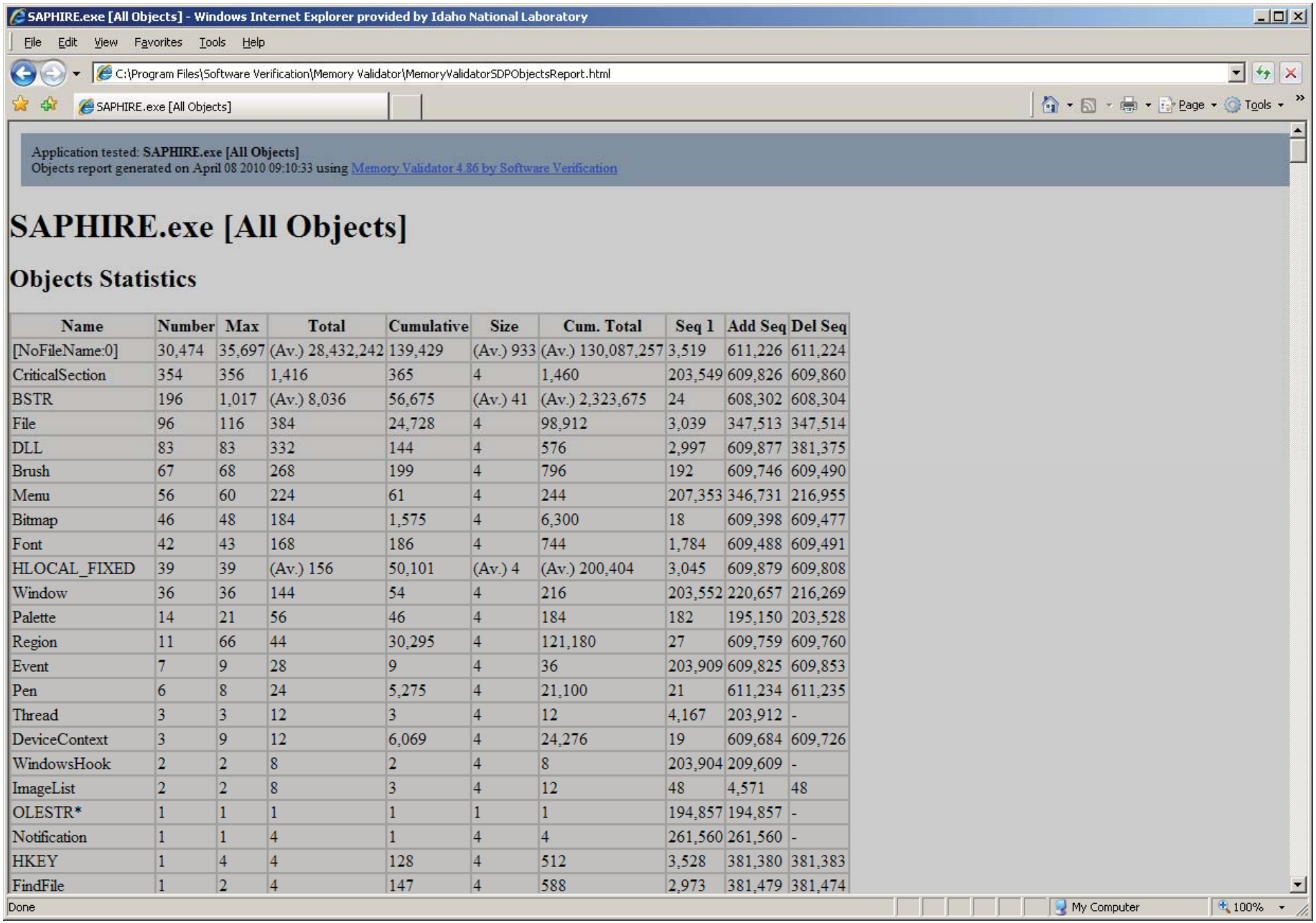
Figure 8-6 Memory Validator Memory Report - Bottom



SAPHIRE.exe:Wed Feb 17 13:01:00 2010 Virtual Memory

Address	Size	Type	Description
0x00000000	(64Kb) (0.06Mb)		Free
0x00010000	(4Kb) (0.00Mb)	Private	Commited
0x00011000	(60Kb) (0.06Mb)		Free
0x00020000	(4Kb) (0.00Mb)	Private	Commited
0x00021000	(60Kb) (0.06Mb)		Free
0x00030000	(1024Kb) (1.00Mb)	Private	Thread Stack: Thread Id: 0x00000544
0x00130000	(12Kb) (0.01Mb)	Mapped	Commited
0x00133000	(52Kb) (0.05Mb)		Free
0x00140000	(8Kb) (0.01Mb)	Mapped	Commited
0x00142000	(56Kb) (0.05Mb)		Free
0x00150000	(44Kb) (0.04Mb)	Private	Heap: handle: 0x00150000
0x0015b000	(60Kb) (0.06Mb)	Private	Commited
0x0016a000	(80Kb) (0.08Mb)	Private	Heap: handle: 0x00150000
0x0017e000	(60Kb) (0.06Mb)	Private	Commited
0x0018d000	(8Kb) (0.01Mb)	Private	Heap: handle: 0x00150000
0x0018f000	(60Kb) (0.06Mb)	Private	Commited
0x0019e000	(252Kb) (0.25Mb)	Private	Heap: handle: 0x00150000
0x001dd000	(60Kb) (0.06Mb)	Private	Commited
0x001ec000	(160Kb) (0.16Mb)	Private	Heap: handle: 0x00150000
0x00214000	(60Kb) (0.06Mb)	Private	Commited
0x00223000	(120Kb) (0.12Mb)	Private	Heap: handle: 0x00150000
0x00241000	(12Kb) (0.01Mb)	Private	Commited
0x00244000	(48Kb) (0.05Mb)	Private	Heap: handle: 0x00150000
0x00250000	(68Kb) (0.07Mb)	Private	Heap: handle: 0x00250000
0x00261000	(8Kb) (0.01Mb)	Mapped	Commited
0x00263000	(56Kb) (0.05Mb)	Mapped	Heap: handle: 0x00260000
0x00271000	(84Kb) (0.08Mb)	Mapped	Commited
0x00286000	(40Kb) (0.04Mb)		Free

Figure 8-7 Memory Validator Virtual Memory Report



Name	Number	Max	Total	Cumulative	Size	Cum. Total	Seq 1	Add Seq	Del Seq
[NoFileName:0]	30,474	35,697	(Av.) 28,432,242	139,429	(Av.) 933	(Av.) 130,087,257	3,519	611,226	611,224
CriticalSection	354	356	1,416	365	4	1,460	203,549	609,826	609,860
BSTR	196	1,017	(Av.) 8,036	56,675	(Av.) 41	(Av.) 2,323,675	24	608,302	608,304
File	96	116	384	24,728	4	98,912	3,039	347,513	347,514
DLL	83	83	332	144	4	576	2,997	609,877	381,375
Brush	67	68	268	199	4	796	192	609,746	609,490
Menu	56	60	224	61	4	244	207,353	346,731	216,955
Bitmap	46	48	184	1,575	4	6,300	18	609,398	609,477
Font	42	43	168	186	4	744	1,784	609,488	609,491
HLOCAL_FIXED	39	39	(Av.) 156	50,101	(Av.) 4	(Av.) 200,404	3,045	609,879	609,808
Window	36	36	144	54	4	216	203,552	220,657	216,269
Palette	14	21	56	46	4	184	182	195,150	203,528
Region	11	66	44	30,295	4	121,180	27	609,759	609,760
Event	7	9	28	9	4	36	203,909	609,825	609,853
Pen	6	8	24	5,275	4	21,100	21	611,234	611,235
Thread	3	3	12	3	4	12	4,167	203,912	-
DeviceContext	3	9	12	6,069	4	24,276	19	609,684	609,726
WindowsHook	2	2	8	2	4	8	203,904	209,609	-
ImageList	2	2	8	3	4	12	48	4,571	48
OLESTR*	1	1	1	1	1	1	194,857	194,857	-
Notification	1	1	4	1	4	4	261,560	261,560	-
HKEY	1	4	4	128	4	512	3,528	381,380	381,383
FindFile	1	2	4	147	4	588	2,973	381,479	381,474

Figure 8-8 Memory Validator Object Report

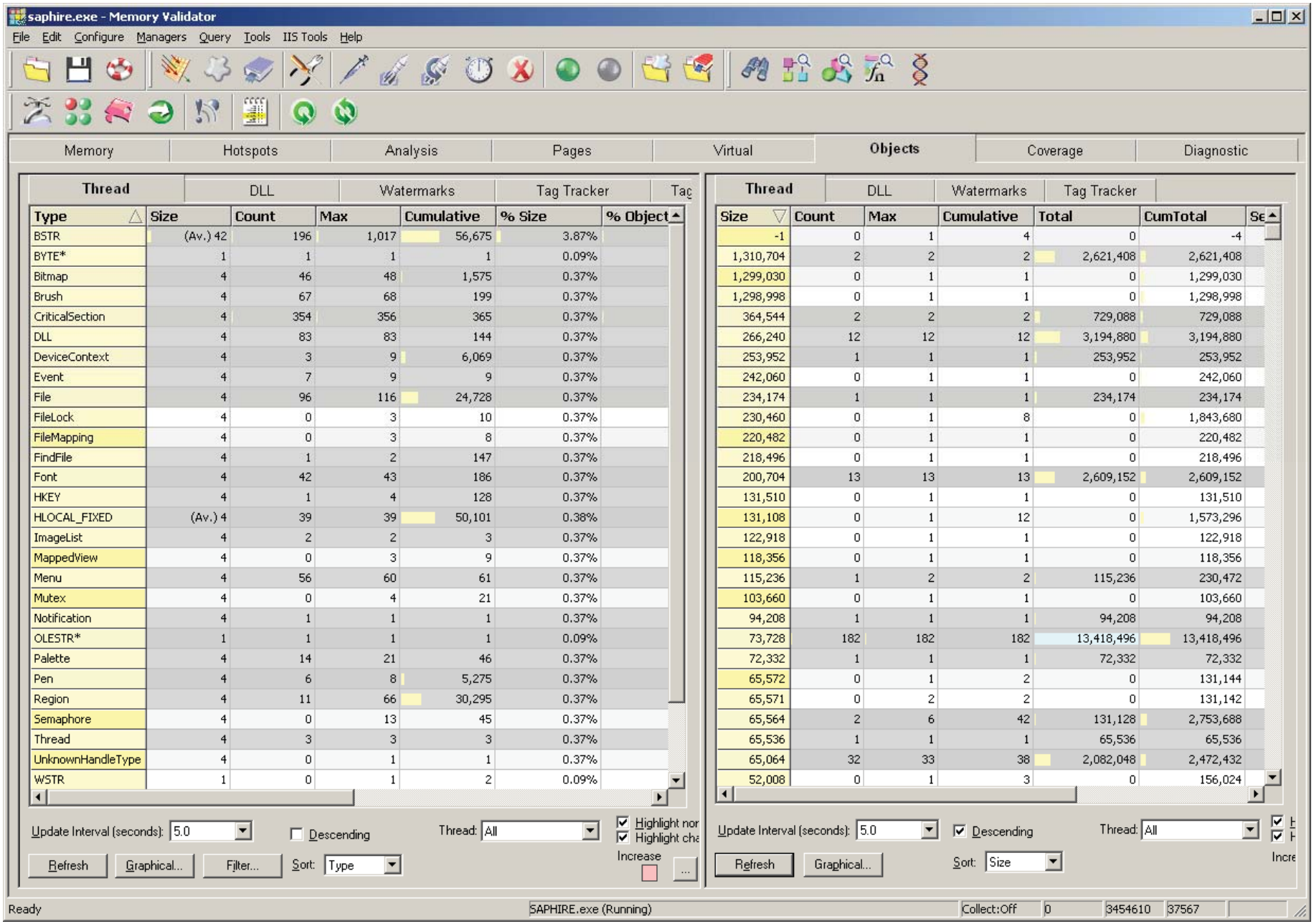


Figure 8-9 Memory Validator Object Tab

Attachment 10: Performance Validator

Figure 8-10 through Figure 8-15 provides partial results for the performance statistics for the SAPHIRE version 8 source code using the performance analyzer *Performance Validator* © Version 2.63. The performance statistics for a Significance Determination Process analysis (Figure 8-10 and Figure 8-11), Events and Condition Assessment analysis (Figure 8-12 and Figure 8-13) and a General analysis (Figure 8-14 and Figure 8-15) have been provided.

The figures show various performance statistics with percentages where appropriate. The statistics displayed are:

- Number of Children – The number of child functions of a function.
- Address – The function address.
- Class – The class name.
- Method / Function Name – The method/function name.
- File Name – The file name.
- Module Name – The module name.
- Call Count – The number of times the function is called.
- Call Count% - The number of times the function is called.
- Function Time – The time a function takes to execute.
- Function Time% - The time a function takes to execute.
- Total Time – The time a function and its child functions take to execute.
- Total Time% - The time a function and its child functions take to execute.
- Average Time – The average time a function takes to execute.
- Average Time% - The average time a function takes to execute.
- Child Time – The time a function's child functions take to execute.
- Child Time% - The time a function's child functions take to execute.
- Longest Time – The longest time a function and its child functions take to execute.
- Longest Time% - The longest time a function and its child functions take to execute.
- Shortest Time – The shortest time a function and its child functions take to execute.
- Shortest Time% - The shortest time a function and its child functions take to execute.

This report identifies functions and methods that are taking the most time, or which are visited more than other functions.

To access the file contents shown in Figure 8-10 and Figure 8-11, refer to file "*PerformanceValidatorSDPStatisticsReport.html*" included on the CD as an addendum to this report. To access the file:

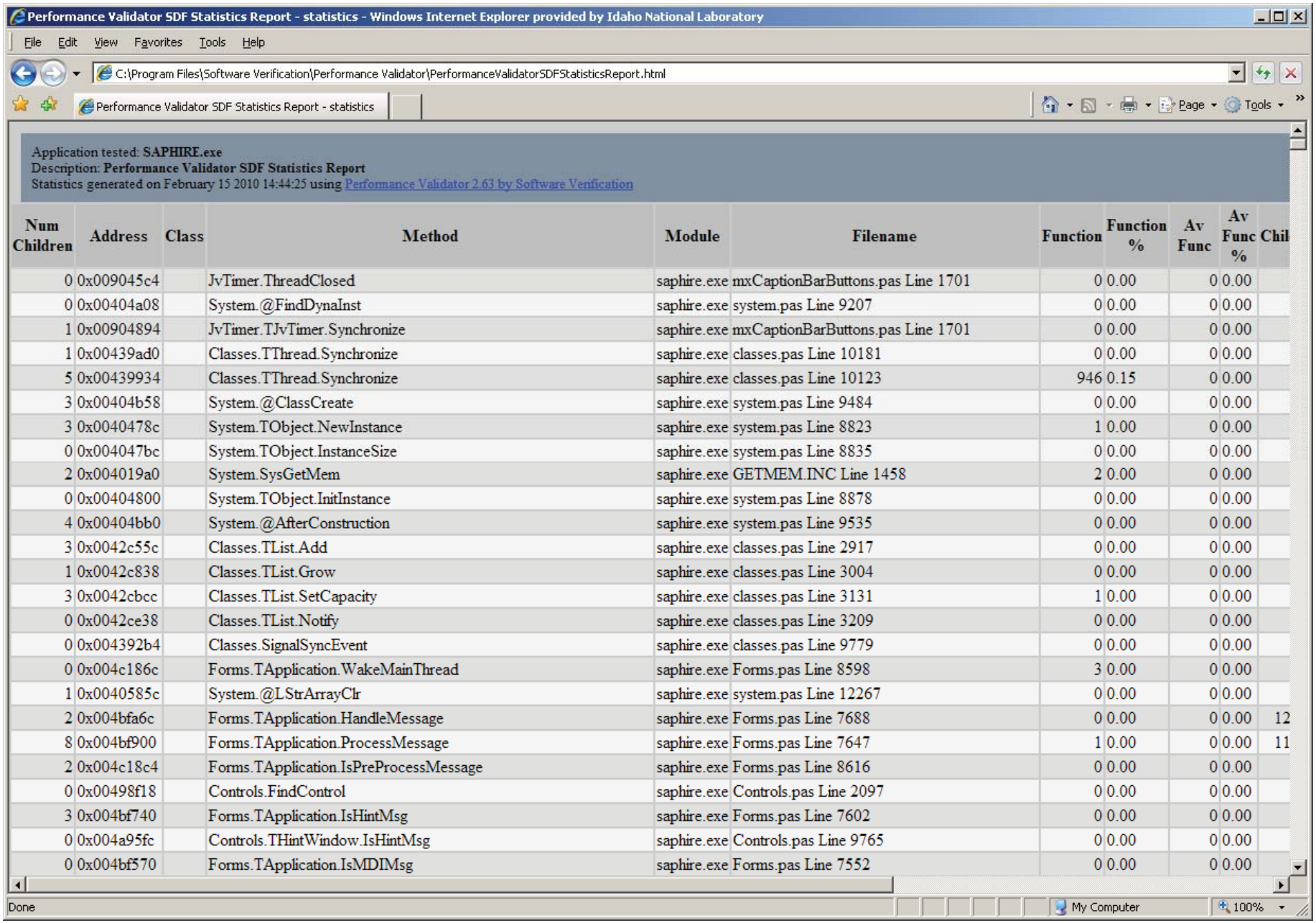
1. Open Internet Explorer.
2. Select "Open" from the "File" menu.
3. The "Open" window will be displayed.
4. Select the "Browse…" button from the "Open" window.
5. The "Windows Internet Explorer" window will be displayed.
6. Navigate to the "*PerformanceValidatorSDPStatisticsReport.html*" file located on the CD.
7. Select the "*PerformanceValidatorSDPStatisticsReport.html*" file on the CD.
8. Select the "Open" button from the "Windows Internet Explorer" window.
9. The "Windows Internet Explorer" window will close.
10. Select the "OK" button from the "Open" window.

To access the file contents shown in Figure 8-12 and Figure 8-13, refer to file "*PerformanceValidatorECAStatisticsReport.html*" included on the CD as an addendum to this report. To access the file:

1. Open Internet Explorer.
2. Select "Open" from the "File" menu.
3. The "Open" window will be displayed.
4. Select the "Browse…" button from the "Open" window.
5. The "Windows Internet Explorer" window will be displayed.
6. Navigate to the "*PerformanceValidatorECAStatisticsReport.html*" file located on the CD.
7. Select the "*PerformanceValidatorECAStatisticsReport.html*" file on the CD.
8. Select the "Open" button from the "Windows Internet Explorer" window.
9. The "Windows Internet Explorer" window will close.
10. Select the "OK" button from the "Open" window.

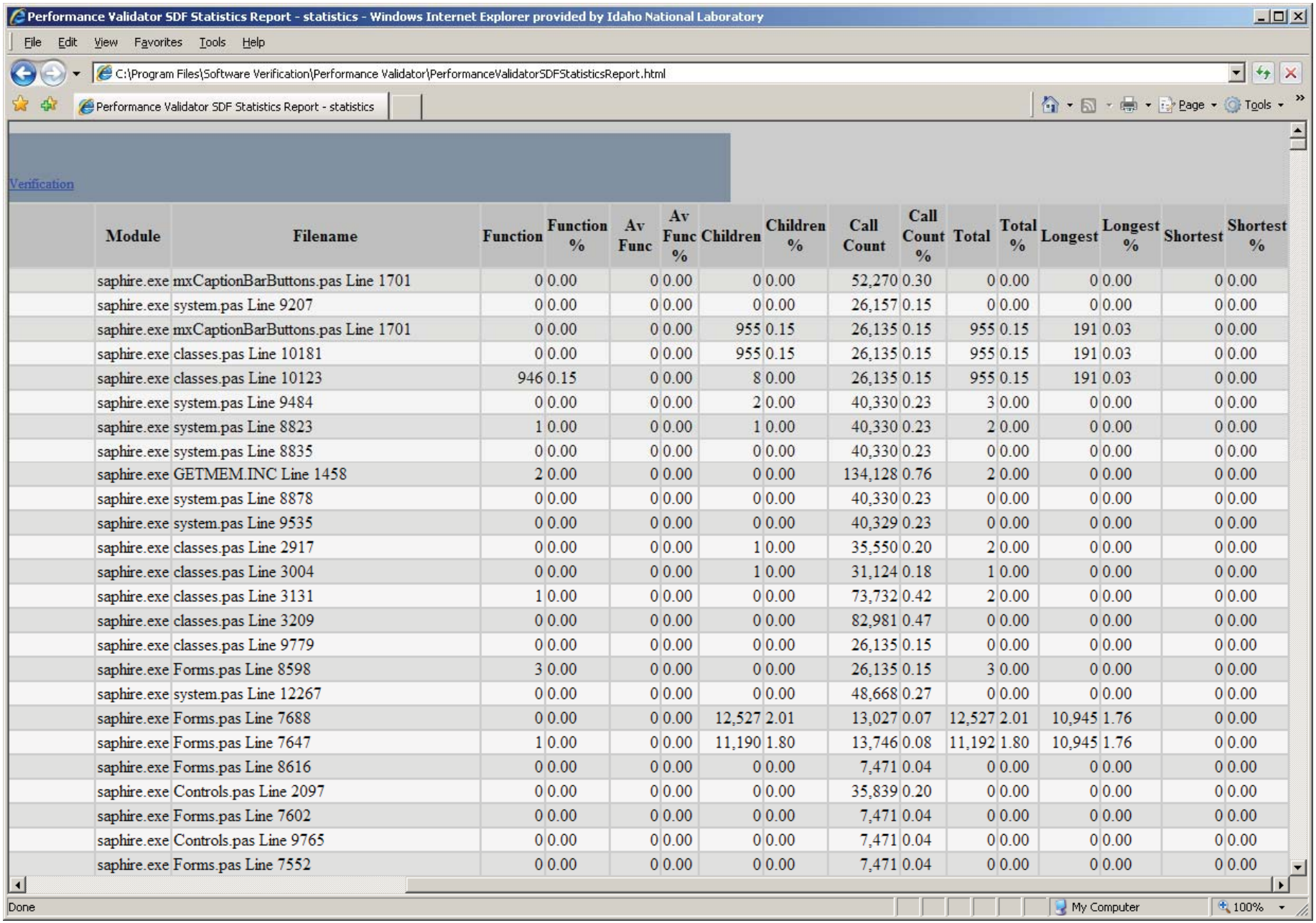
To access the file contents shown in Figure 8-14 and Figure 8-15, refer to file "*PerformanceValidatorGeneralAnalysisStatisticsReportOptions.html*" included on the CD as an addendum to this report. To access the file:

1. Open Internet Explorer.
2. Select "Open" from the "File" menu.
3. The "Open" window will be displayed.
4. Select the "Browse…" button from the "Open" window.
5. The "Windows Internet Explorer" window will be displayed.
6. Navigate to the "*PerformanceValidatorGeneralAnalysisStatisticsReportOptions.html*" file located on the CD.
7. Select the "*PerformanceValidatorGeneralAnalysisStatisticsReportOptions.html*" file on the CD.
8. Select the "Open" button from the "Windows Internet Explorer" window.
9. The "Windows Internet Explorer" window will close.
10. Select the "OK" button from the "Open" window.



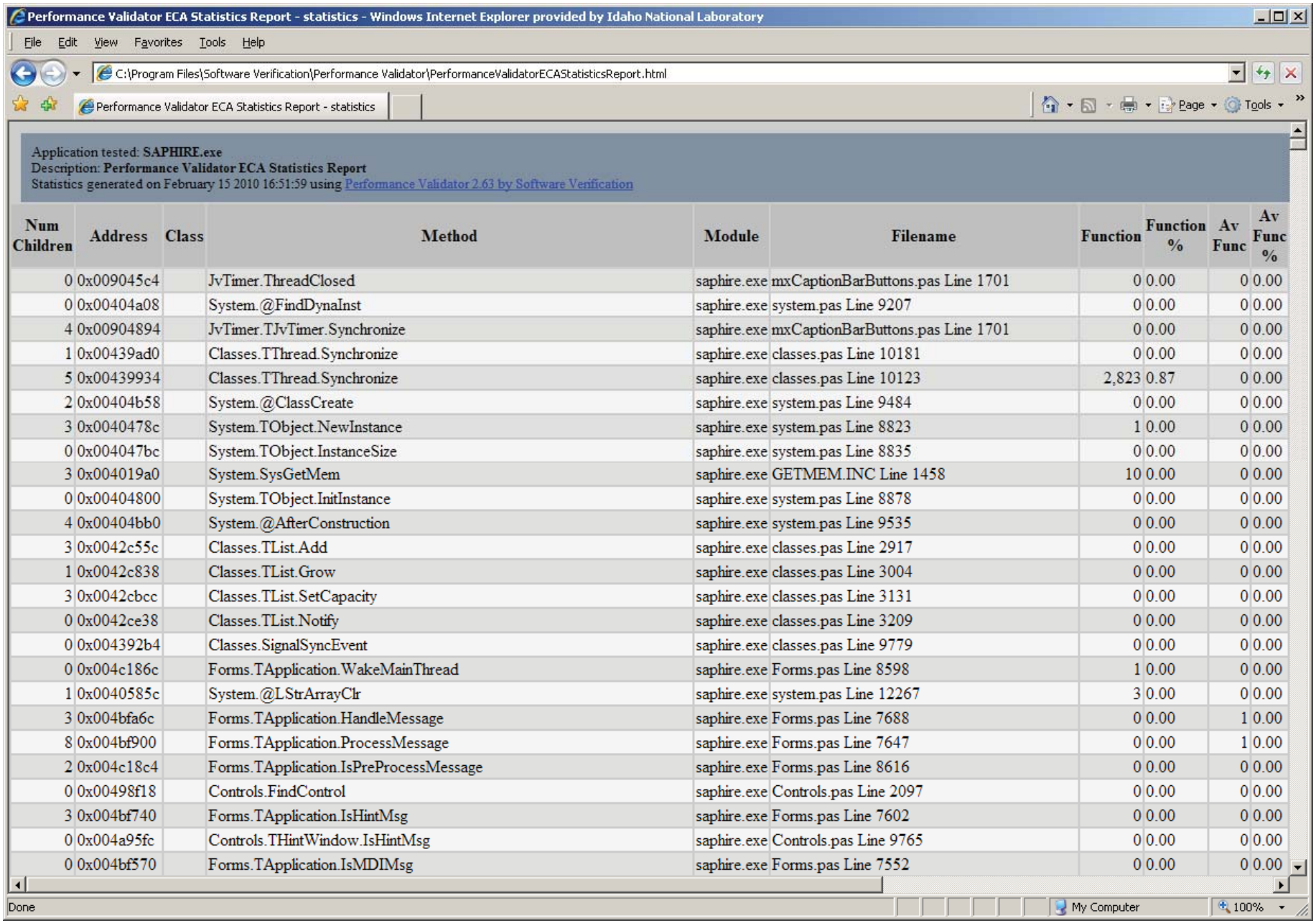
Num Children	Address	Class	Method	Module	Filename	Function	Function %	Av Func	Av Func %	Chil
0	0x009045c4		JvTimer.ThreadClosed	saphire.exe	mxCaptionBarButtons.pas Line 1701	0	0.00	0	0.00	
0	0x00404a08		System.@FindDynaInst	saphire.exe	system.pas Line 9207	0	0.00	0	0.00	
1	0x00904894		JvTimer.TJvTimer.Synchronize	saphire.exe	mxCaptionBarButtons.pas Line 1701	0	0.00	0	0.00	
1	0x00439ad0		Classes.TThread.Synchronize	saphire.exe	classes.pas Line 10181	0	0.00	0	0.00	
5	0x00439934		Classes.TThread.Synchronize	saphire.exe	classes.pas Line 10123	946	0.15	0	0.00	
3	0x00404b58		System.@ClassCreate	saphire.exe	system.pas Line 9484	0	0.00	0	0.00	
3	0x0040478c		System.TObject.NewInstance	saphire.exe	system.pas Line 8823	1	0.00	0	0.00	
0	0x004047bc		System.TObject.InstanceSize	saphire.exe	system.pas Line 8835	0	0.00	0	0.00	
2	0x004019a0		System.SysGetMem	saphire.exe	GETMEM.INC Line 1458	2	0.00	0	0.00	
0	0x00404800		System.TObject.InitInstance	saphire.exe	system.pas Line 8878	0	0.00	0	0.00	
4	0x00404bb0		System.@AfterConstruction	saphire.exe	system.pas Line 9535	0	0.00	0	0.00	
3	0x0042c55c		Classes.TList.Add	saphire.exe	classes.pas Line 2917	0	0.00	0	0.00	
1	0x0042c838		Classes.TList.Grow	saphire.exe	classes.pas Line 3004	0	0.00	0	0.00	
3	0x0042cbcc		Classes.TList.SetCapacity	saphire.exe	classes.pas Line 3131	1	0.00	0	0.00	
0	0x0042ce38		Classes.TList.Notify	saphire.exe	classes.pas Line 3209	0	0.00	0	0.00	
0	0x004392b4		Classes.SignalSyncEvent	saphire.exe	classes.pas Line 9779	0	0.00	0	0.00	
0	0x004c186c		Forms.TApplication.WakeMainThread	saphire.exe	Forms.pas Line 8598	3	0.00	0	0.00	
1	0x0040585c		System.@LStrArrayClr	saphire.exe	system.pas Line 12267	0	0.00	0	0.00	
2	0x004bfa6c		Forms.TApplication.HandleMessage	saphire.exe	Forms.pas Line 7688	0	0.00	0	0.00	12
8	0x004bf900		Forms.TApplication.ProcessMessage	saphire.exe	Forms.pas Line 7647	1	0.00	0	0.00	11
2	0x004c18c4		Forms.TApplication.IsPreProcessMessage	saphire.exe	Forms.pas Line 8616	0	0.00	0	0.00	
0	0x00498f18		Controls.FindControl	saphire.exe	Controls.pas Line 2097	0	0.00	0	0.00	
3	0x004bf740		Forms.TApplication.IsHintMsg	saphire.exe	Forms.pas Line 7602	0	0.00	0	0.00	
0	0x004a95fc		Controls.THintWindow.IsHintMsg	saphire.exe	Controls.pas Line 9765	0	0.00	0	0.00	
0	0x004bf570		Forms.TApplication.IsMDIMsg	saphire.exe	Forms.pas Line 7552	0	0.00	0	0.00	

Figure 8-10 Performance Validator SDP Statistics Report - Left



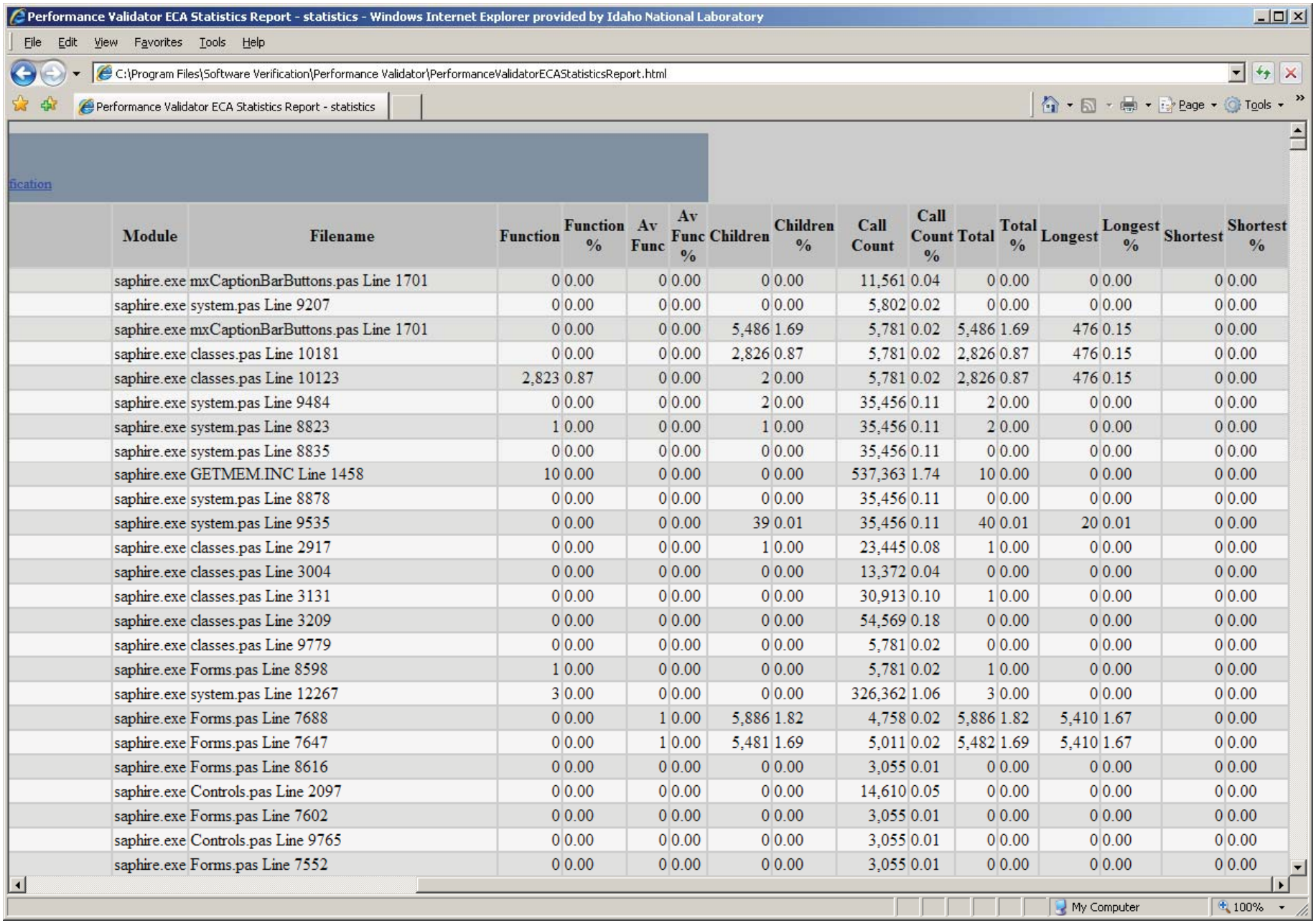
	Module	Filename	Function	Function %	Av Func	Av Func %	Children	Children %	Call Count	Call Count %	Total	Total %	Longest	Longest %	Shortest	Shortest %
	saphire.exe	mxCaptionBarButtons.pas Line 1701	0	0.00	0	0.00	0	0.00	52,270	0.30	0	0.00	0	0.00	0	0.00
	saphire.exe	system.pas Line 9207	0	0.00	0	0.00	0	0.00	26,157	0.15	0	0.00	0	0.00	0	0.00
	saphire.exe	mxCaptionBarButtons.pas Line 1701	0	0.00	0	0.00	955	0.15	26,135	0.15	955	0.15	191	0.03	0	0.00
	saphire.exe	classes.pas Line 10181	0	0.00	0	0.00	955	0.15	26,135	0.15	955	0.15	191	0.03	0	0.00
	saphire.exe	classes.pas Line 10123	946	0.15	0	0.00	8	0.00	26,135	0.15	955	0.15	191	0.03	0	0.00
	saphire.exe	system.pas Line 9484	0	0.00	0	0.00	2	0.00	40,330	0.23	3	0.00	0	0.00	0	0.00
	saphire.exe	system.pas Line 8823	1	0.00	0	0.00	1	0.00	40,330	0.23	2	0.00	0	0.00	0	0.00
	saphire.exe	system.pas Line 8835	0	0.00	0	0.00	0	0.00	40,330	0.23	0	0.00	0	0.00	0	0.00
	saphire.exe	GETMEM.INC Line 1458	2	0.00	0	0.00	0	0.00	134,128	0.76	2	0.00	0	0.00	0	0.00
	saphire.exe	system.pas Line 8878	0	0.00	0	0.00	0	0.00	40,330	0.23	0	0.00	0	0.00	0	0.00
	saphire.exe	system.pas Line 9535	0	0.00	0	0.00	0	0.00	40,329	0.23	0	0.00	0	0.00	0	0.00
	saphire.exe	classes.pas Line 2917	0	0.00	0	0.00	1	0.00	35,550	0.20	2	0.00	0	0.00	0	0.00
	saphire.exe	classes.pas Line 3004	0	0.00	0	0.00	1	0.00	31,124	0.18	1	0.00	0	0.00	0	0.00
	saphire.exe	classes.pas Line 3131	1	0.00	0	0.00	0	0.00	73,732	0.42	2	0.00	0	0.00	0	0.00
	saphire.exe	classes.pas Line 3209	0	0.00	0	0.00	0	0.00	82,981	0.47	0	0.00	0	0.00	0	0.00
	saphire.exe	classes.pas Line 9779	0	0.00	0	0.00	0	0.00	26,135	0.15	0	0.00	0	0.00	0	0.00
	saphire.exe	Forms.pas Line 8598	3	0.00	0	0.00	0	0.00	26,135	0.15	3	0.00	0	0.00	0	0.00
	saphire.exe	system.pas Line 12267	0	0.00	0	0.00	0	0.00	48,668	0.27	0	0.00	0	0.00	0	0.00
	saphire.exe	Forms.pas Line 7688	0	0.00	0	0.00	12,527	2.01	13,027	0.07	12,527	2.01	10,945	1.76	0	0.00
	saphire.exe	Forms.pas Line 7647	1	0.00	0	0.00	11,190	1.80	13,746	0.08	11,192	1.80	10,945	1.76	0	0.00
	saphire.exe	Forms.pas Line 8616	0	0.00	0	0.00	0	0.00	7,471	0.04	0	0.00	0	0.00	0	0.00
	saphire.exe	Controls.pas Line 2097	0	0.00	0	0.00	0	0.00	35,839	0.20	0	0.00	0	0.00	0	0.00
	saphire.exe	Forms.pas Line 7602	0	0.00	0	0.00	0	0.00	7,471	0.04	0	0.00	0	0.00	0	0.00
	saphire.exe	Controls.pas Line 9765	0	0.00	0	0.00	0	0.00	7,471	0.04	0	0.00	0	0.00	0	0.00
	saphire.exe	Forms.pas Line 7552	0	0.00	0	0.00	0	0.00	7,471	0.04	0	0.00	0	0.00	0	0.00

Figure 8-11 Performance Validator SDP Statistics Report - Right



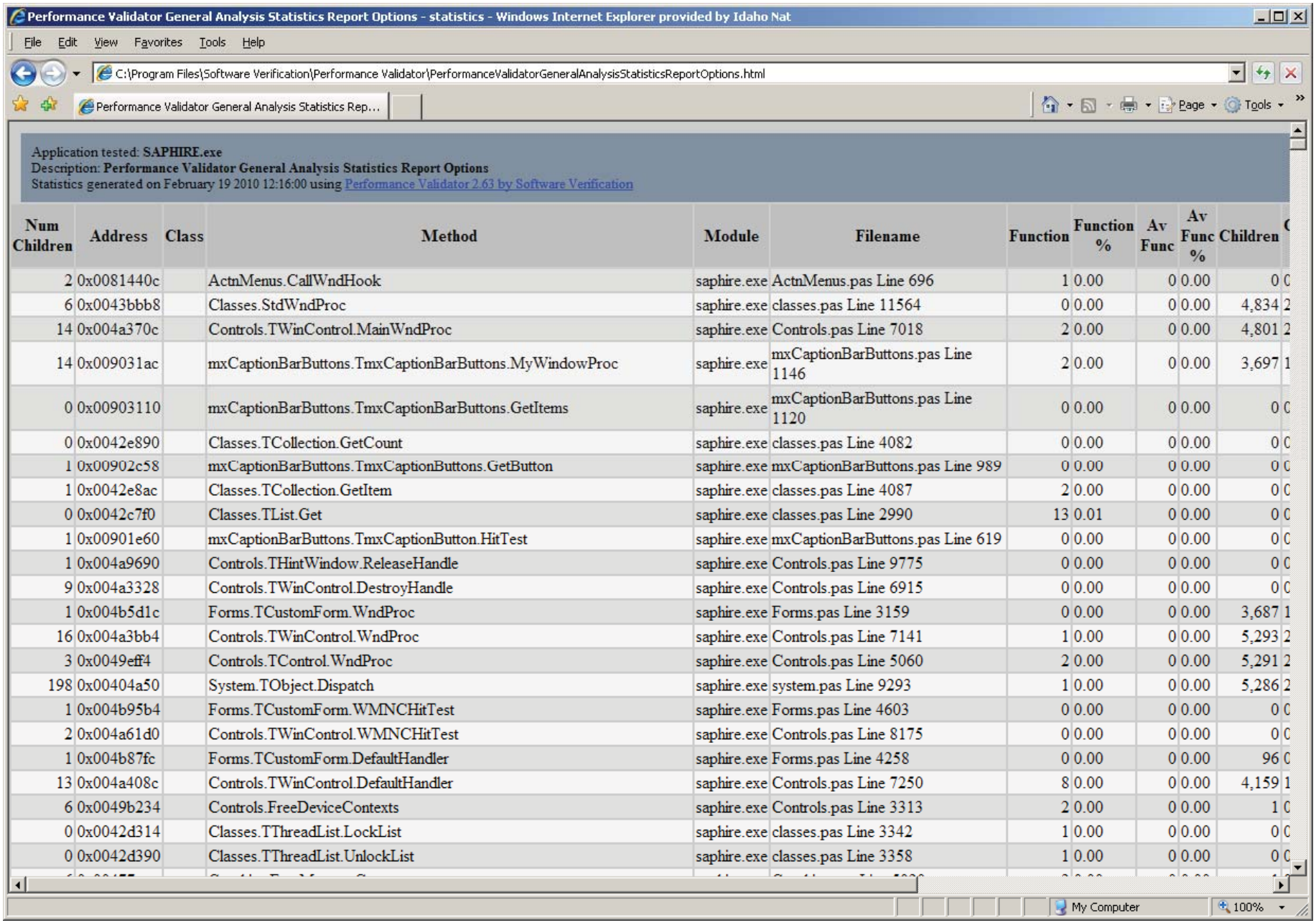
Num Children	Address	Class	Method	Module	Filename	Function	Function %	Av Func	Av Func %
0	0x009045c4		JvTimer.ThreadClosed	saphire.exe	mxCaptionBarButtons.pas Line 1701	0	0.00	0	0.00
0	0x00404a08		System.@FindDynaInst	saphire.exe	system.pas Line 9207	0	0.00	0	0.00
4	0x00904894		JvTimer.TJvTimer.Synchronize	saphire.exe	mxCaptionBarButtons.pas Line 1701	0	0.00	0	0.00
1	0x00439ad0		Classes.TThread.Synchronize	saphire.exe	classes.pas Line 10181	0	0.00	0	0.00
5	0x00439934		Classes.TThread.Synchronize	saphire.exe	classes.pas Line 10123	2,823	0.87	0	0.00
2	0x00404b58		System.@ClassCreate	saphire.exe	system.pas Line 9484	0	0.00	0	0.00
3	0x0040478c		System.TObject.NewInstance	saphire.exe	system.pas Line 8823	1	0.00	0	0.00
0	0x004047bc		System.TObject.InstanceSize	saphire.exe	system.pas Line 8835	0	0.00	0	0.00
3	0x004019a0		System.SysGetMem	saphire.exe	GETMEM.INC Line 1458	10	0.00	0	0.00
0	0x00404800		System.TObject.InitInstance	saphire.exe	system.pas Line 8878	0	0.00	0	0.00
4	0x00404bb0		System.@AfterConstruction	saphire.exe	system.pas Line 9535	0	0.00	0	0.00
3	0x0042c55c		Classes.TList.Add	saphire.exe	classes.pas Line 2917	0	0.00	0	0.00
1	0x0042c838		Classes.TList.Grow	saphire.exe	classes.pas Line 3004	0	0.00	0	0.00
3	0x0042cbcc		Classes.TList.SetCapacity	saphire.exe	classes.pas Line 3131	0	0.00	0	0.00
0	0x0042ce38		Classes.TList.Notify	saphire.exe	classes.pas Line 3209	0	0.00	0	0.00
0	0x004392b4		Classes.SignalSyncEvent	saphire.exe	classes.pas Line 9779	0	0.00	0	0.00
0	0x004c186c		Forms.TApplication.WakeMainThread	saphire.exe	Forms.pas Line 8598	1	0.00	0	0.00
1	0x0040585c		System.@LStrArrayClr	saphire.exe	system.pas Line 12267	3	0.00	0	0.00
3	0x004bfa6c		Forms.TApplication.HandleMessage	saphire.exe	Forms.pas Line 7688	0	0.00	1	0.00
8	0x004bf900		Forms.TApplication.ProcessMessage	saphire.exe	Forms.pas Line 7647	0	0.00	1	0.00
2	0x004c18c4		Forms.TApplication.IsPreProcessMessage	saphire.exe	Forms.pas Line 8616	0	0.00	0	0.00
0	0x00498f18		Controls.FindControl	saphire.exe	Controls.pas Line 2097	0	0.00	0	0.00
3	0x004bf740		Forms.TApplication.IsHintMsg	saphire.exe	Forms.pas Line 7602	0	0.00	0	0.00
0	0x004a95fc		Controls.THintWindow.IsHintMsg	saphire.exe	Controls.pas Line 9765	0	0.00	0	0.00
0	0x004bf570		Forms.TApplication.IsMDIMsg	saphire.exe	Forms.pas Line 7552	0	0.00	0	0.00

Figure 8-12 Performance Validator ECA Statistics Report - Left



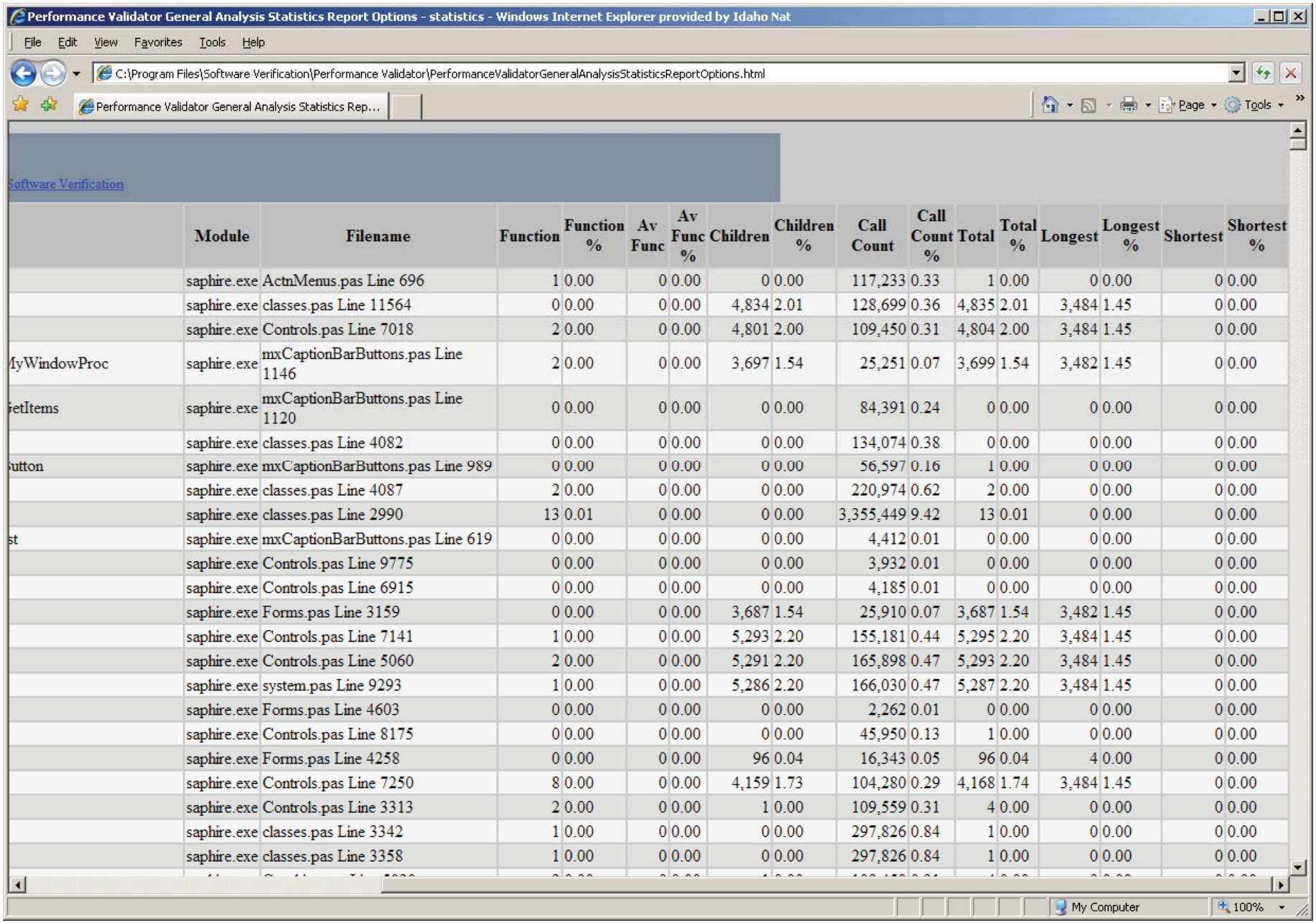
	Module	Filename	Function	Function %	Av Func	Av Func %	Children	Children %	Call Count	Call Count %	Total	Total %	Longest	Longest %	Shortest	Shortest %
	saphire.exe	mxCaptionBarButtons.pas Line 1701	0	0.00	0	0.00	0	0.00	11,561	0.04	0	0.00	0	0.00	0	0.00
	saphire.exe	system.pas Line 9207	0	0.00	0	0.00	0	0.00	5,802	0.02	0	0.00	0	0.00	0	0.00
	saphire.exe	mxCaptionBarButtons.pas Line 1701	0	0.00	0	0.00	5,486	1.69	5,781	0.02	5,486	1.69	476	0.15	0	0.00
	saphire.exe	classes.pas Line 10181	0	0.00	0	0.00	2,826	0.87	5,781	0.02	2,826	0.87	476	0.15	0	0.00
	saphire.exe	classes.pas Line 10123	2,823	0.87	0	0.00	2	0.00	5,781	0.02	2,826	0.87	476	0.15	0	0.00
	saphire.exe	system.pas Line 9484	0	0.00	0	0.00	2	0.00	35,456	0.11	2	0.00	0	0.00	0	0.00
	saphire.exe	system.pas Line 8823	1	0.00	0	0.00	1	0.00	35,456	0.11	2	0.00	0	0.00	0	0.00
	saphire.exe	system.pas Line 8835	0	0.00	0	0.00	0	0.00	35,456	0.11	0	0.00	0	0.00	0	0.00
	saphire.exe	GETMEM.INC Line 1458	10	0.00	0	0.00	0	0.00	537,363	1.74	10	0.00	0	0.00	0	0.00
	saphire.exe	system.pas Line 8878	0	0.00	0	0.00	0	0.00	35,456	0.11	0	0.00	0	0.00	0	0.00
	saphire.exe	system.pas Line 9535	0	0.00	0	0.00	39	0.01	35,456	0.11	40	0.01	20	0.01	0	0.00
	saphire.exe	classes.pas Line 2917	0	0.00	0	0.00	1	0.00	23,445	0.08	1	0.00	0	0.00	0	0.00
	saphire.exe	classes.pas Line 3004	0	0.00	0	0.00	0	0.00	13,372	0.04	0	0.00	0	0.00	0	0.00
	saphire.exe	classes.pas Line 3131	0	0.00	0	0.00	0	0.00	30,913	0.10	1	0.00	0	0.00	0	0.00
	saphire.exe	classes.pas Line 3209	0	0.00	0	0.00	0	0.00	54,569	0.18	0	0.00	0	0.00	0	0.00
	saphire.exe	classes.pas Line 9779	0	0.00	0	0.00	0	0.00	5,781	0.02	0	0.00	0	0.00	0	0.00
	saphire.exe	Forms.pas Line 8598	1	0.00	0	0.00	0	0.00	5,781	0.02	1	0.00	0	0.00	0	0.00
	saphire.exe	system.pas Line 12267	3	0.00	0	0.00	0	0.00	326,362	1.06	3	0.00	0	0.00	0	0.00
	saphire.exe	Forms.pas Line 7688	0	0.00	1	0.00	5,886	1.82	4,758	0.02	5,886	1.82	5,410	1.67	0	0.00
	saphire.exe	Forms.pas Line 7647	0	0.00	1	0.00	5,481	1.69	5,011	0.02	5,482	1.69	5,410	1.67	0	0.00
	saphire.exe	Forms.pas Line 8616	0	0.00	0	0.00	0	0.00	3,055	0.01	0	0.00	0	0.00	0	0.00
	saphire.exe	Controls.pas Line 2097	0	0.00	0	0.00	0	0.00	14,610	0.05	0	0.00	0	0.00	0	0.00
	saphire.exe	Forms.pas Line 7602	0	0.00	0	0.00	0	0.00	3,055	0.01	0	0.00	0	0.00	0	0.00
	saphire.exe	Controls.pas Line 9765	0	0.00	0	0.00	0	0.00	3,055	0.01	0	0.00	0	0.00	0	0.00
	saphire.exe	Forms.pas Line 7552	0	0.00	0	0.00	0	0.00	3,055	0.01	0	0.00	0	0.00	0	0.00

Figure 8-13 Performance Validator ECA Statistics Report - Right



Num Children	Address	Class	Method	Module	Filename	Function	Function %	Av Func	Av Func %	Children	C
2	0x0081440c		ActnMenus.CallWndHook	saphire.exe	ActnMenus.pas Line 696	1	0.00	0	0.00	0	0
6	0x0043bbb8		Classes.StdWndProc	saphire.exe	classes.pas Line 11564	0	0.00	0	0.00	4,834	2
14	0x004a370c		Controls.TWinControl.MainWndProc	saphire.exe	Controls.pas Line 7018	2	0.00	0	0.00	4,801	2
14	0x009031ac		mxCaptionBarButtons.TmxCaptionBarButtons.MyWindowProc	saphire.exe	mxCaptionBarButtons.pas Line 1146	2	0.00	0	0.00	3,697	1
0	0x00903110		mxCaptionBarButtons.TmxCaptionBarButtons.GetItems	saphire.exe	mxCaptionBarButtons.pas Line 1120	0	0.00	0	0.00	0	0
0	0x0042e890		Classes.TCollection.GetCount	saphire.exe	classes.pas Line 4082	0	0.00	0	0.00	0	0
1	0x00902c58		mxCaptionBarButtons.TmxCaptionButtons.GetButton	saphire.exe	mxCaptionBarButtons.pas Line 989	0	0.00	0	0.00	0	0
1	0x0042e8ac		Classes.TCollection.GetItem	saphire.exe	classes.pas Line 4087	2	0.00	0	0.00	0	0
0	0x0042c7f0		Classes.TList.Get	saphire.exe	classes.pas Line 2990	13	0.01	0	0.00	0	0
1	0x00901e60		mxCaptionBarButtons.TmxCaptionButton.HitTest	saphire.exe	mxCaptionBarButtons.pas Line 619	0	0.00	0	0.00	0	0
1	0x004a9690		Controls.THintWindow.ReleaseHandle	saphire.exe	Controls.pas Line 9775	0	0.00	0	0.00	0	0
9	0x004a3328		Controls.TWinControl.DestroyHandle	saphire.exe	Controls.pas Line 6915	0	0.00	0	0.00	0	0
1	0x004b5d1c		Forms.TCustomForm.WndProc	saphire.exe	Forms.pas Line 3159	0	0.00	0	0.00	3,687	1
16	0x004a3bb4		Controls.TWinControl.WndProc	saphire.exe	Controls.pas Line 7141	1	0.00	0	0.00	5,293	2
3	0x0049eff4		Controls.TControl.WndProc	saphire.exe	Controls.pas Line 5060	2	0.00	0	0.00	5,291	2
198	0x00404a50		System.TObject.Dispatch	saphire.exe	system.pas Line 9293	1	0.00	0	0.00	5,286	2
1	0x004b95b4		Forms.TCustomForm.WMNCHitTest	saphire.exe	Forms.pas Line 4603	0	0.00	0	0.00	0	0
2	0x004a61d0		Controls.TWinControl.WMNCHitTest	saphire.exe	Controls.pas Line 8175	0	0.00	0	0.00	0	0
1	0x004b87fc		Forms.TCustomForm.DefaultHandler	saphire.exe	Forms.pas Line 4258	0	0.00	0	0.00	96	0
13	0x004a408c		Controls.TWinControl.DefaultHandler	saphire.exe	Controls.pas Line 7250	8	0.00	0	0.00	4,159	1
6	0x0049b234		Controls.FreeDeviceContexts	saphire.exe	Controls.pas Line 3313	2	0.00	0	0.00	1	0
0	0x0042d314		Classes.TThreadList.LockList	saphire.exe	classes.pas Line 3342	1	0.00	0	0.00	0	0
0	0x0042d390		Classes.TThreadList.UnlockList	saphire.exe	classes.pas Line 3358	1	0.00	0	0.00	0	0

Figure 8-14 Performance Validator General Analysis Statistics Report - Left



	Module	Filename	Function	Function %	Av Func	Av Func %	Children	Children %	Call Count	Call Count %	Total	Total %	Longest	Longest %	Shortest	Shortest %
	saphire.exe	ActnMenus.pas Line 696	1	0.00	0	0.00	0	0.00	117,233	0.33	1	0.00	0	0.00	0	0.00
	saphire.exe	classes.pas Line 11564	0	0.00	0	0.00	4,834	2.01	128,699	0.36	4,835	2.01	3,484	1.45	0	0.00
	saphire.exe	Controls.pas Line 7018	2	0.00	0	0.00	4,801	2.00	109,450	0.31	4,804	2.00	3,484	1.45	0	0.00
MyWindowProc	saphire.exe	mxCaptionBarButtons.pas Line 1146	2	0.00	0	0.00	3,697	1.54	25,251	0.07	3,699	1.54	3,482	1.45	0	0.00
GetItems	saphire.exe	mxCaptionBarButtons.pas Line 1120	0	0.00	0	0.00	0	0.00	84,391	0.24	0	0.00	0	0.00	0	0.00
	saphire.exe	classes.pas Line 4082	0	0.00	0	0.00	0	0.00	134,074	0.38	0	0.00	0	0.00	0	0.00
Button	saphire.exe	mxCaptionBarButtons.pas Line 989	0	0.00	0	0.00	0	0.00	56,597	0.16	1	0.00	0	0.00	0	0.00
	saphire.exe	classes.pas Line 4087	2	0.00	0	0.00	0	0.00	220,974	0.62	2	0.00	0	0.00	0	0.00
	saphire.exe	classes.pas Line 2990	13	0.01	0	0.00	0	0.00	3,355,449	9.42	13	0.01	0	0.00	0	0.00
st	saphire.exe	mxCaptionBarButtons.pas Line 619	0	0.00	0	0.00	0	0.00	4,412	0.01	0	0.00	0	0.00	0	0.00
	saphire.exe	Controls.pas Line 9775	0	0.00	0	0.00	0	0.00	3,932	0.01	0	0.00	0	0.00	0	0.00
	saphire.exe	Controls.pas Line 6915	0	0.00	0	0.00	0	0.00	4,185	0.01	0	0.00	0	0.00	0	0.00
	saphire.exe	Forms.pas Line 3159	0	0.00	0	0.00	3,687	1.54	25,910	0.07	3,687	1.54	3,482	1.45	0	0.00
	saphire.exe	Controls.pas Line 7141	1	0.00	0	0.00	5,293	2.20	155,181	0.44	5,295	2.20	3,484	1.45	0	0.00
	saphire.exe	Controls.pas Line 5060	2	0.00	0	0.00	5,291	2.20	165,898	0.47	5,293	2.20	3,484	1.45	0	0.00
	saphire.exe	system.pas Line 9293	1	0.00	0	0.00	5,286	2.20	166,030	0.47	5,287	2.20	3,484	1.45	0	0.00
	saphire.exe	Forms.pas Line 4603	0	0.00	0	0.00	0	0.00	2,262	0.01	0	0.00	0	0.00	0	0.00
	saphire.exe	Controls.pas Line 8175	0	0.00	0	0.00	0	0.00	45,950	0.13	1	0.00	0	0.00	0	0.00
	saphire.exe	Forms.pas Line 4258	0	0.00	0	0.00	96	0.04	16,343	0.05	96	0.04	4	0.00	0	0.00
	saphire.exe	Controls.pas Line 7250	8	0.00	0	0.00	4,159	1.73	104,280	0.29	4,168	1.74	3,484	1.45	0	0.00
	saphire.exe	Controls.pas Line 3313	2	0.00	0	0.00	1	0.00	109,559	0.31	4	0.00	0	0.00	0	0.00
	saphire.exe	classes.pas Line 3342	1	0.00	0	0.00	0	0.00	297,826	0.84	1	0.00	0	0.00	0	0.00
	saphire.exe	classes.pas Line 3358	1	0.00	0	0.00	0	0.00	297,826	0.84	1	0.00	0	0.00	0	0.00

Figure 8-15 Performance Validator General Analysis Statistics Report - Right

Attachment 11: Thread Validator

Figure 8-17, Figure 8-18 and Figure 8-19 provides the deadlocks, potential deadlocks, bad lock strategies, and deadlock postmortem analysis for the SAPHIRE version 8 source code using the deadlock detector *Thread Validator* Version 1.52. The partial results of deadlocks, potential deadlocks, bad lock strategies, and deadlock postmortem analysis for a Significance Determination Process analysis (Figure 8-17), Events and Condition Assessment analysis (Figure 8-18) and a General analysis (Figure 8-19) have been provided. Figure 8-16 provides the color code definitions for the memory and resource allocations that have not been deallocated and any information about damaged memory presented in Figure 8-17 through Figure 8-19.

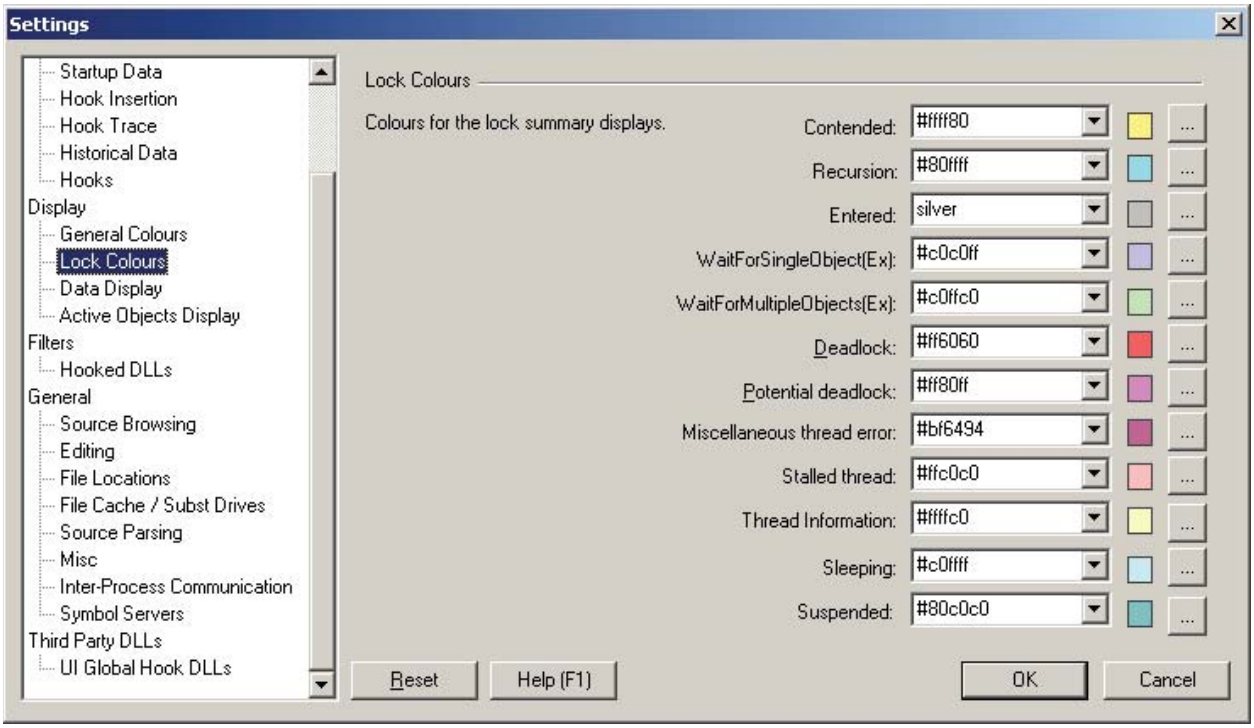


Figure 8-16 Thread Validator Lock Colors Definitions

Figure 8-17 through Figure 8-19 provide the following information about all memory and resource allocations that have not been deallocated and any information about damaged memory:

- The first column provides the Critical Section Address.
- The second column provides the Entered Count.
- The third column provides the Recursion Count, the number of times the critical section has been re-entered while locked by the current thread.
- The fourth column provides the Contended Count, the number of times that a thread has tried to acquire the critical section but has had to wait because another thread already owns the critical section.
- The fifth column provides the Number of Waiting Processor Cycles.
- The sixth column provides the Thread Id.
- The seventh column provides the Number of Waiting Threads.
- The eighth column provides the Location Where the Object Was Allocated, Locked or Waiting.

To access the file contents shown in Figure 8-17, refer to file "*ThreadValidatorSDPReport.html*" included on the CD as an addendum to this report. To access the file:

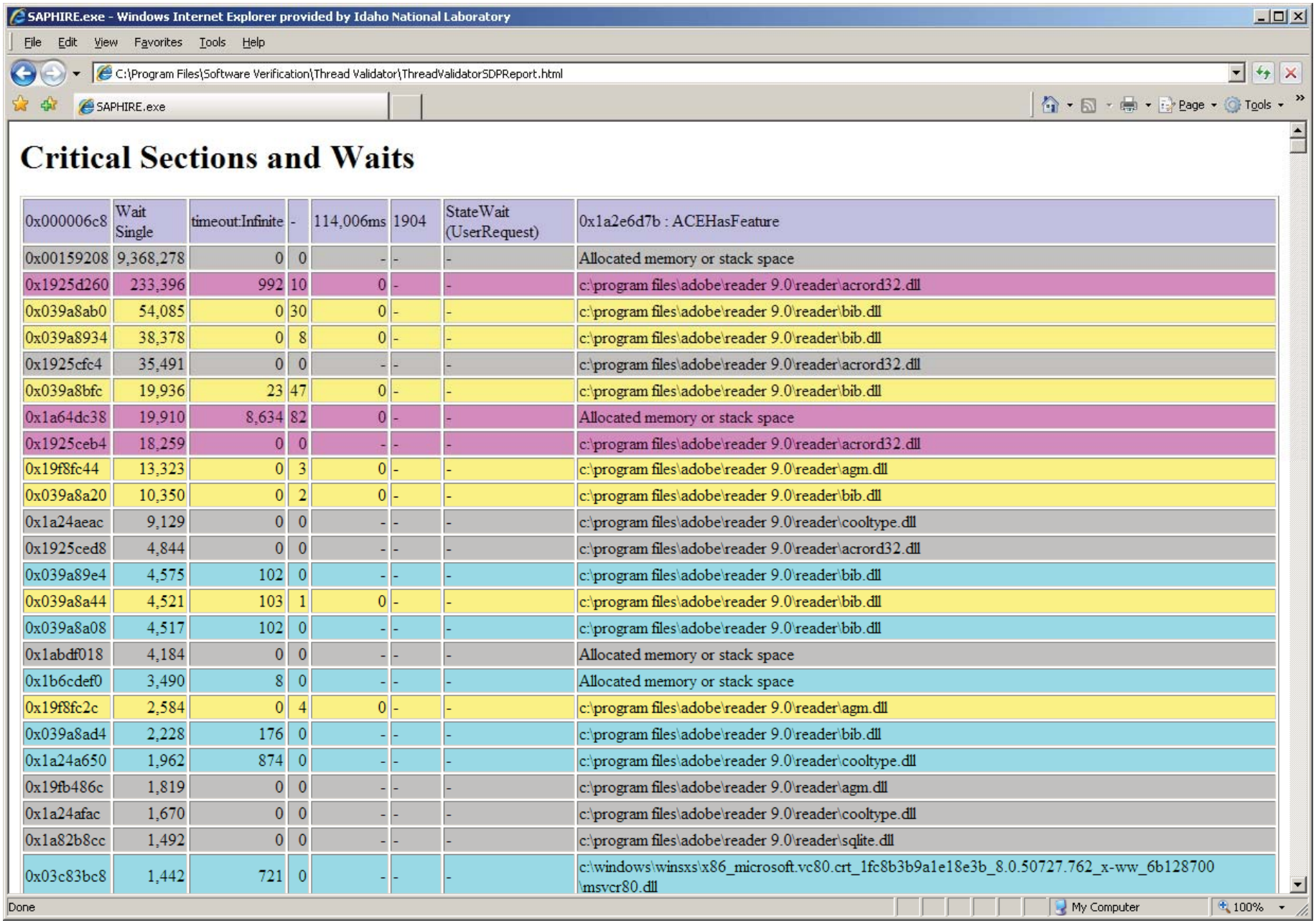
1. Open Internet Explorer.
2. Select "Open" from the "File" menu.
3. The "Open" window will be displayed.
4. Select the "Browse…" button from the "Open" window.
5. The "Windows Internet Explorer" window will be displayed.
6. Navigate to the "*ThreadValidatorSDPReport.html*" file located on the CD.
7. Select the "*ThreadValidatorSDPReport.html ml*" file on the CD.
8. Select the "Open" button from the "Windows Internet Explorer" window.
9. The "Windows Internet Explorer" window will close.
10. Select the "OK" button from the "Open" window.

To access the file contents shown in Figure 8-18, refer to file "*ThreadValidatorECAReport.html*" included on the CD as an addendum to this report. To access the file:

1. Open Internet Explorer.
2. Select "Open" from the "File" menu.
3. The "Open" window will be displayed.
4. Select the "Browse…" button from the "Open" window.
5. The "Windows Internet Explorer" window will be displayed.
6. Navigate to the "*ThreadValidatorECAReport.html*" file located on the CD.
7. Select the "*ThreadValidatorECAReport.html ml*" file on the CD.
8. Select the "Open" button from the "Windows Internet Explorer" window.
9. The "Windows Internet Explorer" window will close.
10. Select the "OK" button from the "Open" window.

To access the file contents shown in Figure 8-19, refer to file "*ThreadValidatorGeneralAnalysisReport.html*" included on the CD as an addendum to this report. To access the file:

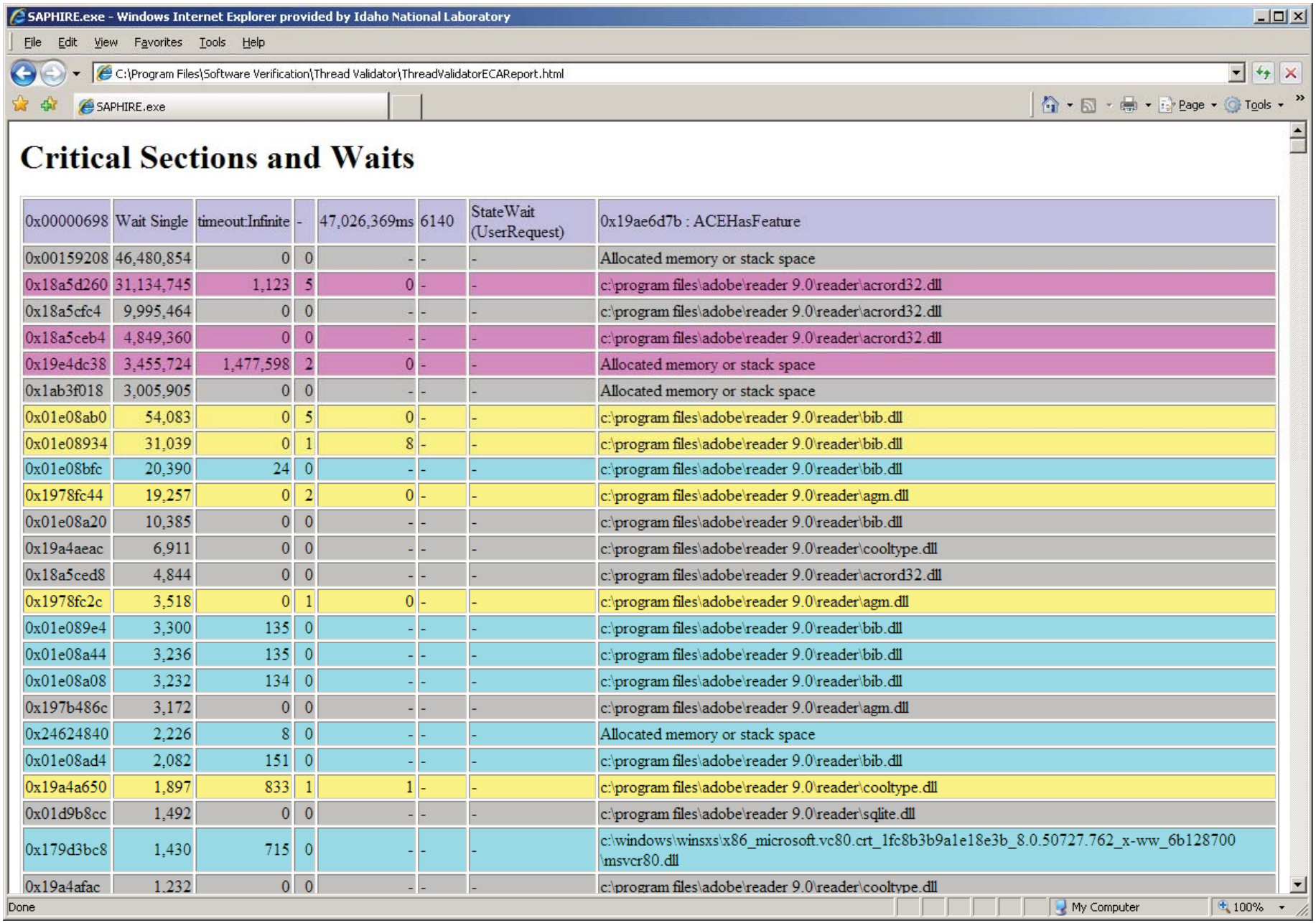
1. Open Internet Explorer.
2. Select "Open" from the "File" menu.
3. The "Open" window will be displayed.
4. Select the "Browse…" button from the "Open" window.
5. The "Windows Internet Explorer" window will be displayed.
6. Navigate to the "*ThreadValidatorGeneralAnalysisReport.html*" file located on the CD.
7. Select the "*ThreadValidatorGeneralAnalysisReport.html ml*" file on the CD.
8. Select the "Open" button from the "Windows Internet Explorer" window.
9. The "Windows Internet Explorer" window will close.
10. Select the "OK" button from the "Open" window.



Critical Sections and Waits

0x000006c8	Wait Single	timeout:Infinite	-	114,006ms	1904	StateWait (UserRequest)	0x1a2e6d7b : ACEHasFeature
0x00159208	9,368,278	0	0	-	-	-	Allocated memory or stack space
0x1925d260	233,396	992	10	0	-	-	c:\program files\adobe\reader 9.0\reader\acrord32.dll
0x039a8ab0	54,085	0	30	0	-	-	c:\program files\adobe\reader 9.0\reader\bib.dll
0x039a8934	38,378	0	8	0	-	-	c:\program files\adobe\reader 9.0\reader\bib.dll
0x1925cfc4	35,491	0	0	-	-	-	c:\program files\adobe\reader 9.0\reader\acrord32.dll
0x039a8bfc	19,936	23	47	0	-	-	c:\program files\adobe\reader 9.0\reader\bib.dll
0x1a64dc38	19,910	8,634	82	0	-	-	Allocated memory or stack space
0x1925ceb4	18,259	0	0	-	-	-	c:\program files\adobe\reader 9.0\reader\acrord32.dll
0x19f8fc44	13,323	0	3	0	-	-	c:\program files\adobe\reader 9.0\reader\agm.dll
0x039a8a20	10,350	0	2	0	-	-	c:\program files\adobe\reader 9.0\reader\bib.dll
0x1a24aeac	9,129	0	0	-	-	-	c:\program files\adobe\reader 9.0\reader\cooltype.dll
0x1925ced8	4,844	0	0	-	-	-	c:\program files\adobe\reader 9.0\reader\acrord32.dll
0x039a89e4	4,575	102	0	-	-	-	c:\program files\adobe\reader 9.0\reader\bib.dll
0x039a8a44	4,521	103	1	0	-	-	c:\program files\adobe\reader 9.0\reader\bib.dll
0x039a8a08	4,517	102	0	-	-	-	c:\program files\adobe\reader 9.0\reader\bib.dll
0x1abdf018	4,184	0	0	-	-	-	Allocated memory or stack space
0x1b6cdef0	3,490	8	0	-	-	-	Allocated memory or stack space
0x19f8fc2c	2,584	0	4	0	-	-	c:\program files\adobe\reader 9.0\reader\agm.dll
0x039a8ad4	2,228	176	0	-	-	-	c:\program files\adobe\reader 9.0\reader\bib.dll
0x1a24a650	1,962	874	0	-	-	-	c:\program files\adobe\reader 9.0\reader\cooltype.dll
0x19fb486c	1,819	0	0	-	-	-	c:\program files\adobe\reader 9.0\reader\agm.dll
0x1a24afac	1,670	0	0	-	-	-	c:\program files\adobe\reader 9.0\reader\cooltype.dll
0x1a82b8cc	1,492	0	0	-	-	-	c:\program files\adobe\reader 9.0\reader\sqlite.dll
0x03c83bc8	1,442	721	0	-	-	-	c:\windows\winsxs\x86_microsoft.vc80.crt_1fc8b3b9a1e18e3b_8.0.50727.762_x-ww_6b128700\msvcr80.dll

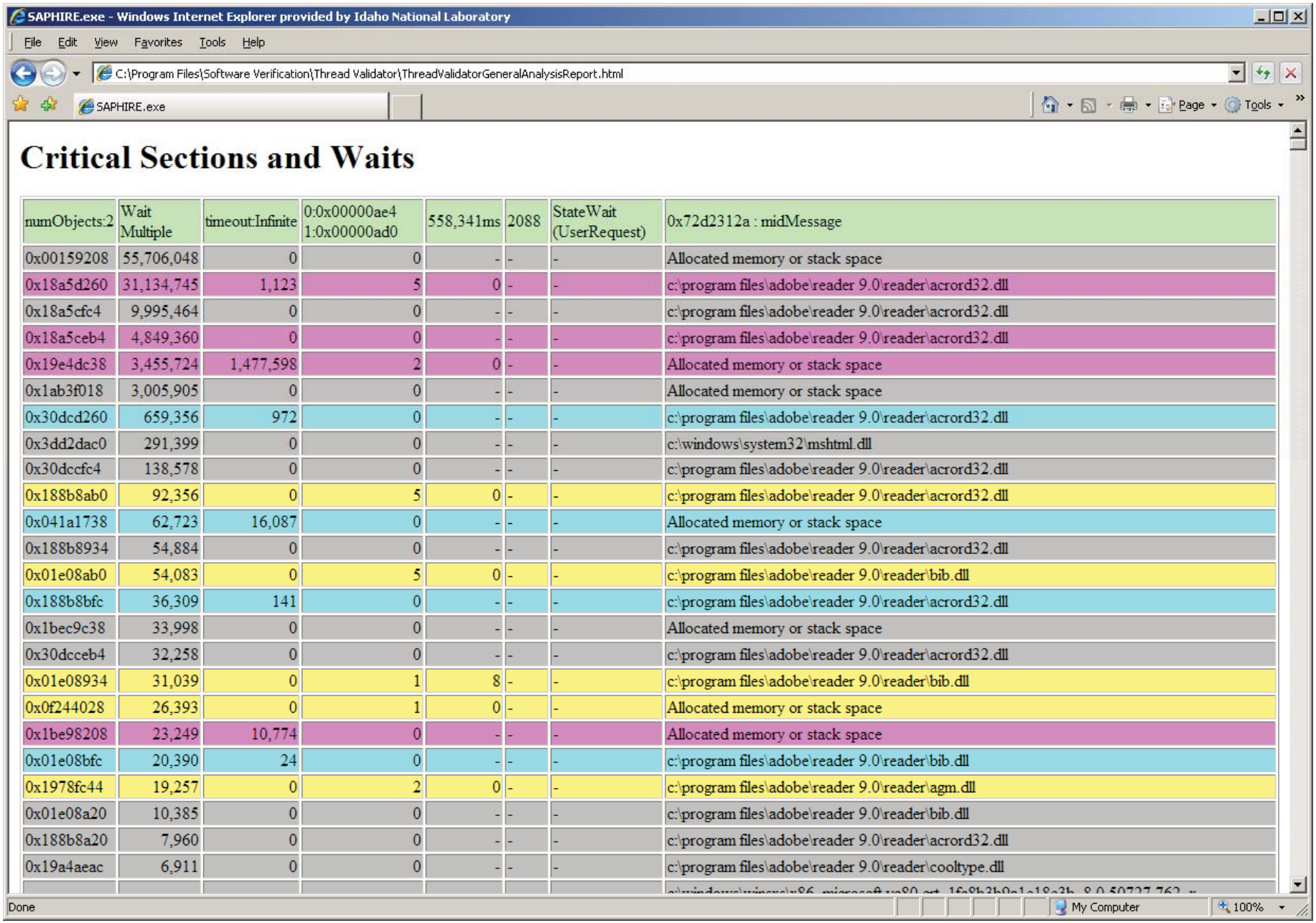
Figure 8-17 Thread Validator SDP Critical Sections and Waits Report



Critical Sections and Waits

0x00000698	Wait Single	timeout:Infinite	-	47,026,369ms	6140	StateWait (UserRequest)	0x19ae6d7b : ACEHasFeature
0x00159208	46,480,854	0	0	-	-	-	Allocated memory or stack space
0x18a5d260	31,134,745	1,123	5	0	-	-	c:\program files\adobe\reader 9.0\reader\acrord32.dll
0x18a5cfc4	9,995,464	0	0	-	-	-	c:\program files\adobe\reader 9.0\reader\acrord32.dll
0x18a5ceb4	4,849,360	0	0	-	-	-	c:\program files\adobe\reader 9.0\reader\acrord32.dll
0x19e4dc38	3,455,724	1,477,598	2	0	-	-	Allocated memory or stack space
0x1ab3f018	3,005,905	0	0	-	-	-	Allocated memory or stack space
0x01e08ab0	54,083	0	5	0	-	-	c:\program files\adobe\reader 9.0\reader\bib.dll
0x01e08934	31,039	0	1	8	-	-	c:\program files\adobe\reader 9.0\reader\bib.dll
0x01e08bfc	20,390	24	0	-	-	-	c:\program files\adobe\reader 9.0\reader\bib.dll
0x1978fc44	19,257	0	2	0	-	-	c:\program files\adobe\reader 9.0\reader\agm.dll
0x01e08a20	10,385	0	0	-	-	-	c:\program files\adobe\reader 9.0\reader\bib.dll
0x19a4aeac	6,911	0	0	-	-	-	c:\program files\adobe\reader 9.0\reader\cooltype.dll
0x18a5ced8	4,844	0	0	-	-	-	c:\program files\adobe\reader 9.0\reader\acrord32.dll
0x1978fc2c	3,518	0	1	0	-	-	c:\program files\adobe\reader 9.0\reader\agm.dll
0x01e089e4	3,300	135	0	-	-	-	c:\program files\adobe\reader 9.0\reader\bib.dll
0x01e08a44	3,236	135	0	-	-	-	c:\program files\adobe\reader 9.0\reader\bib.dll
0x01e08a08	3,232	134	0	-	-	-	c:\program files\adobe\reader 9.0\reader\bib.dll
0x197b486c	3,172	0	0	-	-	-	c:\program files\adobe\reader 9.0\reader\agm.dll
0x24624840	2,226	8	0	-	-	-	Allocated memory or stack space
0x01e08ad4	2,082	151	0	-	-	-	c:\program files\adobe\reader 9.0\reader\bib.dll
0x19a4a650	1,897	833	1	1	-	-	c:\program files\adobe\reader 9.0\reader\cooltype.dll
0x01d9b8cc	1,492	0	0	-	-	-	c:\program files\adobe\reader 9.0\reader\sqlite.dll
0x179d3bc8	1,430	715	0	-	-	-	c:\windows\winsxs\x86_microsoft.vc80.crt_1fc8b3b9a1e18e3b_8.0.50727.762_x-ww_6b128700 \msvcr80.dll
0x19a4afac	1,232	0	0	-	-	-	c:\program files\adobe\reader 9.0\reader\cooltype.dll

Figure 8-18 Thread Validator ECA Critical Sections and Waits Report



Critical Sections and Waits

numObjects:2	Wait Multiple	timeout:Infinite	0:0x00000ae4 1:0x00000ad0	558,341ms	2088	StateWait (UserRequest)	0x72d2312a : midMessage
0x00159208	55,706,048	0	0	-	-	-	Allocated memory or stack space
0x18a5d260	31,134,745	1,123	5	0	-	-	c:\program files\adobe\reader 9.0\reader\acrord32.dll
0x18a5cfc4	9,995,464	0	0	-	-	-	c:\program files\adobe\reader 9.0\reader\acrord32.dll
0x18a5ceb4	4,849,360	0	0	-	-	-	c:\program files\adobe\reader 9.0\reader\acrord32.dll
0x19e4dc38	3,455,724	1,477,598	2	0	-	-	Allocated memory or stack space
0x1ab3f018	3,005,905	0	0	-	-	-	Allocated memory or stack space
0x30dcd260	659,356	972	0	-	-	-	c:\program files\adobe\reader 9.0\reader\acrord32.dll
0x3dd2dac0	291,399	0	0	-	-	-	c:\windows\system32\mshtml.dll
0x30dccfc4	138,578	0	0	-	-	-	c:\program files\adobe\reader 9.0\reader\acrord32.dll
0x188b8ab0	92,356	0	5	0	-	-	c:\program files\adobe\reader 9.0\reader\acrord32.dll
0x041a1738	62,723	16,087	0	-	-	-	Allocated memory or stack space
0x188b8934	54,884	0	0	-	-	-	c:\program files\adobe\reader 9.0\reader\acrord32.dll
0x01e08ab0	54,083	0	5	0	-	-	c:\program files\adobe\reader 9.0\reader\bib.dll
0x188b8bfc	36,309	141	0	-	-	-	c:\program files\adobe\reader 9.0\reader\acrord32.dll
0x1bec9c38	33,998	0	0	-	-	-	Allocated memory or stack space
0x30dcceb4	32,258	0	0	-	-	-	c:\program files\adobe\reader 9.0\reader\acrord32.dll
0x01e08934	31,039	0	1	8	-	-	c:\program files\adobe\reader 9.0\reader\bib.dll
0x0f244028	26,393	0	1	0	-	-	Allocated memory or stack space
0x1be98208	23,249	10,774	0	-	-	-	Allocated memory or stack space
0x01e08bfc	20,390	24	0	-	-	-	c:\program files\adobe\reader 9.0\reader\bib.dll
0x1978fc44	19,257	0	2	0	-	-	c:\program files\adobe\reader 9.0\reader\agm.dll
0x01e08a20	10,385	0	0	-	-	-	c:\program files\adobe\reader 9.0\reader\bib.dll
0x188b8a20	7,960	0	0	-	-	-	c:\program files\adobe\reader 9.0\reader\acrord32.dll
0x19a4aeac	6,911	0	0	-	-	-	c:\program files\adobe\reader 9.0\reader\cooltype.dll

Figure 8-19 Thread Validator General Analysis Critical Sections and Waits Report

Attachment 12: IV&V Acceptance Test Results

Independent Verificaiton and Validation Acceptance Testing were performed using the Automated Test Suite as described in the Software Acceptance Test Plan for SAPHIRE Version 8 (INL/EXT-09-16236) and the SAPHIRE Version 8 Software Verification and Validation Plan Volume II (INL/EXT-05-00821). The results for each individual test case identifier are presented in Table 12-1 Independent Verification and Validation Test Results.

Expected results for 2qa tests:

- Byron Initiating Event Analysis
- Peach Bottom Initiating Event Analysis
- Dresden Initiating Event Analysis
- Grand Gulf Initiating Event Analysis
- Millstone 3 Initiating Event Analysis
- Oconee Initiating Event Analysis
- Oyster Creek Initiating Event Analysis
- San Onofre Initiating Event Assessment
- St. Lucie 1 Initiating Event Assessment
- Surry 2qa Initiating Event Assessment

Using test cases:

- Test-08
- Test-09
- Test-10
- Test-11

are expected failures ("Fail").

Expected results for test Simple Fault Tree – Testing Compound Events etc. is expected to fail ("Fail"). Visual inspection of the results generated against expected results verifies that the results generated are within the values of the expected results.

Expected results for test DEMO – Testing For Incorrect Comparison is expected to fail ("Fail").

Expected results for all other test are successful completion ("Pass").

The results are provided for the following test case identifiers as documented in the individual macro files:

Test-01	Solve Fault Trees. Fault Tree Probability Results. Fault Tree Probability Results: DG Failed Condition Assessment Of 100 Hours (unit = default). Fault Tree Probability Results: The LPI MDP Train A Was Failed During The Grid LOOP (units = year).
Test-02	Solve Sequences. Core Damage Frequency Results. Solve Sequence Cut Sets.

	Core Damage Frequency Results: The LPI MDP Train A Was Failed During The Grid LOOP (units = hour).
Test-03	Events and Conditions Assessment: AFW Out Of Service For 72 Hours.
	Events and Conditions Assessment: HPCI Out Of Service For 72 Hours.
	Events and Conditions Assessment: HPCS Out Of Service For 72 Hours.
	Events and Conditions Assessment: EFW Out Of Service For 72 Hours.
	Events and Conditions Assessment: MFW Out Of Service For 72 Hours.
Test-04	Events and Conditions Assessment: Emergency Diesel Generator Out Of Service For 3 Months.
	Events and Conditions Assessment: DG Failed Condition Assessment Of 100 Hours (unit = hours).
	Events and Conditions Assessment: 3TC Out Of Service For 3 Months.
Test-05	Initiating Event Assessment: Transient Initiator With No Other Failures.
Test-06	Initiating Event Assessment: Small LOCA Initiator With No Other Failures.
	Initiating Event Assessment: Small LOCA Initiator With HSW-PUMPA Fails To Start.
	Initiating Event Assessment: Small LOCA Initiator With HPI-PUMPA In T&M And CVC-PUMPA Fails To Start.
Test-07	Initiating Event Assessment: Steam Generator Initiator With No Other Failures.
Test-08	Initiating Event Assessment: Grid-Related LOOP Initiator With No Other Failures.
Test-09	Initiating Event Assessment: Plant-Centered LOOP Initiator With No Other Failures.
Test-10	Initiating Event Assessment: Servere Weather LOOP Initiator With No Other Failures.
Test-11	Initiating Event Assessment: Extreme Severe Weather LOOP Initiator With No Other Failures.
Test-12	Initiating Event Assessment: Transient Initiator With AFW Failed.
	Initiating Event Assessment: Transient Initiator With HPCI Failed.
	Initiating Event Assessment: Transient Initiator With HPCS Failed.
	Initiating Event Assessment: Transient Initiator With EFW Failed.
	Initiating Event Assessment: Transient Initiator With MFW Failed.
Test-13	Project Uncertainty.
Test-14	Fault Tree Uncertainty: Log Normal Distribution Using MCS.
Test-15	Fault Tree Uncertainty: Normal Distribution.
Test-16	Fault Tree Uncertainty: Beta Distribution.
Test-17	Fault Tree Uncertainty: Chi Squared Distribution.
Test-18	Fault Tree Uncertainty: Exponential Distribution.
Test-19	Fault Tree Uncertainty: Uniform Distribution.
Test-20	Fault Tree Uncertainty: Gamma Distribution.
Test-21	Fault Tree Uncertainty: Maximum Entropy Distribution.
Test-22	Sequence Uncertainty: Dirichlet Distribution Using Monte Carlo Simulation.
Test-23	Fault Tree Uncertainty: Seismic Log Normal Distribution.
Test-24	Fault Tree Uncertainty: Constrained Noninformative Distribution.
Test-25	Fault Tree Uncertainty: Log Normal Distribution Using LHS.
Test-26	Fault Tree Uncertainty: Normal Distribution.
Test-27	Fault Tree Uncertainty: Beta Distribution.
Test-28	Fault Tree Uncertainty: Chi Squared Distribution.
Test-29	Fault Tree Uncertainty: Exponential Distribution.
Test-30	Fault Tree Uncertainty: Uniform Distribution.
Test-31	Fault Tree Uncertainty: Gamma Distribution.

Test-32	Sequence Uncertainty: Maximum Entropy Distribution.
Test-33	Sequence Uncertainty: Latin Hypercube Method/Dirichlet Distribution.
Test-34	Fault Tree Uncertainty: Seismic Log Normal Distribution.
Test-35	Fault Tree and Sequence Uncertainty: Constrained Noninformative Distribution.
Test-36	Fault Tree Uncertainty: Histogram Distribution.
Test-37	Fault Tree Uncertainty: Histogram Distribution.
Test-38	Gathering Of End States.
Test-39	End State Single Uncertainty: Monte Carlo Method.
Test-40	End State Single Uncertainty: Latin Hypercube Method.
Test-41	Cut Set Verification: Solve Selected Fault Trees. Cut Set Verification: Sequences and End States. Cut Set Verification: Solve Fault Trees.
Test-42	Link Small Event Tree: Link Level 1 Event Trees (small event trees). Link Small Event Tree: Link Event Trees (small event trees).
Test-43	Partition Sequence Cut Sets.
Test-44	Link Large Event Tree: Link PDS Event Trees (large event trees).
Test-45	Fault Tree Importance Measures: Fault Tree Fussell-Vesely Importance (ratio). Fault Tree Importance Measures: Fault Tree Birnbaum Importance (interval or difference). Fault Tree Importance Measures: Fault Tree Uncertainty Importance.
Test-46	Sequence Importance Measures: Sequence Fussell-Vesely Importance (ratio). Sequence Importance Measures: Fault Tree Birnbaum Importance (interval or difference). Sequence Importance Measures: Sequence Uncertainty Importance.
Test-47	Sequence Group Importance Measures. Sequence Group Importance Measures: Sequence Group Fussell-Vesely Importance (ratio). Sequence Group Importance Measures: Sequence Group Birnbaum Importance (interval or difference). Sequence Group Importance Measures: Sequence Group Uncertainty Importance.
Test-48	End State Importance Measures: End State Fussell-Vesely Importance. End State Importance Measures: End State Birnbaum Importance. End State Importance Measures: End State Uncertainty Importance.
Test-49	End State Group Importance: End State Fussell-Vesely Group Importance. End State Group Importance: End State Birnbaum Importance. End State Group Importance: End State Uncertainty Group Importance.
Test-50	Change Set Processing: Single. Change Set Processing: Single Change – LPR-MOV-FT-1862A Event. Change Set Processing: Single Change – E-MOV-A Event. Change Set Processing: Change Set On Compound Event. Change Set Processing: Single Change Set On Compound Event.
Test-51	Change Set Processing: Class Change Set Processing: Class Change – All Events. Change Set Processing: Class Change – LPR-MOV-FT* Events. Change Set Processing: Class Change - ?-MOV-1 Events.
Test-52	Change Set Processing: Marked Order Change Set Processing: Marked Change Sets From Scenarios 1, 2, 3 (marked in that order).
Test-53	Extract, Delete, Load, Solve: Basic Events Load/Extract . Extract, Delete, Load, Solve: Fault Tree Load/Extract.
Test-54	Fault Tree Utility Functions: Auto Page/Solve.

	Fault Tree Utility Functions: Cut Sets To End State.
Test-55	Event Tree Linkage (including rules).
Test-56	End-State Gathering.
Test-57	Compound Event Plug-ins.
Test-58	Base Case Update.
Test-59	Calculation Types.
Test-60	Application of Change Sets.
Test-61	Uncertainty Distributions.
Test-62	N of M Gates.
Test-63	Sequence Stress Testing.
Test-64	Calculations on the Common-Cause Plug-in.
Test-65	Event Transformations. (*No Test Being Run*.)
Test-66	Wrong Results.
Test-67	Event And Condition Analysis-Initiating Event Assessment: Switchyard-Related Loss Of Off-Site Power (LOOP) With Other Failures And Conditions On The Oyster Creek 345 Model, Switchyard LOOP. Event And Condition Analysis-Initiating Event Assessment: Switchyard-Related Loss Of Off-Site Power (LOOP) With Other Failures And Conditions On The Oyster Creek 345 Model, Switchyard LOOP With TM Off.
Test-68	Event And Condition Analysis- Condition Event Assessment: Blue Max SBO Diesel Out For Four Days On The Susquehanna Unit 1 And 2 Model, EDG Out For 4 Days, Multipass Option. Event And Condition Analysis- Condition Event Assessment: Blue Max SBO Diesel Out For Four Days On The Susquehanna Unit 1 And 2 Model, EDG Out For 4 Days, Single Pass WITHOUT Cut Set Update Option. Event And Condition Analysis- Condition Event Assessment: Blue Max SBO Diesel Out For Four Days On The Susquehanna Unit 1 And 2 Model, EDG Out For 4 Days, Single Pass WITH Cut Set Update Option. Event And Condition Analysis- Condition Event Assessment: Blue Max SBO Diesel Out For Four Days On The Susquehanna Unit 1 And 2 Model, ECA Cond TM Effect On CCF. Event And Condition Analysis-Condition Event Assessment: Blue Max SBO Diesel Out For Four Days On The Susquehanna Unit 1 And 2 Model, EDG Out For 4 Days, Multipass Option. Event And Condition Analysis- Condition Event Assessment: Blue Max SBO Diesel Out For Four Days On The Susquehanna Unit 1 And 2 Model, EDG Out For 4 Days, Single Pass WITHOUT Cut Set Update Option. Event And Condition Analysis- Condition Event Assessment: Blue Max SBO Diesel Out For Four Days On The Susquehanna Unit 1 And 2 Model, EDG Out For 4 Days, Single Pass WITH Cut Set Update Option. Event And Condition Analysis- Condition Event Assessment: Blue Max SBO Diesel Out For Four Days On The Susquehanna Unit 1 And 2 Model, EDG Out For TM For 4 Days, Multipass Option With TM Turned Off.
Test-69	Significance Determination Process-Blue Max SBO Diesel Out For Four Days On The Susquehanna Unit 1 And 2 Model, EDG Failed To Run For 4 Days, Multiple Pass Option. Significance Determination Process-Blue Max SBO Diesel Out For Four Days On The Susquehanna Unit 1 And 2 Model, EDG Failed To Run For 4 Days, Single Pass WITHOUT cut Set Update.

	Significance Determination Process-Blue Max SBO Diesel Out For Four Days On The Susquehanna Unit 1 And 2 Model, EDG Failed To Run For 4 Days, Single Pass WITH cut Set Update.
Test-70	General Analysis-Blue Max SBO Diesel Out For Four Days On The Susquehanna Unit 1 and 2 Model. EDG Failed To Run For 4 Days, Multiple Pass Option.
	General Analysis-Blue Max SBO Diesel Out For Four Days On The Susquehanna Unit 1 and 2 Model. EDG Failed To Run For 4 Days, Single Pass WITHOUT Cut Set Update.
	General Analysis-Blue Max SBO Diesel Out For Four Days On The Susquehanna Unit 1 and 2 Model. EDG Failed To Run For 4 Days, Single Pass WITH Cut Set Update.
	General Analysis-Blue Max SBO Diesel Out For Four Days On The Susquehanna Unit 1 And 2 model. ECA Cond TM Effect On CCF.
Test-71	'N' Calculation Type. Verify Initiating Event Type'N'.
	'N' Calculation Type. Solve Sequences, Core Damage Frequency Results
Test-72	RASP Common Cause Failure (CCF) Validation.
Test-73	External Event Models – Solve Event Trees. Solve Sequences, Core Damage Frequency Results.
Test-74	Shutdown Models – Solve Event Trees. Solve Sequences, Core Damage Frequency Results.
Test-75	Workspace Model Independence. Sovle Fault Trees.
	Workspace Model Independence. Core Damage Frequencey Test.
	Workspace Model Independence. Report BE Data.
	Workspace Model Independence. ECA-IE-LOOP-SC.
	Workspace Model Independence. Switch Yard LOOP.
	Workspace Model Independence. ECA Cond EDG-FR 4 Days Multiple Pass.
	Workspace Model Independence. EDG FR For 4 Days.
	Workspace Model Independence. Fault Tree Same Frequencey Test.
	Workspace Model Independence. Sequence Same Frequency Test.
	Workspace Model Independence. Report BE Data.
Test-76	Repetition Of Critical Calculations Over N Times. SA Solve Fault Trees, Fault Tree Probability Results.
	Repetition Of Critical Calculations Over N Times. SA Sovle Sequences, Core Damage Frequency Results.
	Repetition Of Critical Calculations Over N Times. ECA.
	Repetition Of Critical Calculations Over N Times. GA.
	Repetition Of Critical Calculations Over N Times. SDP.
Test-77	Significance Determination Process – LERF Multiplier Calculations (Manual Test).
Test-78	Accident Sequence Matrix – Solve Event Trees (Manual Test).
Test-79	Multiple Pass Algorithm Test (TRUE and 1.0).
Test-80	Multiple Pass Algorithm Test (False and Ignore), EDG Out For 4 Days, Multipass Option.
Test-81	Min-Max Test On Demo-EE Model For Event And Condition Analysis And General Analysis Interfaces. Core Damage Frequency And Report.
	Min-Max Test On Demo-EE Model For Event And Condition Analysis And General Analysis Interfaces. Report BE Data.
	Min-Max Test On Demo-EE Model For Event And Condition Analysis And General Analysis Interfaces. ECA-IE-LOOP-SC.
	Min-Max Test On Demo-EE Model For Event And Condition Analysis And General Analysis Interfaces. Switch Yard LOOP.

	Min-Max Test On Demo-EE Model For Event And Condition Analysis And General Analysis Interfaces. ECA Cond EDG-FR 4 Days Multiple Pass.
	Min-Max Test On Demo-EE Model For Event And Condition Analysis And General Analysis Interfaces. EDG Fr For 4 Days.
	Min-Max Test On Demo-EE Model For Event And Condition Analysis And General Analysis Interfaces.SDP EDG-FR 4 Days Multiple Pass.
	Min-Max Test On Demo-EE Model For Event And Condition Analysis And General Analysis Interfaces. GEN EDG-FR 4 Days Multiple Pass.
	Min-Max Test On Demo-EE Model For Event And Condition Analysis And General Analysis Interfaces. Report And Compare Fault Tree Data.
	Min-Max Test On Demo-EE Model For Event And Condition Analysis And General Analysis Interfaces. EDG FR For 4 Days.
	Min-Max Test On Demo-EE Model For Event And Condition Analysis And General Analysis Interfaces. Report And Compare Fault Tree Data.
	Min-Max Test On Demo-EE Model For Event And Condition Analysis And General Analysis Interfaces. Report And Compare CDF Data.
	Min-Max Test On Demo-EE Model For Event And Condition Analysis And General Analysis Interfaces. Report And Compare BE Data.
Test-82	Single Pass Algorithm Tests On Event And Condition Analysis And General Analysis: LCS-MDP-FS-P3A Failed For 1 Year (no update), Failed Event Contributes To CCF.
	Single Pass Algorithm Tests On Event And Condition Analysis And General Analysis: LCS-MDP-FS-P3A Failed For 1 Year (yes update), Failed Event Contributes To CCF.
Test-83	Cress-Referencing Is Validated (Manual Test).
Test-84	Verify Database Recovery Works. Solve And Report Fault Trees.
	Verify Database Recovery Works. Core Damage Frequency And Report.
	Verify Database Recovery Works. Report BE Data.
Test-85	Verify Event Tree/Fault Tree Transfers Function Correctly (Manual Test).
Test-86	Gather End States On A Demo Model With Multiple Phases.
Test-87	Large Early Release Frequency (LERF) Model Functionality.
Test-88	Event Tree, Fault Tree Creation In A New Project.
Test-89	Menu Navigation (Manual Test).
Test-90	Tree View Expanded (Manual Test).
Test-91	Workspace To Standard Analysis Interface Independence. Solve And Report Fault Trees.
	Workspace To Standard Analysis Interface Independence. Core Damage Frequency And Report.
	Workspace To Standard Analysis Interface Independence. Report BE Data.
	Workspace To Standard Analysis Interface Independence. ECA-IE-LOOP-SC.
	Workspace To Standard Analysis Interface Independence. ECA Cond EDG-FR 4 Days Multiple Pass.
	Workspace To Standard Analysis Interface Independence. EDG FR For 4 Days.
	Workspace To Standard Analysis Interface Independence. SDP EDG-FR 4 Days Multiple Pass.
	Workspace To Standard Analysis Interface Independence. GEN EDG-FR 4 Days Multiple Pass.
	Workspace To Standard Analysis Interface Independence. Report And Compare Fault Tree Data.
	Workspace To Standard Analysis Interface Independence. Report And Compare CDF Data.

	Workspace To Standard Analysis Interface Independence. Report And Compare BE Data.
Test-92	Standard Analysis Interface To Workspace Independence.
Test-93	Workspace To Workspace Independence (Manual Test).
Test-94	Project To Project Independence (Manual Test).
Test-95	Workspace To Workspace Independence.
Test-96	Integrated Models.
Test-97	Event Tree Linking And Unlink In Integrated Models (External Events and Shutdown) (Manual Test).
Test-98	Verification Of Cut Set View Path (Manual Test).
Test-99	Verification Rule Layering Works.
Test-100	Verification Rule Nesting Works.
Test-101	All Reports Produce Expected Reports.
Test-102	Significance Determination Process Interface Testing Of Basic Event Changes (Manual Test).
Test-103	Significance Determination Process Interface Testing Of Figure III-D (Change in delta CDF as a function of duration) Point Estimate Checks (Manual Test).
Test-104	Event And Condition Analysis Uncertainty Calculations (Manual Test).
Test-105	SPAR-H Worksheet Calculations. Compares Basic Events Of X Calc Type.

A summary of the Independent Verification and Validation Acceptance Testing results using the Automated Test Suite script file "runplant.bat" is presented in Figure 12-1 SAPHIRE Tests 01-66 Summary Report.

The detail of the individual results of the Independent Verification and Validation Acceptance Testing using the Automated Test Suite script file "runplant.bat" is included on the CD as an addendum to this report. Refer to the test file "*IVV01-66Detail-2010-04-26*".

A summary of the Independent Verification and Validation Acceptance Testing results using the Automated Test Suite Script file "runplant8.bat" is presented in Figure 12-2 SAPHIRE Tests 67-105 Summary Report.

The detail of the individual results of the Independent Verification and Validation Acceptance Testing using the Automated Test Suite script file "runplant8.bat" is included on the CD as an addendum to this report. Refer to the test file "*IVV67-105Detail-2010-04-26*".

Manual testing was used to augment the automated test suite for Test Cases: Test-77, Test-78, Test-83, Test-85, Test-89, Test-90, Test-93, Test-94, Test-97, Test-98, Test-102, Test-103 and Test-104. Refer to Appendix A – Manual Test Results.

Figure 12-1 SAPHIRE Tests 01-66 Summary Report

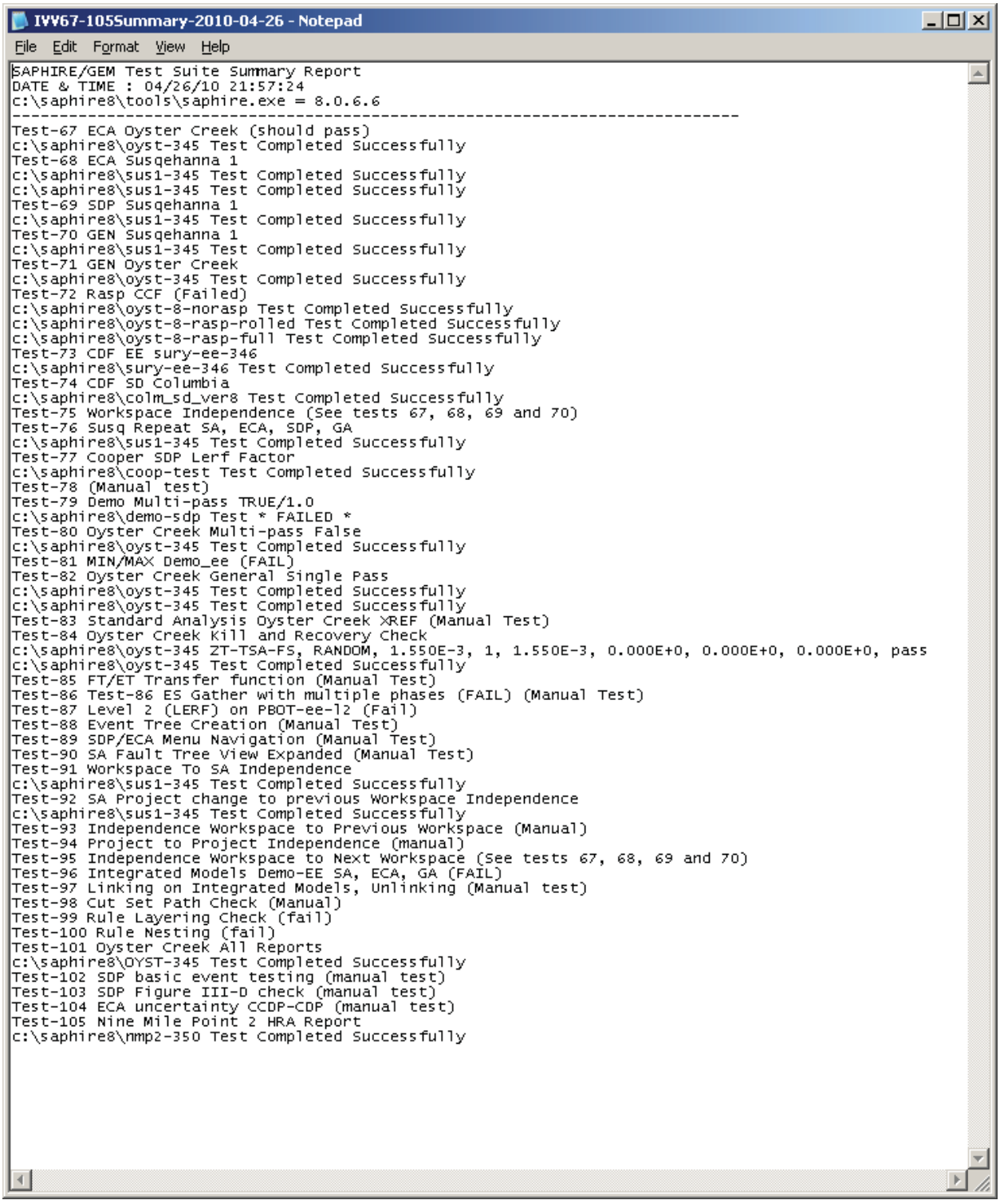


Figure 12-2 SAPHIRE Tests 67-105 Summary Report

Table 12-1 Independent Verification and Validation Acceptance Test Results

Test Description	Project Short Name	Test Case ID(s)	Expected Results	Independent Verification and Validation Results
Byron Core Damage Frequency Analysis	byrn_2qa	**Test-01** – Solve Fault Trees, Fault Tree Probability Results.	Pass	Pass
		Test-02 – Solve Sequences, Core Damage Frequency Results.	Pass	Pass
		Test-58 – Base Case Update.	Pass	Pass
Byron Condition Assessment Analysis	byrn_2qa	**Test-03** – Events and Conditions Assessment: AFW Out Of Service For 72 Hours.	Pass	Pass
		Test-04 – Events and Condition Assessment: Emergency Diesel Generator Out of Service For 3 Months.	Pass	Pass
Byron Initiating Event Analysis	byrn_2qa	**Test-05** – Initiating Event Assessment: Transient Initiator With No Other Failures.	Pass	Pass
		Test-06 – Initiating Event Assessment: Small LOCA Initiator With No Other Failures.	Pass	Pass
		Test-07 – Initiating Event Assessment: Steam Generator Initiator With No Other Failures.	Pass	Pass
		Test-12 – Initiating Event Assessment: Transient Initiator With AFW Failed.	Pass	Pass
		Test-08 – Initiating Event Assessment: Grid-Related LOOP Initiator With No Other Failures.	Fail	Fail
		Test-09 – Initiating Event Assessment: Plant-Centered LOOP Initiator With No Other Failures.	Fail	Fail
		Test-10 – Initiating Event Assessment: Severe Weather LOOP Initiator With No Other Failures**.**	Fail	Fail
		Test-11 – Initiating Event Assessment: Extreme Severe Weather LOOP Initiator With No Other Failures.	Fail	Fail
Peach Bottom Core Damage Frequency Analysis	pbot_2qa	**Test-01** – Solve Fault Trees, Fault Tree Probability Results.	Pass	Pass
		Test-02 – Solve Sequences, Core Damage Frequency Results.	Pass	Pass
		Test-58 – Base Case Update.	Pass	Pass
Peach Bottom Condition Assessment Analysis	pbot_2qa	**Test-03** – Events and Conditions Assessment: HPCI Out Of Service For 72 hours.	Pass	Pass
		Test-04 – Events and Condition Assessment: Emergency Diesel Generator Out Of Service for 3 Months.	Pass	Pass
Peach Bottom Initiating Event Analysis	pbot_2qa	**Test-05** – Initiating Event Assessment: Transient Initiator With No Other Failures.	Pass	Pass
		Test-06 – Initiating Event Assessment: Small LOCA Initiator With No Other Failures.	Pass	Pass

Test Description	Project Short Name	Test Case ID(s)	Expected Results	Independent Verification and Validation Results
		Test-12 – Initiating Event Assessment: Transient Initiator With HPCI Failed.	Pass	Pass
		Test-08 – Initiating Event Assessment: Grid-Related LOOP Initiator With No Other Failures.	Fail	Fail
		Test-09 – Initiating Event Assessment: Plant-Centered LOOP Initiator With No Other Failures.	Fail	Fail
		Test-10 – Initiating Event Assessment: Severe Weather LOOP Initiator With No Other Failures**.**	Fail	Fail
		Test-11 – Initiating Event Assessment: Extreme Severe Weather LOOP Initiator With No Other Failures.	Fail	Fail
Dresden Core Damage Frequency Analysis	dres_2qa	**Test-01** – Solve Fault Trees, Fault Tree Probability Results.	Pass	Pass
		Test-02 – Solve Sequences, Core Damage Frequency Results.	Pass	Pass
		Test-58 – Base Case Update.	Pass	Pass
Dresden Condition Assessment Analysis	dres_2qa	**Test-03** – Events and Conditions Assessment: HPCI Out Of Service For 72 hours.	Pass	Pass
		Test-04 – Events and Condition Assessment: Emergency Diesel Generator Out of Service for 3 Months.	Pass	Pass
Dresden Initiating Event Analysis	dres_2qa	**Test-05** – Initiating Event Assessment: Transient Initiator With No Other Failures.	Pass	Pass
		Test-06 – Initiating Event Assessment: Small LOCA Initiator With No Other Failures.	Pass	Pass
		Test-12 – Initiating Event Assessment: Transient Initiator HPCI Failed.	Pass	Pass
		Test-08 – Initiating Event Assessment: Grid-Related LOOP Initiator With No Other Failures.	Fail	Fail
		Test-09 – Initiating Event Assessment: Plant-Centered LOOP Initiator With No Other Failures.	Fail	Fail
		Test-10 – Initiating Event Assessment: Severe Weather LOOP Initiator With No Other Failures**.**	Fail	Fail
		Test-11 – Initiating Event Assessment: Extreme Severe Weather LOOP Initiator With No Other Failures.	Fail	Fail
Grand Gulf Core Damage Frequency Analysis	ggul_2qa	**Test-01** – Solve Fault Trees, Fault Tree Probability Results.	Pass	Pass
		Test-02 – Solve Sequences, Core Damage Frequency Results.	Pass	Pass
		Test-58 – Base Case Update.	Pass	Pass
Grand Gulf Condition Assessment Analysis	ggul_2qa	**Test-03** – Events and Conditions Assessment: HPCS Out Of Service For 72 Hours.	Pass	Pass
		Test-04 – Events and Condition Assessment: Emergency	Pass	Pass

Test Description	Project Short Name	Test Case ID(s)	Expected Results	Independent Verification and Validation Results
		Diesel Generator Out of Service For 3 Months.		
Grand Gulf Initiating Event Analysis	ggul_2qa	**Test-05** – Initiating Event Assessment: Transient Initiator With No Other Failures.	Pass	Pass
		Test-06 – Initiating Event Assessment: Small LOCA Initiator With No Other Failures.	Pass	Pass
		Test-12 – Initiating Event Assessment: Transient Initiator With HPCS Failed.	Pass	Pass
		Test-08 – Initiating Event Assessment: Grid-Related LOOP Initiator With No Other Failures.	Fail	Fail
		Test-09 – Initiating Event Assessment: Plant-Centered LOOP Initiator With No Other Failures.	Fail	Fail
		Test-10 – Initiating Event Assessment: Severe Weather LOOP Initiator With No Other Failures**.**	Fail	Fail
		Test-11 – Initiating Event Assessment: Extreme Severe Weather LOOP Initiator With No Other Failures.	Fail	Fail
Millstone 3 Core Damage Frequency Analysis	mil3_2qa	**Test-01** – Solve Fault Trees, Fault Tree Probability Results.	Pass	Pass
		Test-02 – Solve Sequences, Core Damage Frequency Results.	Pass	Pass
		Test-58 – Base Case Update.	Pass	Pass
Millstone 3 Condition Assessment Analysis	mil3_2qa	**Test-03** – Events and Conditions Assessment: Auxiliary Feed Water (AFW) Out Of Service For 72 hours.	Pass	Pass
		Test-04 – Events and Condition Assessment: Emergency Diesel Generator (EDG) Out of Service for 3 Months.	Pass	Pass
Millstone 3 Initiating Event Analysis	mil3_2qa	**Test-05** – Initiating Event Assessment: Transient Initiator With No Other Failures.	Pass	Pass
		Test-06 – Initiating Event Assessment: Small LOCA Initiator With No Other Failures.	Pass	Pass
		Test-07 – Initiating Event Assessment: Steam Generator Initiator With No Other Failures.	Pass	Pass
		Test-12 – Initiating Event Assessment: Transient Initiator With AFW Failed.	Pass	Pass
		Test-08 – Initiating Event Assessment: Grid-Related LOOP Initiator With No Other Failures.	Fail	Fail
		Test-09 – Initiating Event Assessment: Plant-Centered LOOP Initiator With No Other Failures.	Fail	Fail
		Test-10 – Initiating Event Assessment: Severe Weather LOOP Initiator With No Other Failures**.**	Fail	Fail
		Test-11 – Initiating Event Assessment: Extreme Severe Weather LOOP Initiator With No Other Failures.	Fail	Fail
Oconee Core Damage Frequency Analysis	ocon_2qa	**Test-01** – Solve Fault Trees, Fault Tree Probability	Pass	Pass

Test Description	Project Short Name	Test Case ID(s)	Expected Results	Independent Verification and Validation Results
		Results.		
		Test-02 – Solve Sequences, Core Damage Frequency Results.	Pass	Pass
		Test-58 – Base Case Update.	Pass	Pass
Oconee Condition Assessment Analysis	ocon_2qa	**Test-03** – Events and Conditions Assessment: Emergency Feed Water (EFW) Out Of Service For 72 Hours.	Pass	Pass
		Test-04 – Events and Conditions Assessment: 3TC Out Of Service For 3 Months.	Pass	Pass
Oconee Initiating Event Analysis	ocon_2qa	**Test-05** – Initiating Event Assessment: Transient Initiator With No Other Failures.	Pass	Pass
		Test-06 – Initiating Event Assessment: Small LOCA Initiator With No Other Failures.	Pass	Pass
		Test-07 – Initiating Event Assessment: Steam Generator Initiator With No Other Failures.	Pass	Pass
		Test-12 – Initiating Event Assessment: Transient Initiator With EFW Failed.	Pass	Pass
		Test-08 – Initiating Event Assessment: Grid-Related LOOP Initiator With No Other Failures.	Fail	Fail
		Test-09 – Initiating Event Assessment: Plant-Centered LOOP Initiator With No Other Failures.	Fail	Fail
		Test-10 – Initiating Event Assessment: Severe Weather LOOP Initiator With No Other Failures**.**	Fail	Fail
		Test-11 – Initiating Event Assessment: Extreme Severe Weather LOOP Initiator With No Other Failures.	Fail	Fail
Oyster Creek Core Damage Frequency Analysis	oyst_2qa	**Test-01** – Solve Fault Trees, Fault Tree Probability Results.	Pass	Pass
		Test-02 – Solve Sequences, Core Damage Frequency Results.	Pass	Pass
		Test-58 – Base Case Update.	Pass	Pass
Oyster Creek Condition Assessment Analysis	oyst_2qa	**Test-03** – Events and Conditions Assessment: MFW Out Of Service For 72 hours.	Pass	Pass
		Test-04 – Events and Condition Assessment: Emergency Diesel Generator (EDG) Out of Service For 3 Months.	Pass	Pass
Oyster Creek Initiating Event Analysis	oyst_2qa	**Test-05** – Initiating Event Assessment: Transient Initiator With No Other Failures.	Pass	Pass
		Test-06 – Initiating Event Assessment: Small LOCA Initiator With No Other Failures.	Pass	Pass
		Test-12 – Initiating Event Assessment: Transient Initiator With MFW Failed.	Pass	Pass
		Test-08 – Initiating Event Assessment: Grid-Related LOOP Initiator With No Other Failures.	Fail	Fail

Test Description	Project Short Name	Test Case ID(s)	Expected Results	Independent Verification and Validation Results
		Test-09 – Initiating Event Assessment: Plant-Centered LOOP Initiator With No Other Failures.	Fail	Fail
		Test-10 – Initiating Event Assessment: Severe Weather LOOP Initiator With No Other Failures**.**	Fail	Fail
		Test-11 – Initiating Event Assessment: Extreme Severe Weather LOOP Initiator With No Other Failures.	Fail	Fail
San Onofre Core Damage Frequency Analysis	song_2qa	**Test-01** – Solve Fault Trees, Fault Tree Probability Results.	Pass	Pass
		Test-02 – Solve Sequences, Core Damage Frequency Results.	Pass	Pass
		Test-58 – Base Case Update.	Pass	Pass
San Onofre Condition Assessment Analysis	song_2qa	**Test-03** – Events and Conditions Assessment: Auxiliary Feed Water (AFW) Out Of Service For 72 hours.	Pass	Pass
		Test-04 – Events and Condition Assessment: Emergency Diesel Generator (EDG) Out Of Service For 3 Months.	Pass	Pass
San Onofre Initiating Event Assessment	song_2qa	**Test-05** – Initiating Event Assessment: Transient Initiator With No Other Failures.	Pass	Pass
		Test-06 – Initiating Event Assessment: Small LOCA Initiator With No Other Failures.	Pass	Pass
		Test-07 – Initiating Event Assessment: Steam Generator Initiator With No Other Failures.	Pass	Pass
		Test-12 – Initiating Event Assessment: Transient Initiator With AFW Failed.	Pass	Pass
		Test-08 – Initiating Event Assessment: Grid-Related LOOP Initiator With No Other Failures.	Fail	Fail
		Test-09 – Initiating Event Assessment: Plant-Centered LOOP Initiator With No Other Failures.	Fail	Fail
		Test-10 – Initiating Event Assessment: Severe Weather LOOP Initiator With No Other Failures**.**	Fail	Fail
		Test-11 – Initiating Event Assessment: Extreme Severe Weather LOOP Initiator With No Other Failures.	Fail	Fail
St. Lucie 1 Core Damage Frequency Analysis	stl1_2qa	**Test-01** – Solve Fault Trees, Fault Tree Probability Results.	Pass	Pass
		Test-02 – Solve Sequences, Core Damage Frequency Results.	Pass	Pass
		Test-58 – Base Case Update.	Pass	Pass
St. Lucie 1 Condition Assessment Analysis	stl1_2qa	**Test-03** – Events and Conditions Assessment: Auxiliary Feed Water (AFW) Out Of Service For 72 hours.	Pass	Pass
		Test-04 – Events and Condition Assessment: Emergency Diesel Generator (EDG) Out Of Service For 3 Months.	Pass	Pass
St. Lucie 1 Initiating Event Assessment	stl1_2qa	**Test-05** – Initiating Event Assessment: Transient Initiator	Pass	Pass

Test Description	Project Short Name	Test Case ID(s)	Expected Results	Independent Verification and Validation Results
		With No Other Failures.		
		Test-06 – Initiating Event Assessment: Small LOCA Initiator With No Other Failures.	Pass	Pass
		Test-07 – Initiating Event Assessment: Steam Generator Initiator With No Other Failures.	Pass	Pass
		Test-12 – Initiating Event Assessment: Transient Initiator With AFW Failed.	Pass	Pass
		Test-08 – Initiating Event Assessment: Grid-Related LOOP Initiator With No Other Failures.	Fail	Fail
		Test-09 – Initiating Event Assessment: Plant-Centered LOOP Initiator With No Other Failures.	Fail	Fail
		Test-10 – Initiating Event Assessment: Severe Weather LOOP Initiator With No Other Failures**.**	Fail	Fail
		Test-11 – Initiating Event Assessment: Extreme Severe Weather LOOP Initiator With No Other Failures.	Fail	Fail
Surry 2qa Core Damage Frequency Analysis	sury_2qa	**Test-01** – Solve Fault Trees, Fault Tree Probability Results.	Pass	Pass
		Test-02 – Solve Sequences, Core Damage Frequency Results.	Pass	Pass
		Test-58 – Base Case Update.	Pass	Pass
Surry 2qa Condition Assessment Analysis	sury_2qa	**Test-03** – Events and Conditions Assessment: Auxiliary Feed Water (AFW) Out Of Service For 72 hours.	Pass	Pass
		Test-04 – Events and Condition Assessment: Emergency Diesel Generator (EDG) Out Of Service For 3 Months.	Pass	Pass
Surry 2qa Initiating Event Assessment	sury_2qa	**Test-05** – Initiating Event Assessment: Transient Initiator With No Other Failures.	Pass	Pass
		Test-06 – Initiating Event Assessment: Small LOCA Initiator With No Other Failures.	Pass	Pass
		Test-07 – Initiating Event Assessment: Steam Generator Initiator With No Other Failures.	Pass	Pass
		Test-12 – Initiating Event Assessment: Transient Initiator with AFW Failed.	Pass	Pass
		Test-08 – Initiating Event Assessment: Grid-Related LOOP Initiator With No Other Failures.	Fail	Fail
		Test-09 – Initiating Event Assessment: Plant-Centered LOOP Initiator With No Other Failures.	Fail	Fail
		Test-10 – Initiating Event Assessment: Severe Weather LOOP Initiator With No Other Failures**.**	Fail	Fail
		Test-11 – Initiating Event Assessment: Extreme Severe Weather LOOP Initiator With No Other Failures.	Fail	Fail
Surry-40 Sequence Cut Sets, Project	Surry40	**Test-02** – Solve Sequences, Core Damage Frequency	Pass	Pass

Test Description	Project Short Name	Test Case ID(s)	Expected Results	Independent Verification and Validation Results
Uncertainty		Results.		
		Test-13 – Project Uncertainty.	Pass	Pass
		Test-58 – Base Case Update.	Pass	Pass
		Test-60 – Application Of Change Sets.	Pass	Pass
		Test-61 – Uncertainty Distributions.	Pass	Pass
Fault Tree Uncertainty (tstu database) Using MCS	tstu	**Test-14** – Fault Tree Uncertainty: Log Normal Distribution Using MCS.	Pass	Pass
		Test-15 – Fault Tree Uncertainty: Normal Distribution.	Pass	Pass
		Test-16 – Fault Tree Uncertainty: Beta Distribution.	Pass	Pass
		Test-17 – Fault Tree Uncertainty: Chi Squared Distribution.	Pass	Pass
		Test-18 – Fault Tree Uncertainty: Exponential Distribution.	Pass	Pass
		Test-19 – Fault Tree Uncertainty: Uniform Distribution.	Pass	Pass
		Test-20 – Fault Tree Uncertainty: Gamma Distribution.	Pass	Pass
		Test-21 – Fault Tree Uncertainty: Maximum Entropy Distribution.	Pass	Pass
		Test-24 – Fault Tree and Sequence Uncertainty: Constrained Noninformative Distribution.	Pass	Pass
		Test-23 – Fault Tree Uncertainty: Seismic Log Normal Distribution.	Pass	Pass
		Test-36 – Fault Tree Uncertainty: Histogram Distribution.	Pass	Pass
		Test-60 – Application Of Change Sets.	Pass	Pass
		Test-61 – Uncertainty Distributions.	Pass	Pass
Fault Tree Uncertainty (tstu database) Using LHS	tstu	**Test-25** – Fault Tree Uncertainty: Log Normal Distribution Using LHS.	Pass	Pass
		Test-26 – Fault Tree Uncertainty: Normal Distribution	Pass	Pass
		Test-27 – Fault Tree Uncertainty: Beta Distribution.	Pass	Pass
		Test-28 – Fault Tree Uncertainty: Chi Squared Distribution	Pass	Pass
		Test-29 – Fault Tree Uncertainty: Exponential Distribution.	Pass	Pass
		Test-30 – Fault Tree Uncertainty: Uniform Distribution.	Pass	Pass
		Test-31 – Fault Tree Uncertainty: Gamma Distribution.	Pass	Pass
		Test-32 – Sequence Uncertainty: Maximum Entropy Distribution.	Pass	Pass
		Test-35 – Fault Tree and Sequence Uncertainty: Constrained Noninformative Distribution.	Pass	Pass
		Test-34 – Fault Tree Uncertainty: Seismic Log Normal Distribution.	Pass	Pass

Test Description	Project Short Name	Test Case ID(s)	Expected Results	Independent Verification and Validation Results
		Test-37 – Fault Tree Uncertainty: Histogram Distribution.	Pass	Pass
		Test-60 – Application Of Change Sets.	Pass	Pass
		Test-61 – Uncertainty Distributions.	Pass	Pass
Sequence Uncertainty (tstu database) Using MCS	tstu	**Test-24** – Fault Tree and Sequence Uncertainty: Constrained Noninformative Distribution.	Pass	Pass
		Test-22 – Sequence Uncertainty: Dirichlet Distribution Using Monte Carlo Simulation.	Pass	Pass
		Test-33 – Sequence Uncertainty: Latin Hypercube Method/Dirichlet Distribution.	Pass	Pass
		Test-60 – Application Of Change Sets.	Pass	Pass
		Test-61 – Uncertainty Distributions.	Pass	Pass
Beaver Valley End State Uncertainty	BV2-5	**Test-38** – Gathering Of End States.	Pass	Pass
		Test-39 – End State Single Uncertainty: Monte Carlo Method.	Pass	Pass
		Test-40 – End State Single Uncertainty: Latin Hypercube Method.	Pass	Pass
		Test-39 – End State Group Uncertainty: Monte Carlo Method.	Pass	Pass
		Test-40 – End State Group Uncertainty: Latin Hypercube Method.	Pass	Pass
Surry-50 (seq, ft, es) runs 01 through 05	surry-50	**Test-41** – Cut Set Verification, Solve Selected Fault Trees, Sequences and End States.	Pass	Pass
Surry-50 (sequence change set) runs 06 through 09	surry-50	**Test-51** – Change Set Processing: Class, Class Change – All events, Class Change – LPR-MOV-FT* Events.	Pass	Pass
		Test-50 – Change Set Processing: Single, Single Change – LPR-MOV-FT-1862A Event.	Pass	Pass
		Test-52 – Change Set Processing: Marked Order, Marked Change Sets From Scenarios 1, 2, 3 (marked in that order).	Pass	Pass
Comanche Peak Sequence and Fault Tree Cut Sets w/ & w/o Flag Sets	COM-PEAK	**Test-41** – Cut Set Verification: Solve Fault Trees, Sequences And End States.	Pass	Pass
Surry 2QA LERF Analysis	Sury_ler	**Test-42** – Link Small Event Tree: Link Level 1 Event Trees (small event trees).	Pass	Pass
		Test-43 – Partition Sequence Cut Sets.	Pass	Pass
		Test-44 – Link Large Event Tree: Link PDS Event Trees (large event trees).	Pass	Pass
		Test-55 – Event Tree Linkage (including rules).	Pass	Pass
		Test-56 – End-State Gathering.	Pass	Pass
		Test-57 – Compound Event Plug-ins.	Pass	Pass
Demo Fault Tree Importance	demo	**Test-45** – Fault Tree Importance Measures: Fault Tree Fussell-Vesely Importance (ratio), Fault Tree Birnbaum	Pass	Pass

Test Description	Project Short Name	Test Case ID(s)	Expected Results	Independent Verification and Validation Results
		Importance (interval or difference), Fault Tree Uncertainty Importance.		
		Test-60 – Application Of Change Sets.	Pass	Pass
		Test-61 – Uncertainty Distributions.	Pass	Pass
Demo Single Sequence Importance	demo	**Test-46** – Sequence Importance Measures: Sequence Fussell-Vesely Importance (ratio), Sequence Birnbaum Importance (interval or difference), Sequence Uncertainty Importance.	Pass	Pass
		Test-60 – Application Of Change Sets.	Pass	Pass
		Test-61 – Uncertainty Distributions.		Pass
Demo Group Sequence Importance	demo	**Test-47** – Sequence Group Importance Measures: Sequence Group Fussell-Vesely Importance (ratio), Sequence Group Birnbaum Importance (interval or difference), Sequence Group Uncertainty Importance.	Pass	Pass
		Test-60 – Application Of Change Sets.	Pass	Pass
		Test-61 – Uncertainty Distributions.	Pass	Pass
Demo Class Change Sets	demo	**Test-51** – Change Set Processing: Class, Class Change – All Events, Class Change - ?-MOV-1 Events (a subset).	Pass	Pass
		Test-50 – Change Set Processing: Single, Single Change – E-MOV-A Event.	Pass	Pass
		Test-52 – Change Set Processing: Marked Order, Marked Change Sets From Scenarios 1, 2, 3 (marked in that order).	Pass	Pass
Beaver Valley End State Importance	BV2-5	**Test-48** – End State Importance Measures: End State Fussell-Vesely Importance, End State Birnbaum Importance, End State Uncertainty Importance.	Pass	Pass
		Test-60 – Application Of Change Sets.	Pass	Pass
		Test-61 – Uncertainty Distributions.	Pass	Pass
Beaver Valley End State Group Importance	BV2-5	**Test-49** – End State Group Importance: End State Fussell-Vesely Group Importance, End State Birnbaum Group Importance, End State Uncertainty Group Importance.	Pass	Pass
		Test-56 – End-State Gathering.	Pass	Pass
		Test-60 – Application Of Change Sets.	Pass	Pass
		Test-61 – Uncertainty Distributions.	Pass	Pass
Crystal River 3 Fault Tree Analysis	CR3-MOD699	**Test-01** – Solve Fault Trees: Fault Tree Solve.	Pass	Pass
		Test-53 – Extract, Delete, Load, Solve: Basic Events Load / Extract Fault Tree Load / Extract.	Pass	Pass
		Test-54 – Fault Tree Utility Functions: Auto Page/Solve.	Pass	Pass
		Test-54 – Fault Tree Utility Functions: Cut Sets To End State.	Pass	Pass
		Test-58 – Base Case Update.	Pass	Pass

Test Description	Project Short Name	Test Case ID(s)	Expected Results	Independent Verification and Validation Results
Peach Bottom Core Damage Frequency Analysis	pbot_302	**Test-01** – Solve Fault Trees, Fault Tree Probability Results.	Pass	Pass
		Test-02 – Solve Sequences, Core Damage Frequency Results.	Pass	Pass
		Test-13 – Project Uncertainty.	Pass	Pass
		Test-58 – Base Case Update.	Pass	Pass
		Test-60 – Application Of Change Sets.	Pass	Pass
		Test-61 – Uncertainty Distributions.	Pass	Pass
		Test-64 – Calculations On The Common-Cause Plug-in.	Pass	Pass
Peach Bottom Importance Measures Analysis	pbot_302	**Test-47** – Sequence Group Importance Measures.	Pass	Pass
		Test-64 – Calculations On The Common-Cause Plug-in.	Pass	Pass
Peach Bottom Change Set Analysis	pbot_302	**Test-50** – Change Set Processing: Single, Change Set On Compound Event.	Pass	Pass
		Test-64 – Calculations On The Common-Cause Plug-in.	Pass	Pass
Peach Bottom Condition/Initiating Event Assessments	pbot_302	**Test-03** – Events and Conditions Assessment: MFW Unavailable For 72 hours.	Pass	Pass
		Test-06 – Initiating Event Assessment: SLOCA w/ HSW-PUMPA Fails To Start.	Pass	Pass
		Test-64 – Calculations On The Common-Cause Plug-in.	Pass	Pass
Wolf Creek Core Damage Frequency Analysis	wolf_302	**Test-01** – Solve Fault Trees, Fault Tree Probability Results.	Pass	Pass
		Test-02 – Solve Sequences, Core Damage Frequency Results.	Pass	Pass
		Test-13 – Project Uncertainty.	Pass	Pass
		Test-58 – Base Case Update.	Pass	Pass
		Test-60 – Application Of Change Sets.	Pass	Pass
		Test-61 – Uncertainty Distributions.	Pass	Pass
		Test-64 – Calculations On The Common-Cause Plug-in.	Pass	Pass
Wolf Creek Importance Measures Analysis	wolf_302	**Test-47** – Sequence Group Importance Measures.	Pass	Pass
		Test-64 – Calculations On The Common-Cause Plug-in.	Pass	Pass
Wolf Creek Change Set Analysis	wolf_302	**Test-50** – Change Set Processing: Single, Single Change Set On Compound Event.	Pass	Pass
		Test-64 – Calculations On The Common-Cause Plug-in.	Pass	Pass
Wolf Creek Condition/Initiating Event Assessments	wolf_302	**Test-03** – Events and Conditions Assessment: AFW Out Of Service For 72 hours.	Pass	Pass
		Test-06 – Initiating Event Assessment: SLOCA w/ HPI-PUMPA In T&M And CVC-PUMPA Fails To Start.	Pass	Pass
		Test-64 – Calculations On The Common-Cause Plug-in.	Pass	Pass
Wolf Creek Event Tree Linking	wolf_302_noet	**Test-42** – Link Small Event Tree: Link Event Trees (small event trees).	Pass	Pass

Test Description	Project Short Name	Test Case ID(s)	Expected Results	Independent Verification and Validation Results
		Test-02 – Solve Sequence Cut Sets.	Pass	Pass
		Test-55 – Event Tree Linkage (including rules).	Pass	Pass
		Test-57 – Compound Event Plug-ins.	Pass	Pass
Peach Bottom Event Tree Linking	pbot_302_noet	**Test-42** – Link Small Event Tree: Link Event Trees (small event trees).	Pass	Pass
		Test-02 – Solve Sequence Cut Sets.	Pass	Pass
		Test-55 – Event Tree Linkage (including rules).	Pass	Pass
		Test-57 – Compound Event Plug-ins.	Pass	Pass
Simple Fault Tree – Testing Compound Events etc.	simple-ft	**Test-01** – Solve Fault Trees, Fault Tree Probability Results.	Pass	Pass
		Test-58 – Base Case Update.	Pass	Pass
		Test-59 – Calculation Types.	Pass	Pass
		Test-62 – N Of M Gates.	Pass	Pass
		Test-63 – Sequence Stress Testing.	Pass	Pass
Freq. Units – Testing Frequency Units on SONG_311	song_311	**Test-01** – Solve Fault Trees, Fault Tree Probability Results. DG Failed Condition Assessment Of 100 Hours (unit = default).	Pass	Pass
		Test-04 – Events and Condition Assessment: DG Failed Condition Assessment Of 100 hours (unit = default), DG Failed Condition Assessment Of 100 Hours (unit = hours).	Pass	Pass
		Test-01 – Solve Fault Trees, Fault Tree Probability Results. The LPI MDP Train A Was Failed During The Grid LOOP (units = year).	Pass	Pass
		Test-02 – Solve Sequences, Core Damage Frequency. The LPI MDP Train A Was Failed During The Grid LOOP (units = hour).	Pass	Pass
DEMO – Testing For Incorrect Comparison	demo	**Test-66** – Wrong Results.	Fail	Fail
Oyster Creek Event And Condition Analysis		**Test-67** – Event And Condition Analysis-Initiating Event Assessment: Switchyard-Related Loss of Off-Site Power (LOOP) with other failures and conditions on the Oyster Creek 345 model. Switchyard LOOP.	Pass	Pass
		Test-67 – Event And Condition Analysis-Initiating Event Assessment: Switchyard-Related Loss of Off-Site Power (LOOP) With Other Failures And Conditions On The Oyster Creek 345 Model. Switchyard LOOP With TM Off.	Pass	Pass
Susquehanna Unit 1 And 2 Event And Condition Analysis		**Test-68** – Event And Condition Analysis-Condition Event Assessment: Blue Max SBO Diesel Out For Four Days On The Susquehanna Unit 1 And 2 Model. EDG Out For 4 Days, Multipass Option.	Pass	Pass
		Test-68 – Event And Condition Analysis-Condition Event	Pass	Pass

Test Description	Project Short Name	Test Case ID(s)	Expected Results	Independent Verification and Validation Results
		Assessment: Blue Max SBO Diesel Out For Four Days On The Susquehanna Unit 1 And 2 Model. EDG Out For 4 Days, Single Pass WITHOUT Cut Set Update Option.		
		Test-68 – Event And Condition Analysis-Condition Event Assessment: Blue Max SBO Diesel Out For Four Days On The Susquehanna Unit 1 And 2 Model. EDG Out For 4 Days, Single Pass WITH Cut Set Update Option.	Pass	Pass
		Test-68 – Event And Condition Analysis-Condition Event Assessment: Blue Max SBO Diesel Out For Four Days On The Susquehanna Unit 1 And 2 Model. ECA Cond TM Effect On CCF.	Pass	Pass
		Test-68 – Event And Condition Analysis-Condition Event Assessment: Blue Max SBO Diesel Out For Four Days On The Susquehanna Unit 1 And 2 Model. EDG Out For TM For 4 Days, Multipass Option.	Pass	Pass
		Test-68 – Event And Condition Analysis-Condition Event Assessment: Blue Max SBO Diesel Out For Four Days On The Susquehanna Unit 1 And 2 Model. EDG Out For TM For 4 Days, Single Pass WITHOUT Cut Set Update Option.	Pass	Pass
		Test-68 – Event And Condition Analysis-Condition Event Assessment: Blue Max SBO Diesel Out For Four Days On The Susquehanna Unit 1 And 2 Model. EDG Out For TM For 4 Days, Single Pass WITH Cut Set Update Option.	Pass	Pass
		Test-68 – Event And Condition Analysis-Condition Event Assessment: Blue Max SBO Diesel Out For Four Days On The Susquehanna Unit 1 And 2 Model. EDG Out For TM For 4 Days, Multipass Option With Other TM Turned OFF.	Pass	Pass
Susquehanna Unit 1 And 2 Significance Determination Process Analysis		**Test-69** – Significance Determination Process -Blue Max SBO Diesel Out For Four Days On The Susquehanna Unit 1 And 2 Model. EDG Failed To Run For 4 Days, Multiple Pass Option.	Pass	Pass
		Test-69 – Significance Determination Process -Blue Max SBO Diesel Out For Four Days On The Susquehanna Unit 1 And 2 Model. EDG Failed To Run For 4 Days, Single Pass WITHOUT Cut Set Update	Pass	Pass
		Test-69 – Significance Determination Process -Blue Max SBO Diesel Out For Four Days On The Susquehanna Unit 1 And 2 Model. EDG Failed To Run For 4 Days, Single Pass WITH Cut Set Update.	Pass	Pass

Test Description	Project Short Name	Test Case ID(s)	Expected Results	Independent Verification and Validation Results
Susquehanna Unit 1 And 2 General Analysis		**Test-70** – General Analysis-Blue Max SBO Diesel Out For Four Days On The Susquehanna Unit 1 And 2 model. EDG Failed To Run For 4 Days, Multiple Pass Option.	Pass	Pass
		Test-70 – General Analysis-Blue Max SBO Diesel Out For Four Days On The Susquehanna Unit 1 And 2 model. EDG Failed To Run For 4 Days, Single Pass WITHOUT Cut Set Update.	Pass	Pass
		Test-70 – General Analysis-Blue Max SBO Diesel Out For Four Days On The Susquehanna Unit 1 And 2 model. EDG Failed To Run For 4 Days, Single Pass WITH Cut Set Update.	Pass	Pass
		Test-70 – General Analysis-Blue Max SBO Diesel Out For Four Days On The Susquehanna Unit 1 And 2 model. ECA Cond TM Effect On CCF.	Pass	Pass
Calculation Type N Oyst-345 Analysis		**Test-71** – 'N' Calculation Type. Verify Initiating Event Type 'N'.	Pass	Pass
		Test-71 – 'N' Calculation Type. Solve Sequences, Core Damage Frequency Results.	Pass	Pass
Risk Assessment Standardization Project Common Cause Failure		**Test-72** – RASP Common Cause Failure (CCF) Validation.	Pass	Pass
Core Damage Frequency External Event Peach Bottom		**Test-58** – Base Case Update.	Pass	Pass
		Test-73 – External Event Models – Solve Event Trees. Solve Sequences, Core Damage Frequency Results.	Pass	Pass
Core Damage Frequency COLM_SD		**Test-58** – Base Case Update.	Pass	Pass
		Test-74 – Shutdown Models - Solve Event Trees. Solve Sequences, Core Damage Frequency Results.	Pass	Pass
Workspace Independence (Based on 67, 68, 69 and 70)		**Test-58** – Base Case Update.	Pass	Pass
		Test-75 – Workspace Model Independence. Solve Fault Trees.	Pass	Pass
		Test-75 – Workspace Model Independence. Core Damage Frequency Test.	Pass	Pass
		Test-75 – Workspace Model Independence. Report BE Data.	Pass	Pass
		Test-75 – Workspace Model Independence. ECA-IE-LOOP-SC.	Pass	Pass
		Test-75 – Workspace Model Independence. Switch Yard LOOP.	Pass	Pass
		Test-75 – Workspace Model Independence. ECA Cond EDG-FR 4 Days Multiple Pass.	Pass	Pass
		Test-75 – Workspace Model Independence. EDG FR For 4 Days.	Pass	Pass

Test Description	Project Short Name	Test Case ID(s)	Expected Results	Independent Verification and Validation Results
		Test-75 – Workspace Model Independence. Fault Tree Same Frequency Test.	Pass	Pass
		Test-75 – Workspace Model Independence. Sequence Same Frequency Test.	Pass	Pass
		Test-75 – Workspace Model Independence. Report BE Data.	Pass	Pass
Susq Repeat SA ECA, SDP, GA		**Test-58** – Base Case Update.	Pass	Pass
		Test-76 – Repetition Of Critical Calculations Over N Times. SA Solve Fault Trees, Fault Tree Probability Results.	Pass	Pass
		Test-76 – Repetition Of Critical Calculations Over N Times. SA Solve Sequences, Core Damage Frequency Results.	Pass	Pass
		Test-76 – Repetition Of Critical Calculations Over N Times. ECA.	Pass	Pass
		Test-76 – Repetition Of Critical Calculations Over N Times. GA.	Pass	Pass
		Test-76 – Repetition Of Critical Calculations Over N Times. SDP.	Pass	Pass
SDP_LERF Factors – Manual Test		**Test-77** – Significance Determination Process –LERF Multiplier Calculations.	Pass	Pass
ASM Load – Manual Test		**Test-78** – Accident Sequence Matrix – Solve Event Trees.	Pass	Pass
Demo Multi Pass		**Test-79** – Multiple Pass Algorithm Test (True and 1.0).	Pass	Fail
Oyster Creek Multi-Pass False		**Test-80** – Multiple Pass Algorithm Test (False and Ignore). EDG Out For 4 Days, Multipass Option.	Pass	Pass
MIN/MAX Demo_EE		**Test-81** – Min-Max Test On Demo-EE Model For Event And Condition Analysis And General Analysis Interfaces. Core Damage Frequency And Report.	Pass	Fail
		Test-81 – Min-Max Test On Demo-EE Model For Event And Condition Analysis And General Analysis Interfaces. Report BE Data.	Pass	Fail
		Test-81 – Min-Max Test On Demo-EE Model For Event And Condition Analysis And General Analysis Interfaces. ECA-IE-LOOP-SC.	Pass	Fail
		Test-81 – Min-Max Test On Demo-EE Model For Event And Condition Analysis And General Analysis Interfaces. Switch Yard LOOP.	Pass	Fail
		Test-81 – Min-Max Test On Demo-EE Model For Event And Condition Analysis And General Analysis Interfaces. ECA Cond EDG-FR 4 Days Multiple Pass.	Pass	Fail
		Test-81 – Min-Max Test On Demo-EE Model For Event	Pass	Fail

Test Description	Project Short Name	Test Case ID(s)	Expected Results	Independent Verification and Validation Results
		And Condition Analysis And General Analysis Interfaces. EDG FR For 4 Days.		
		Test-81 – Min-Max Test On Demo-EE Model For Event And Condition Analysis And General Analysis Interfaces. SDP EDG-FR 4 Days Multiple Pass..	Pass	Fail
		Test-81 – Min-Max Test On Demo-EE Model For Event And Condition Analysis And General Analysis Interfaces. GEN EDG-FR 4 Days Multiple Pass.	Pass	Fail
		Test-81 – Min-Max Test On Demo-EE Model For Event And Condition Analysis And General Analysis Interfaces. Report And Compare Fault Tree Data.	Pass	Fail
		Test-81 – Min-Max Test On Demo-EE Model For Event And Condition Analysis And General Analysis Interfaces. EDG FR For 4 Days.	Pass	Fail
		Test-81 – Min-Max Test On Demo-EE Model For Event And Condition Analysis And General Analysis Interfaces. Report And Compare Fault Tree Data.	Pass	Fail
		Test-81 – Min-Max Test On Demo-EE Model For Event And Condition Analysis And General Analysis Interfaces. Report And Compare CDF Data.	Pass	Fail
		Test-81 – Min-Max Test On Demo-EE Model For Event And Condition Analysis And General Analysis Interfaces. Report And Compare BE Data.	Pass	Fail
ECA Single Pass/General Oyster Creek		**Test-82** – Single Pass Algorithm Tests On Event And Condition Analysis And General Analysis. LCS-MDP-FS-P3A Failed For 1 year. Failed Event Contributes To CCF.	Pass	Pass
		Test-82 – Single Pass Algorithm Tests On Event And Condition Analysis And General Analysis. LCS-MDP-FS-P3A Failed For 1 Year. Failed Event Contributes To CCF.	Pass	Pass
SA Cross Reference – Manual Test		**Test-83** – Cross-Referencing Is Validated.	Pass	Pass
SA Recovery – Oyster Creek Kill And Recovery Check		**Test-58** – Base Case Update.	Pass	Pass
		Test-84 – Verify Database Recovery Works. Solve And Report Fault Trees.	Pass	Pass
		Test-84 – Verify Database Recovery Works. Core Damage Frequency And Report.	Pass	Pass
		Test-84 – Verify Database Recovery Works. Report BE Data.	Pass	Pass
		Test-84 – Verify Database Recovery Works. Solve And Report Fault Trees.	Pass	Pass

Test Description	Project Short Name	Test Case ID(s)	Expected Results	Independent Verification and Validation Results
		Test-84 – Verify Database Recovery Works. Core Damage Frequency And Report.	Pass	Pass
		Test-84 – Verify Database Recovery Works. Report BE Data.	Pass	Pass
FT/ET Transfer Function – Manual Test		**Test-85** – Verify Event Tree/Fault Tree Transfers Function Correctly.	Pass	Pass
ES Gather		**Test-86** – Gather End States On A Demo Model With Multiple Phases.	Pass	Fail
LERF GA/ECA		**Test-87** – Large Early Release Frequency (LERF) Model Functionality.	Pass	Fail
Event Tree Creation		**Test-88** – Event Tree, Fault Tree Creation In A New Project.	Pass	Fail
SDP/ECA Menu Navigation – Manual Test		**Test-89** – Menu Navigation.	Pass	Pass
SA Fault Tree View Expanded – Manual Test		**Test-90** – Tree View Expanded.	Pass	Pass
Workspace To SA Independence		**Test-58** – Base Case Update.	Pass	Pass
		Test-91 – Workspace To Standard Analysis Interface Independence. Solve And Report Fault Trees.	Pass	Pass
		Test-91 – Workspace To Standard Analysis Interface Independence. Core Damage Frequency And Report.	Pass	Pass
		Test-91 – Workspace To Standard Analysis Interface Independence. Report BE Data.	Pass	Pass
		Test-91 – Workspace To Standard Analysis Interface Independence. ECA-IE-LOOP-SC.	Pass	Pass
		Test-91 – Workspace To Standard Analysis Interface Independence. ECA Cond EDG-FR 4 Days Multiple Pass.	Pass	Pass
		Test-91 – Workspace To Standard Analysis Interface Independence. EDG FR For 4 Days.	Pass	Pass
		Test-91 – Workspace To Standard Analysis Interface Independence. SDP EDG-FR 4 Days Multiple Pass.	Pass	Pass
		Test-91 – Workspace To Standard Analysis Interface Independence. GEN EDG-FR 4 Days Multiple Pass.	Pass	Pass
		Test-91 – Workspace To Standard Analysis Interface Independence. Report And Compare Fault Tree Data.	Pass	Pass
		Test-91 – Workspace To Standard Analysis Interface Independence. Report And Compare CDF Data.	Pass	Pass
		Test-91 – Workspace To Standard Analysis Interface Independence. Report And Compare BE Data.	Pass	Pass
SA Independence To Workspace		**Test-92** – Standard Analysis Interface To Workspace Independence.	Pass	Pass
Workspace To Workspace – Manual Test		**Test-93** – Workspace To Workspace Independence.	Pass	Pass
Project To Project Independence – Manual		**Test-94** – Project To Project Independence.	Pass	Pass

Test Description	Project Short Name	Test Case ID(s)	Expected Results	Independent Verification and Validation Results
Test				
Workspace To Workspace (Based on 67, 68, 69 and 70)		**Test-95** – Workspace To Workspace Independence.	Pass	Pass
Integrated Models		**Test-96** – Integrated Models.	Pass	Fail
Linking On Integrated Models – Manual Test		**Test-97** – Event Tree Linking And Unlink In Integrated Models (External Events and Shutdown).	Pass	Pass
Cut Set Path Check – Manual Test		**Test-98** – Verification Of Cut Set View Path.	Pass	Pass
Rule Layering Check		**Test-99** – Verification Rule Layering Works.	Pass	Fail
Rule Nesting Check		**Test-100** – Verification Rule Nesting Works.	Pass	Fail
Oyster Creek All Reports		**Test-101** – All Reports Produce Expected Reports.	Pass	Pass
SDP Basic Event Testing – Manual Test		**Test-102** – Significance Determination Process Interface Testing Of Basic Event Changes.	Pass	Pass
SDP Figure III-D Check – Manual Test		**Test-103** – Significance Determination Process Interface Testing Of Figure III-D (Change in delta CDF as a function of duration) Point Estimate Checks.	Pass	Pass
ECA Uncertainty Check – Manual Test		**Test-104** – Event And Condition Analysis Uncertainty Calculations.	Pass	Pass
		Test-60 – Application Of Change Sets.	Pass	Pass
		Test-61 – Uncertainty Distributions.	Pass	Pass
HRA Report Check – Nine Mile Point 2 HRA Report		**Test-105** – SPAR-H Worksheet Calculations. Compares Basic Events Of X Calc Type.	Pass	Pass

APPENDIX A – Manual Test Results

1.0 Test-77

SAPHIRE 8 Testing

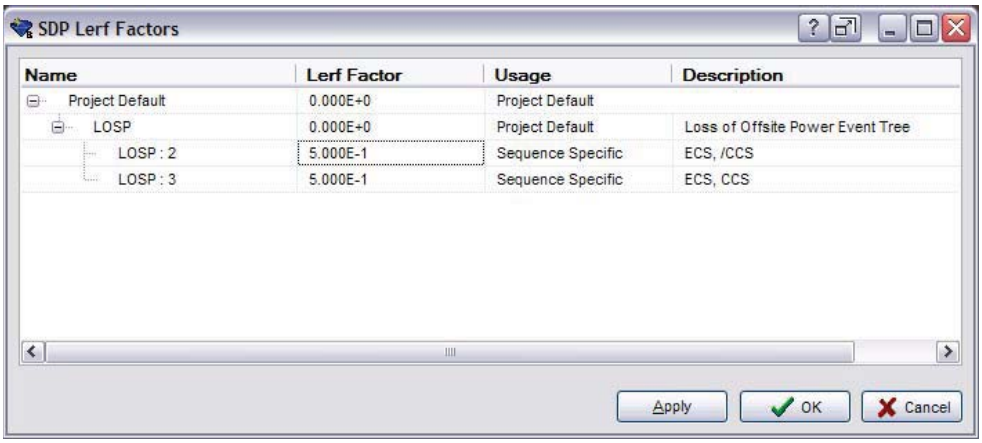
Manual Testing to Augment the Automated Test Suite

April 26, 2010
Tester: Curtis Smith
Version: 8.06.06

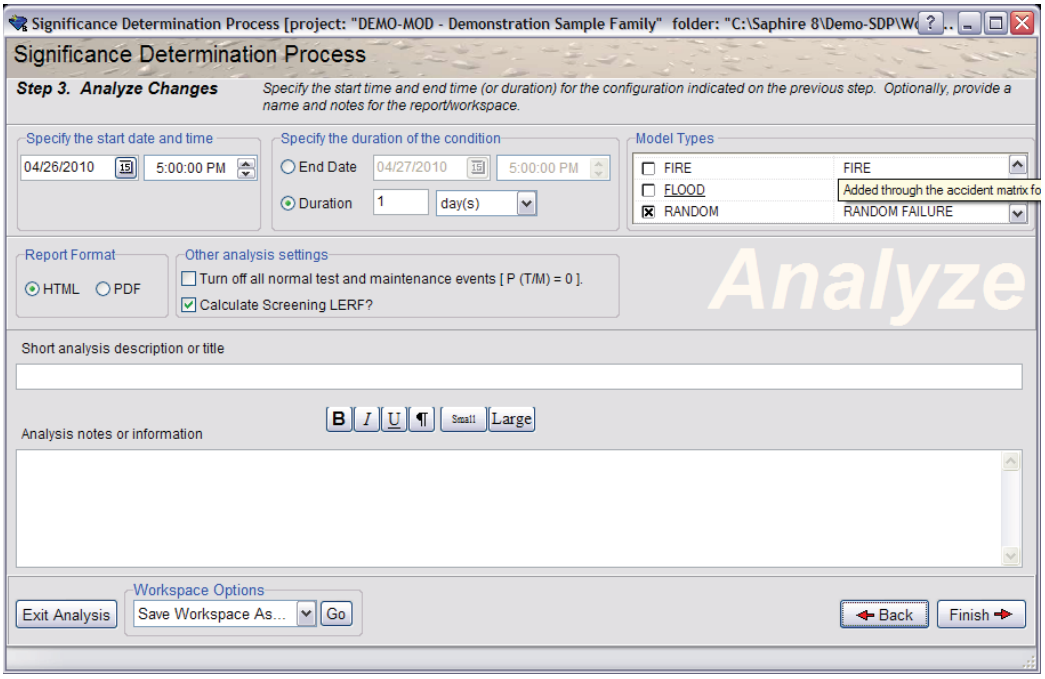
Test 77	**Significance Determination Process - LERF multiplier calculations**	**This test ensures that Significance Determination Process - LERF multipliers are being used properly to calculate Screening LERF values. Results will be compared with results reviewed from a version 7 analysis done by a SPAR model developer at the INL.**

Steps:

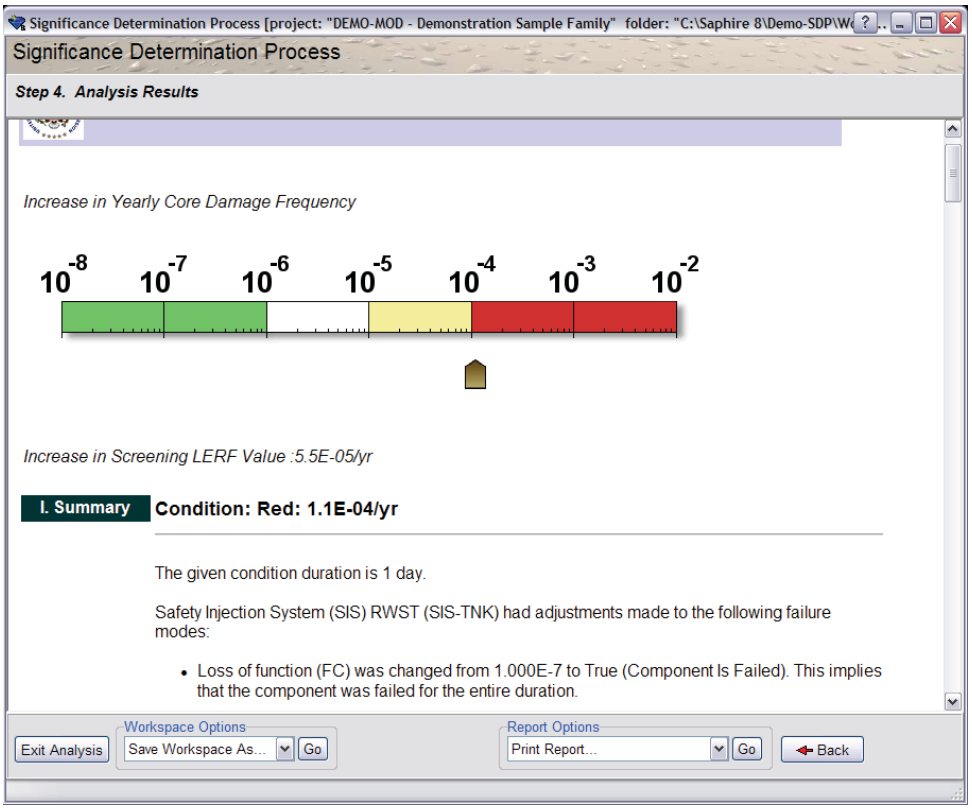
1. Start SAPHIRE and open the DEMO-SDP project.
2. Select the Project → User Settings option.
3. Select the SDP option. Check the Allow LERF Calculation check box.
4. Click the Edit Lerf Factors button.
5. Enter a factor of 0.5 for each sequence (see below) and click Ok. Click Ok.



6. Double click on "New SDP…" option.
7. Click the SIS systems button. Check RWST component.
8. Click Next.
9. Change the Loss of Function failure mode to TRUE.
10. Click Next.
11. Select a 1 day duration, leave the other options at their default values.



12. Click Finish. Click Ok.
13. Verify that the report indicates that the LERF value is 0.5 of the "importance." The importance is 1.1E-4, so the LERF results should be 5.5E-5.



Verified? Yes.

2.0 Test-78

SAPHIRE 8 Testing

Manual Testing to Augment the Automated Test Suite

April 26, 2010
Tester: Curtis Smith
Version: 8.06.06

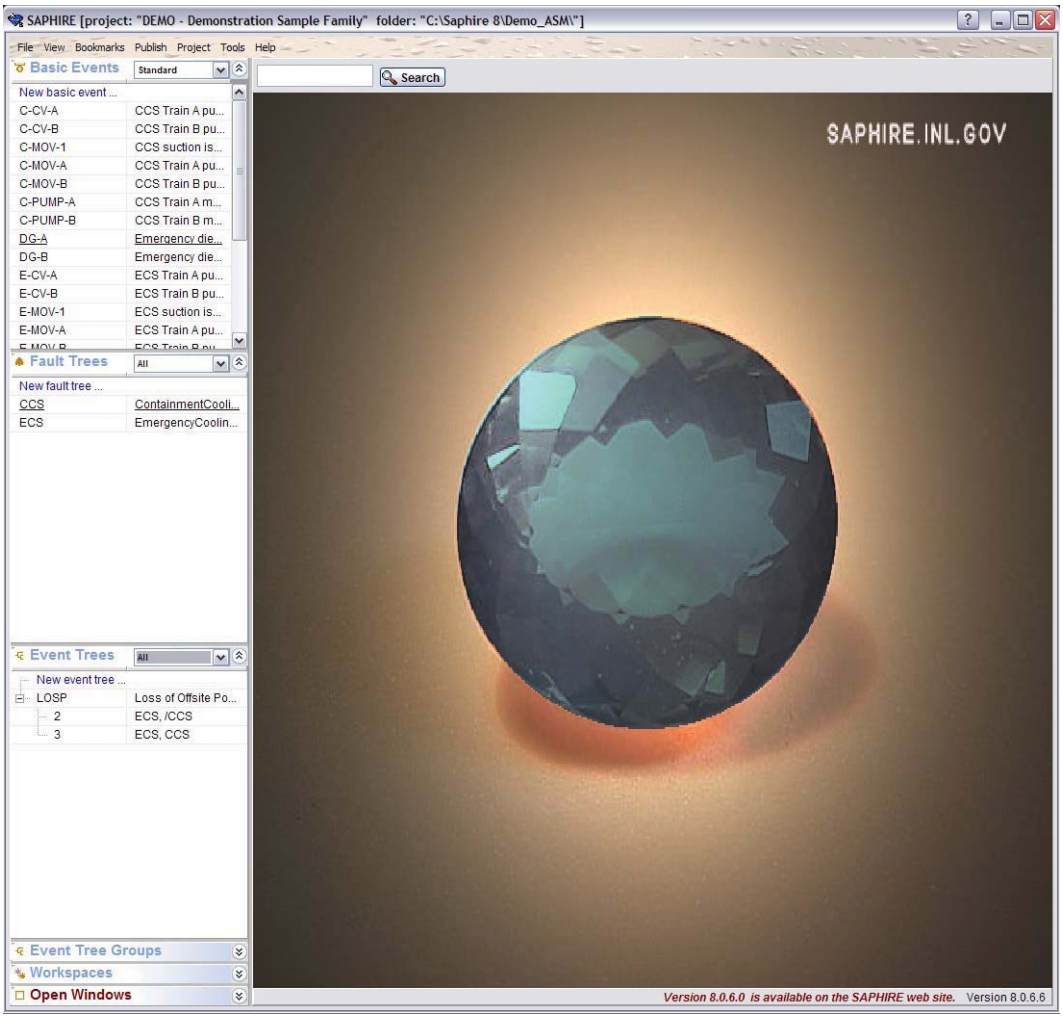
Test 78	**Accident Sequence Matrix - Solve Event Trees**	**This test links event trees after an Accident Sequence Matrix has been loaded, generate basic event data (with no change sets), solve (with cut set probability cutoff) and quantify sequence minimal cut sets, and recovery rules. The current case min cut upper bound, base case min cut upper bound, and cut set totals are verified for each sequence. Results will be compared with results reviewed from a version 7 analysis done by a SPAR model developer at the INL.**

Steps:

14. Copy DEMO project to new folder, Demo_ASM
15. Create Demo_EE_Accident_Matrix.ASM file in the new folder, with below in the .ASM file.

* Model Type Name,Model Type ID,IE,IE Freq.,IE Desc.,Event Tree Name,Event Tree Desc.,X-fer to,End State Substitution,Flag Set Name,Flag Set Desc.,Flag Set Setting(s),,,,
FIRE,FIR,IE-FRI-1,4.84E-05,Fire Scenario 1,FIRE1,"Demo Fire scenario 1",LOSP,,FIRE_FS_1,Flag Set for Fire Scenario 1,E-CV-A
FIRE,FIR,IE-FRI-2,2.67E-04,Fire Scenario 2,FIRE2,"Demo Fire scenario 2",LOSP,,FIRE_FS_2,Flag Set for Fire Scenario 2,E-CV-B
FIRE,FIR,IE-FRI-3,2.58E-04,Fire Scenario 3,FIRE3,"Demo Fire scenario 3",LOSP,,FIRE_FS_3,Flag Set for Fire Scenario 3,E-MOV-1
FLOOD,FLI,IE-FLOOD-1,4.84E-05,Flood Scenario 1,FLOOD1,"Demo Flood scenario 1",LOSP,,FLOOD_FS_1,Flag Set for Flood Scenario 1,E-CV-A
FLOOD,FLI,IE-FLOOD-2,2.67E-04,Flood Scenario 2,FLOOD2,"Demo Flood scenario 2",LOSP,,FLOOD_FS_2,Flag Set for Flood Scenario 2,E-CV-B
FLOOD,FLI,IE-FLOOD-3,2.58E-04,Flood Scenario 3,FLOOD3,"Demo Flood scenario 3",LOSP,,FLOOD_FS_3,Flag Set for Flood Scenario 3,E-MOV-1
SEISMIC1,EQ1,IE-EQ-BIN-1,1.036E-03,Seismic Scenario 1,SEISMIC1,"Demo Seismic scenario 1",LOSP,,SEISMIC_FS_1,Flag Set for Seismic Scenario 1,E-CV-A
SEISMIC2,EQ2,IE-EQ-BIN-2,2.560E-05,Seismic Scenario 2,SEISMIC2,"Demo Seismic scenario 2",LOSP,,SEISMIC_FS_2,Flag Set for Seismic Scenario 2,E-CV-B
SEISMIC3,EQ3,IE-EQ-BIN-3,8.740E-06,Seismic Scenario 3,SEISMIC3,"Demo Seismic scenario 3",LOSP,,SEISMIC_FS_3,Flag Set for Seismic Scenario 3,E-MOV-1

16. Start SAPHIRE, select the new project, and verify that the existing DEMO_ASM project only contains CCS, ECS (fault trees), and LOSP (event tree).



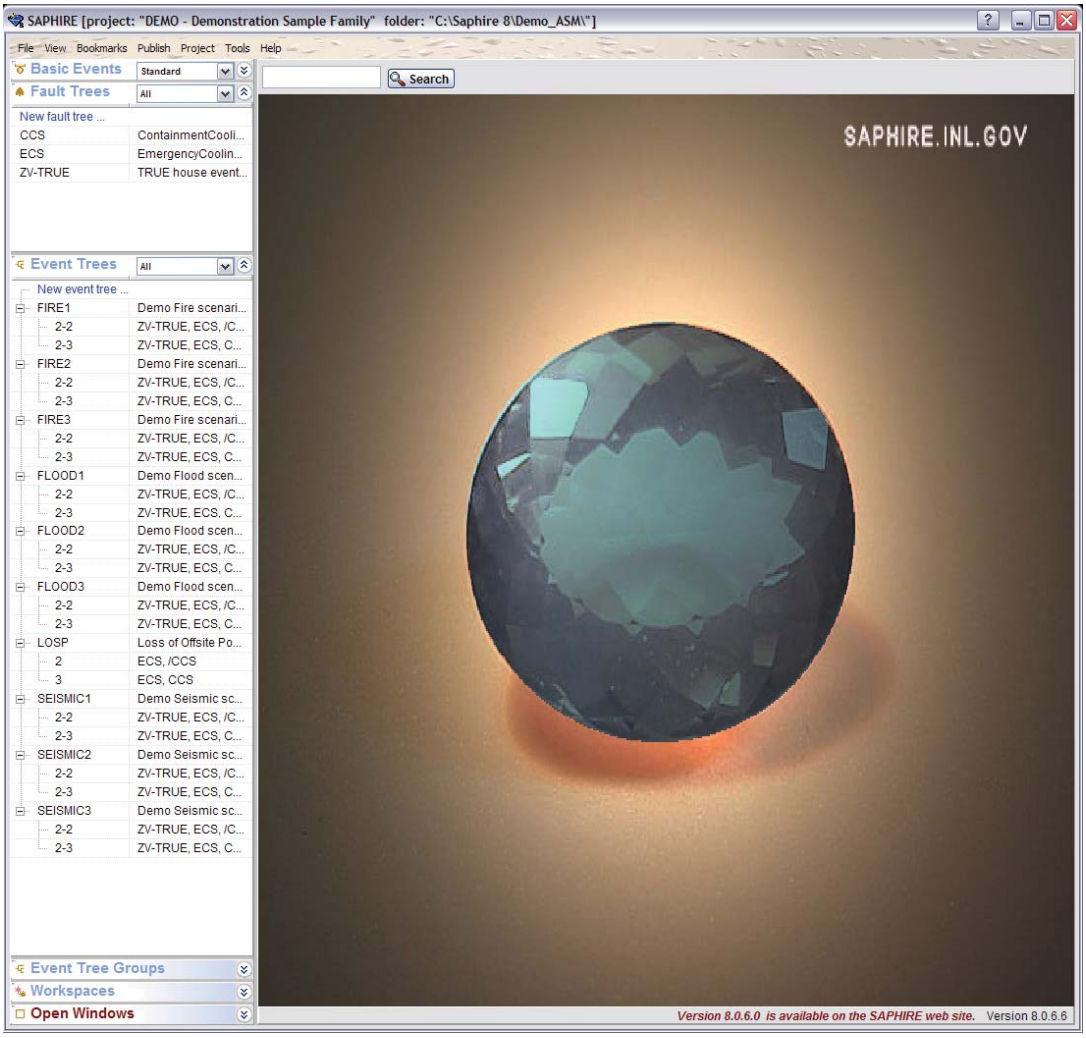
Verified? Yes.

17. Load the ASM file using the Tools → Load Accident Matrix option.
    Verify the "processing log."

```
Adding the Accident Matrix C:\Saphire
8\Demo_ASM\Demo_EE_Accident_Matrix.asm.
Adding IE-FRI-1. Line 2
Adding IE-FRI-2. Line 3
Adding IE-FRI-3. Line 4
Adding IE-FLOOD-1. Line 5
Adding IE-FLOOD-2. Line 6
Adding IE-FLOOD-3. Line 7
Adding IE-EQ-BIN-1. Line 8
Adding IE-EQ-BIN-2. Line 9
Adding IE-EQ-BIN-3. Line 10
Updating Change Lists.
Matrix Processing Complete.
```

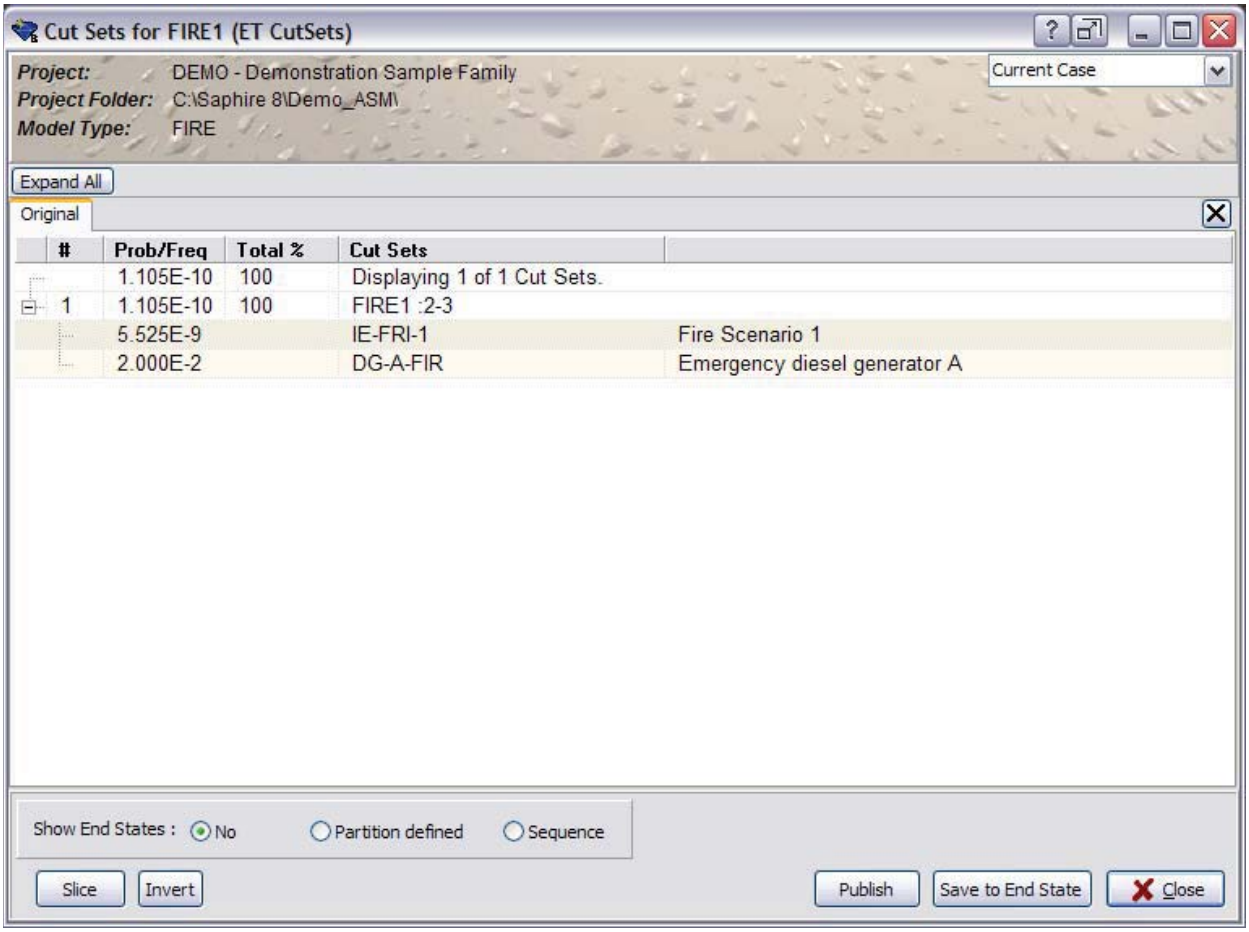
Verified? Yes.

18. Check to see that the applicable fire, flood, and seismic event trees added (as defined in the ASM).



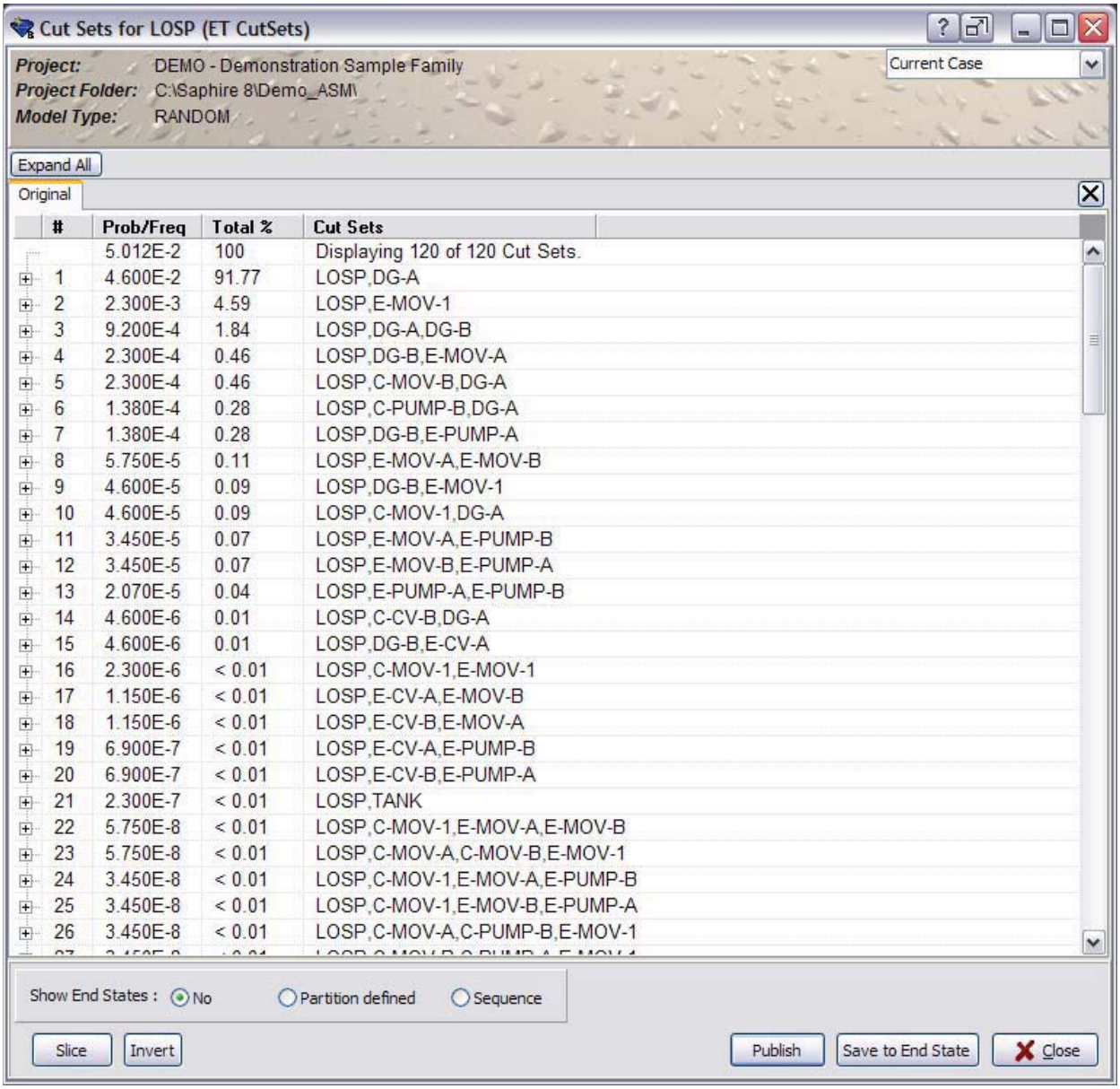
Verified? Yes.

19. Verify that cut sets can be generated for the FIRE1 event tree (using the FIRE model type).



Verified? Yes.

20. Verify that the LOSP event tree can still generate RANDOM model type cut sets.

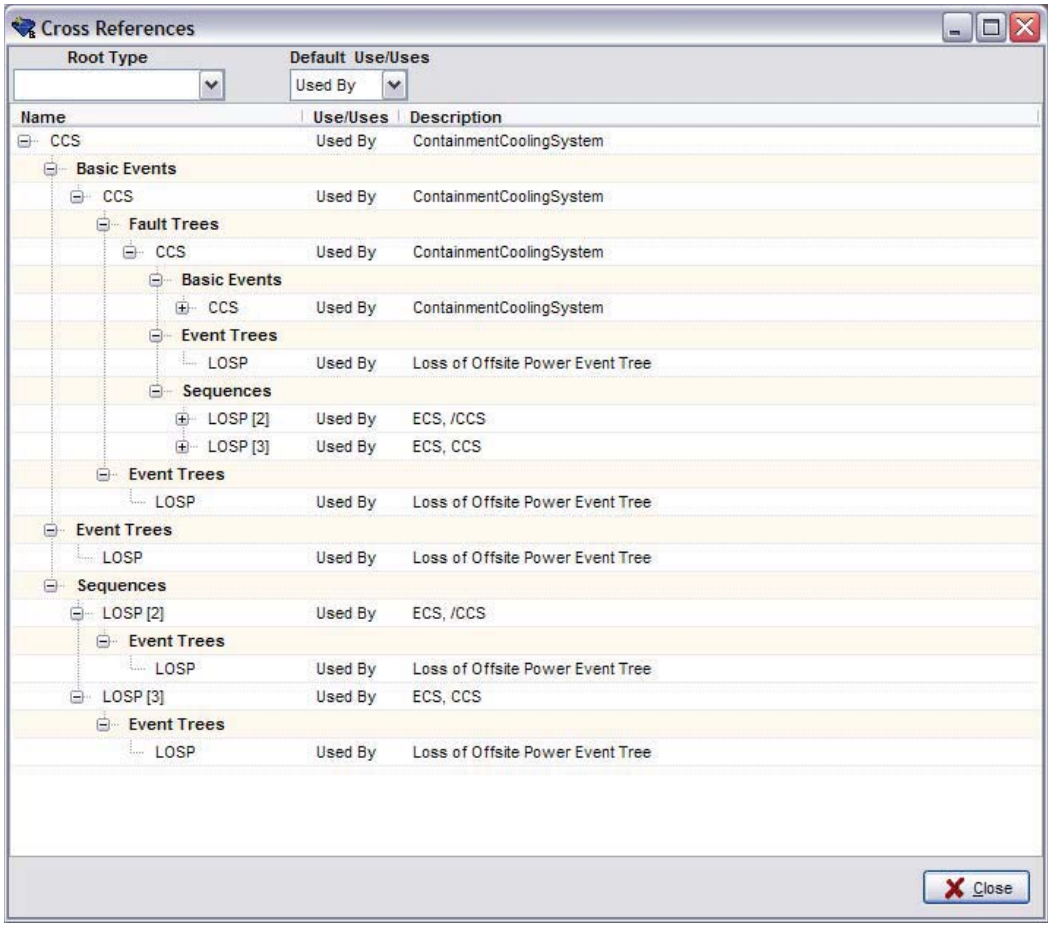


Verified? Yes.

3.0 Test-83

Test 83	**Cross-referencing is validated (See #8 ATP input draft)**	**This test will exercise the various cross referencing capabilities. Results will be reviewed by a SPAR model developer for completeness.**

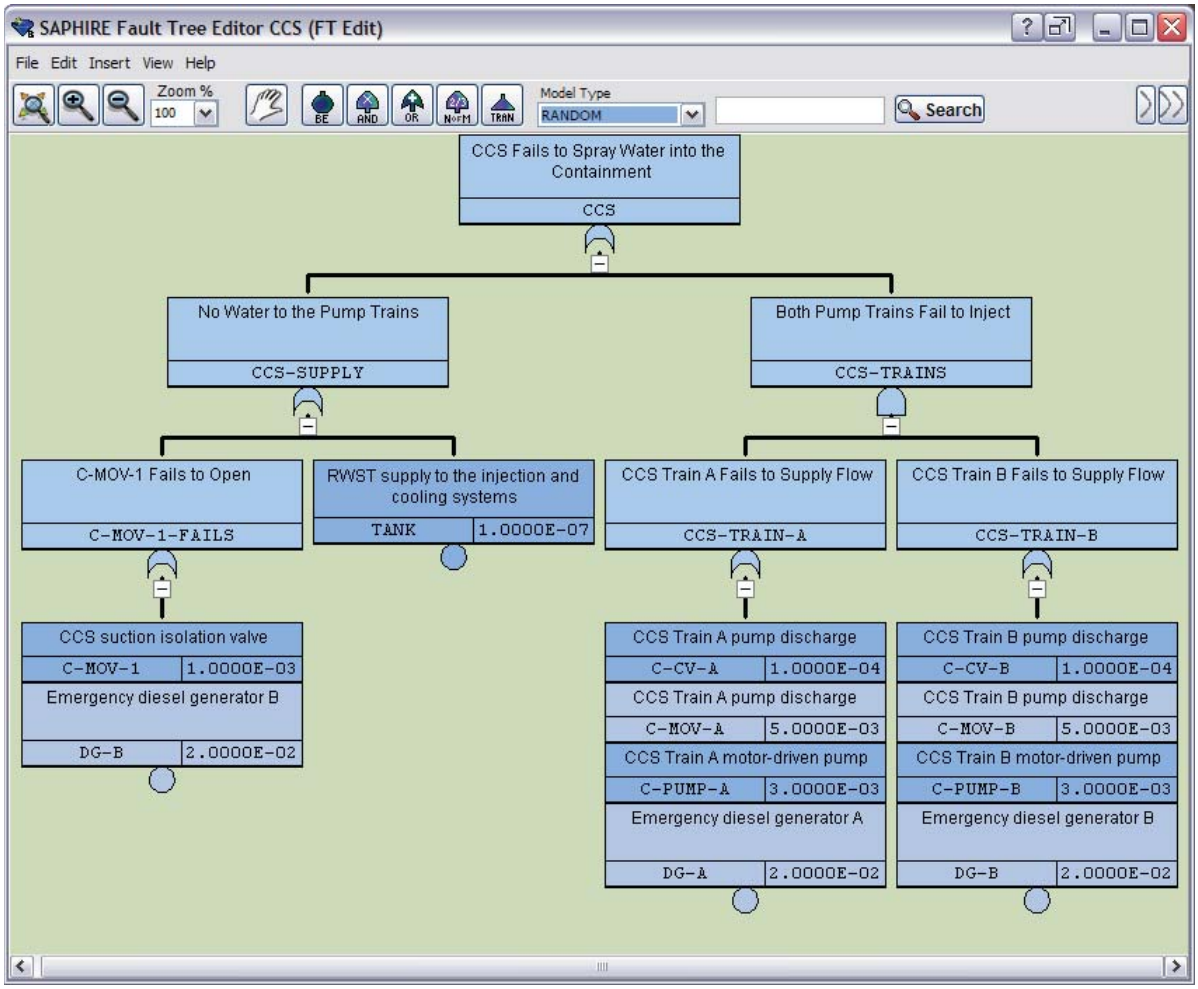
1. Start SAPHIRE, open the DEMO project.
2. Highlight the CCS fault tree.
3. Select Tools → Cross Reference.
4. Open up the "children" nodes to the point where objects are referenced a second time (e.g., CCS using the basic event CCS, which uses the fault tree CCS, which has basic event CCS).



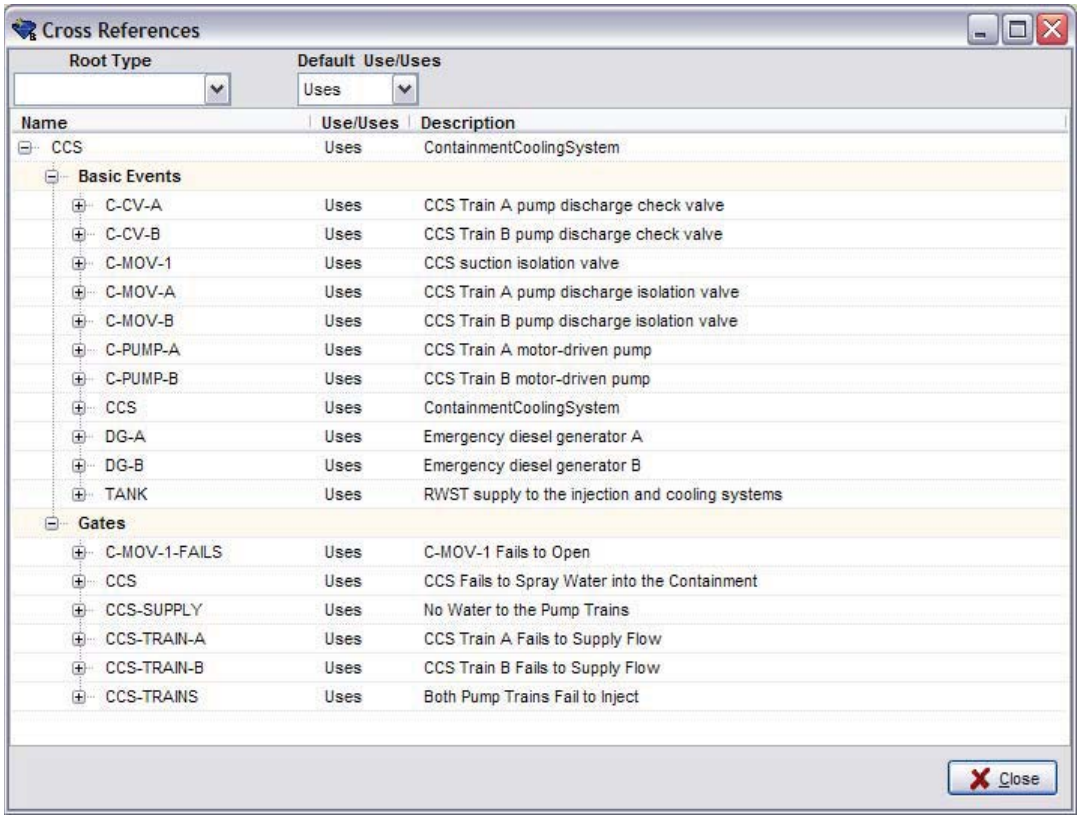
5. Verify that the "used by"cross-referencing appears correct. CCS is used by LOSP (event tree) sequence 2 and 3. CCS is also used by the CCS basic event.

Verified? Yes.

6. Change the "Use/Uses" option to "Uses."
7. Verify that the objects used by the CCS fault tree are correct.
   The fault tree for CCS is:

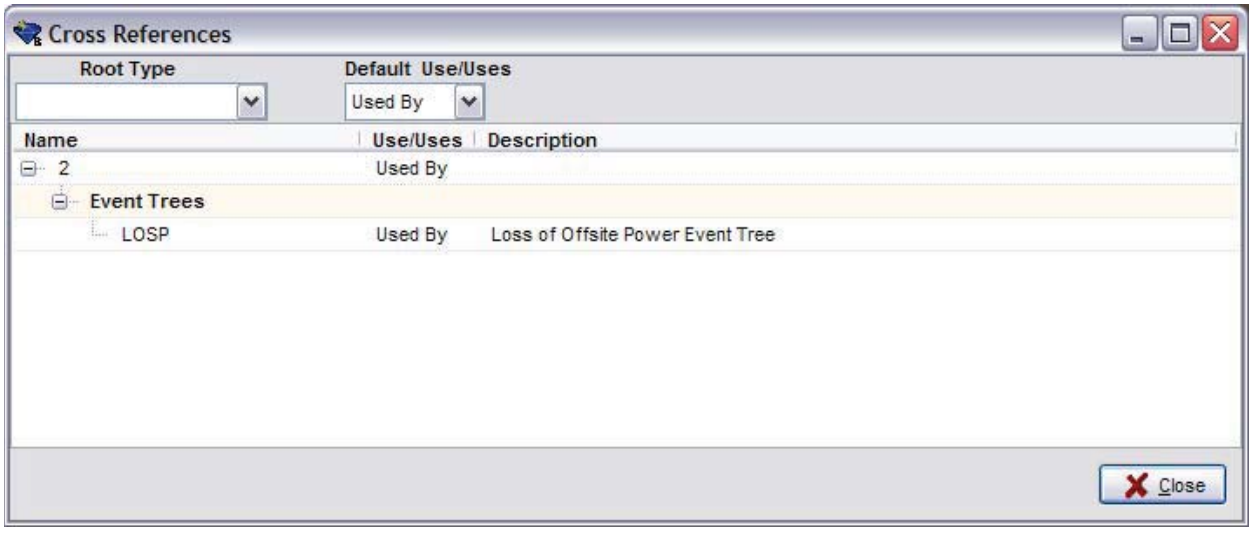


As can be seen, CCS uses gates CCS-SUPPLY, CCS-TRAINS, etc., and basic events TANK, C-MOV-1, etc.



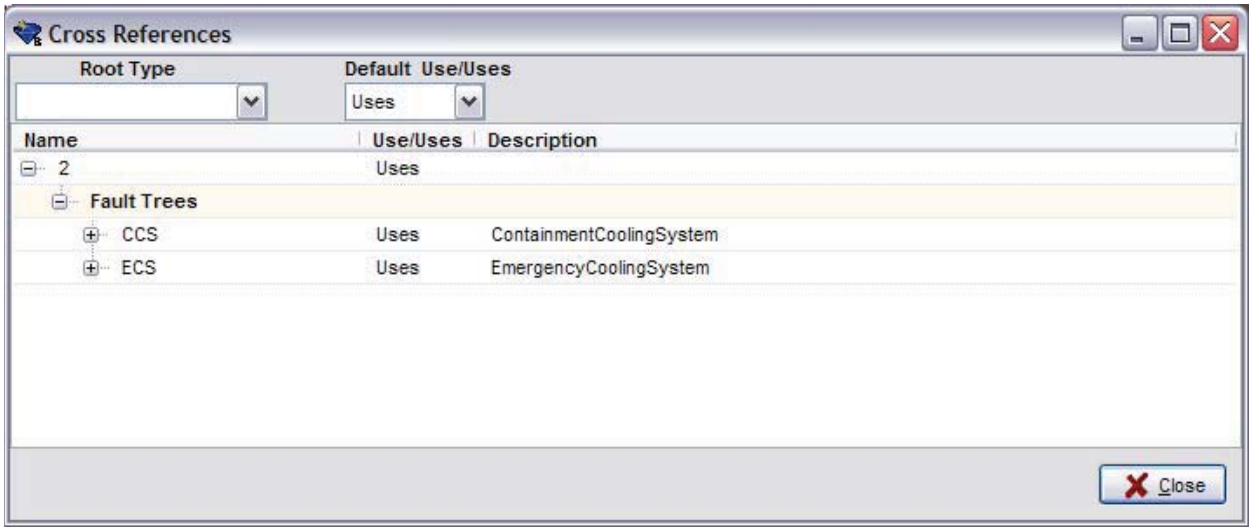
Verified? Yes.

8. Close the Cross Reference screen and highlight the LOSP, Sequence 2 event tree.
9. Select the Tools → Cross References option.
10. Verify the "Used By" option for LOSP sequence 2 (no other tree uses LOSP).



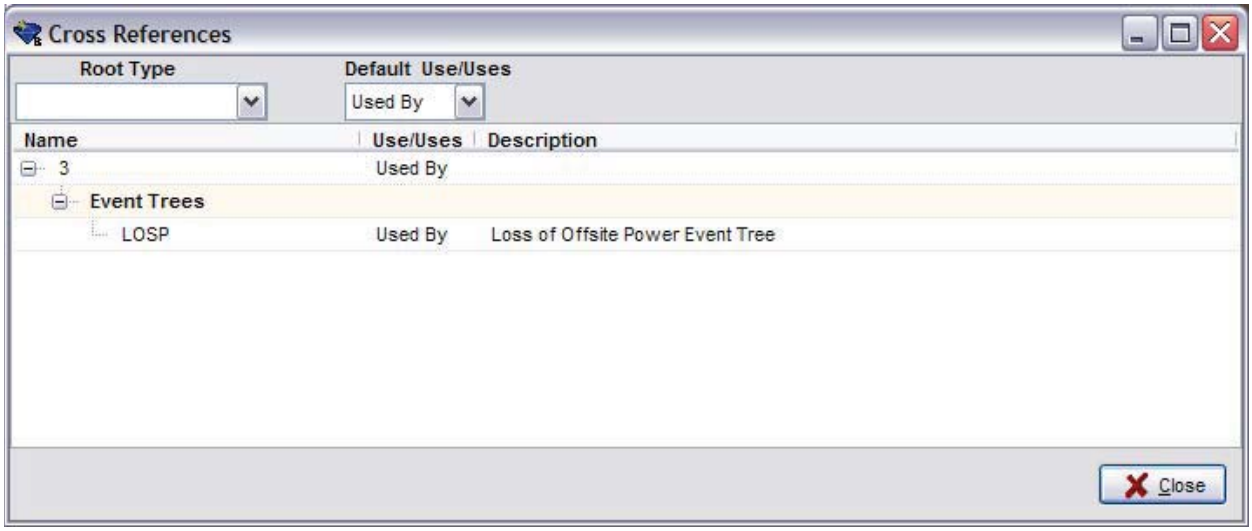
Verified? Yes.

11. Change the "Use/Uses" option to "Uses."
12. Verify the "Uses" option for LOSP sequence 2 (uses both CCS and ECS).



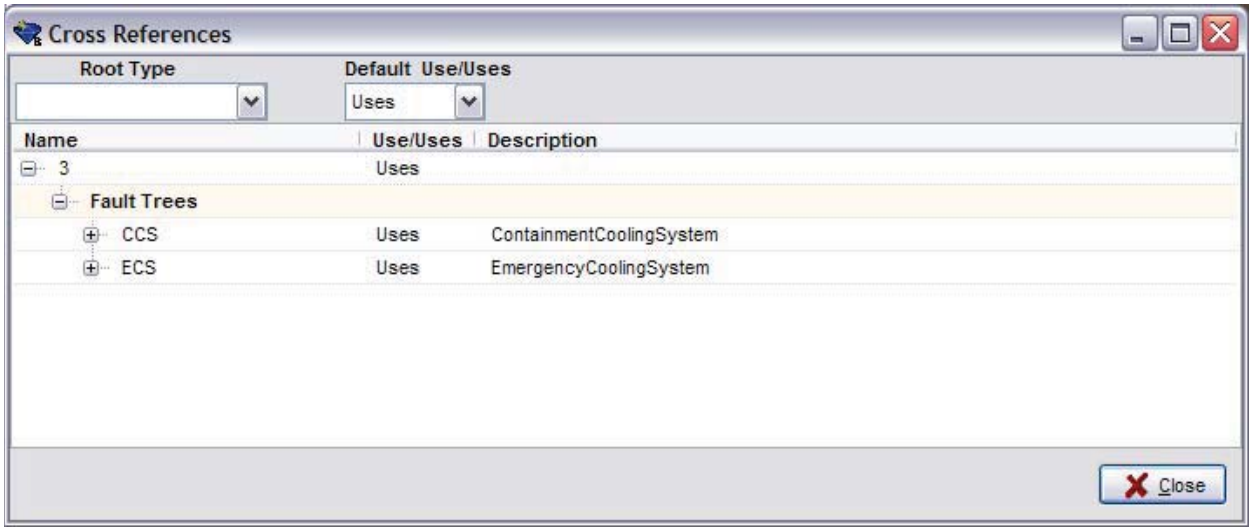
Verified? Yes.

13. Close the Cross Reference screen and highlight the LOSP, Sequence 3 event tree.
14. Select the Tools → Cross References option.
15. Verify the "Used By" option for LOSP sequence 3 (no other tree uses LOSP).



Verified? Yes.

16. Change the "Use/Uses" option to "Uses."
17. Verify the "Uses" option for LOSP sequence 3 (uses both CCS and ECS).



Verified? Yes.

4.0 Test-85

NAME OF APPLICATION UNDER TEST: SAPHIRE 8.0

TEST CASE PURPOSE: Test 85 – Verify event tree/fault tree transfers function correctly.
REQUIREMENT(S) VERIFIED:

SDP Tests

TEST 01 Add an internal transfer to a Fault tree.

TEST 02 Add an external transfer to a Fault tree.

TEST 03 Test "Move to transfer" for internal and external. transfers.

TEST 04 Make an Event Tree End State go to a transfer.

TEST 05 Test Dbl Click brings you to the transferred Event Tree.

TEST CASE ABSTRACT OF TECHNIQUES USED TO TEST THE FEATURE:

None

OTHER FILES REQUIRED TO RUN TEST CASE:

Did test on OYST-345.exe project dated 3-19-2010

TEST PERFORMED BY : Steve Prescott
TEST DATE : 4/26/10

5.0 Test-89

NAME OF APPLICATION UNDER TEST: SAPHIRE 8.0

TEST CASE PURPOSE: Test 89 - This tests the Significance Determination Process and the Event and Condition Analysis interfaces. The buttons for moving back and forth between screens, canceling, and saving will be tested. Results will be reviewed by a software developer.
REQUIREMENT(S) VERIFIED:

SDP Tests

TEST 01 Tested all Next buttons to end of SDP and Back buttons to the start.

TEST 02 Intermediate saves and closes reopen to previous state.

TEST 03 Cancel in middle of solve.

ECA Tests

TEST 01 Tested all Next buttons to end of SDP and Back buttons to the start.

TEST 02 Intermediate saves and closes reopen to previous state.

TEST 03 Cancel in middle of solve.

TEST CASE ABSTRACT OF TECHNIQUES USED TO TEST THE FEATURE:

None

OTHER FILES REQUIRED TO RUN TEST CASE:

OYST-345.exe project dated 3-19-2010

TEST PERFORMED BY : Steve Prescott
TEST DATE : 3/31/10

6.0 Test-90

NAME OF APPLICATION UNDER TEST: SAPHIRE 8.0

TEST CASE PURPOSE: Test 90 - This verifies that the Standard Analysis Interface in the fault tree feature "View Expanded" is working. Results will be reviewed by a software developer.

REQUIREMENT(S) VERIFIED:

TEST 01 Check view Expanded in FT viewer File Options.

TEST CASE ABSTRACT OF TECHNIQUES USED TO TEST THE FEATURE:

OTHER FILES REQUIRED TO RUN TEST CASE:

Demo –SDP project

TEST PERFORMED BY : Steve Prescott
TEST DATE : 3/31/10

7.0 Test-93

SAPHIRE 8 Testing

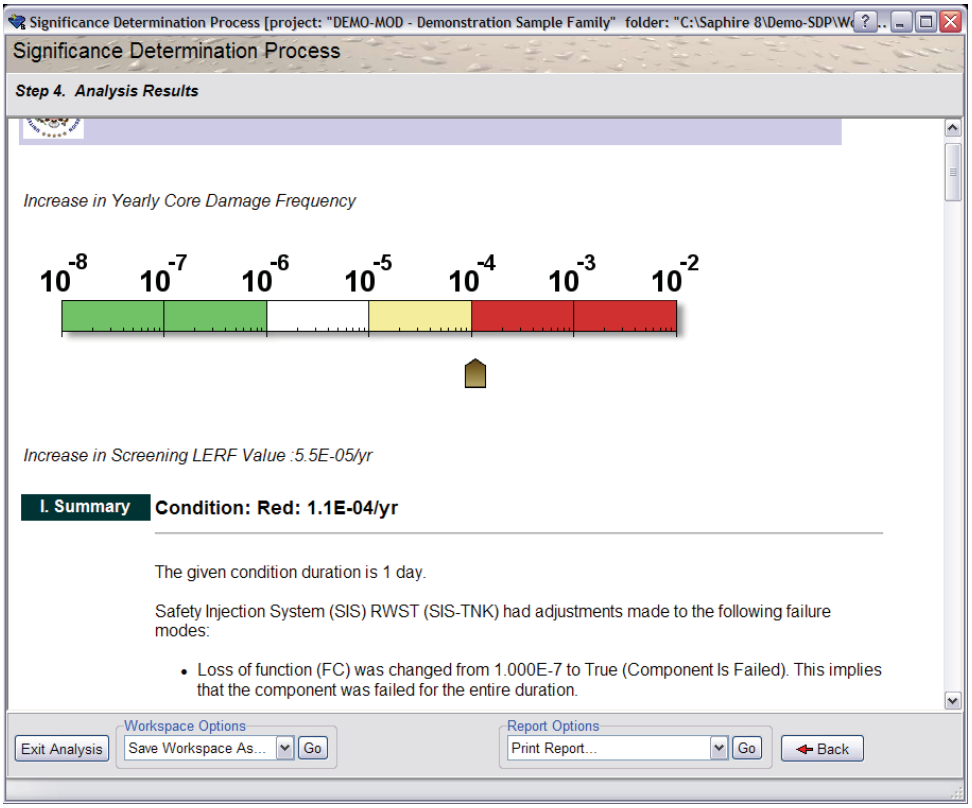
Manual Testing to Augment the Automated Test Suite

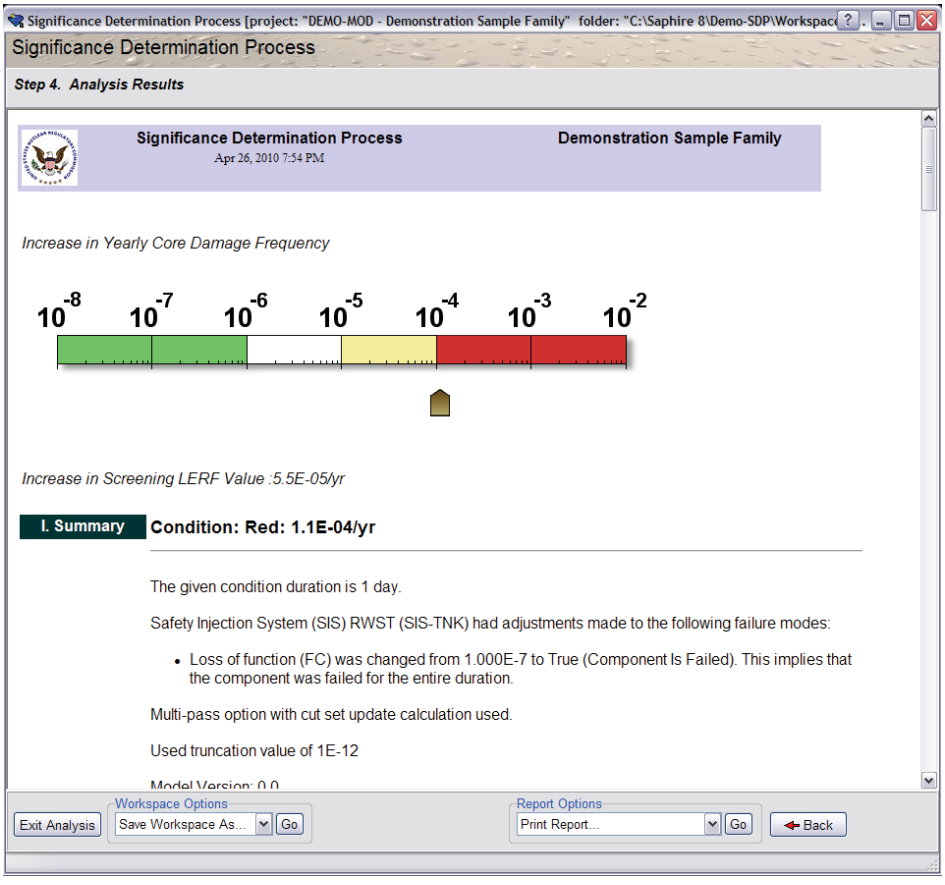
April 26, 2010
Tester: Curtis Smith
Version: 8.06.06

Test 93	**Workspace to Workspace Independence**	**This tests the addition of a new workspace or editing existing workspaces do not impact other workspaces. Tests should verify that changes made to Standard Analysis after the creation of a workspace should not reflect that change. Test on Significance Determination Process, Event and Condition Analysis, General Analysis workspaces. A software analyst will review these results.**

This test will be conducted by using a single project (DEMO-SDP) by rerunning Test 77, running an ECA and GA, then modifying the Standard Analysis and checking to see that the saved workspaces (SDP, ECA, and GA) are untouched.
Steps:

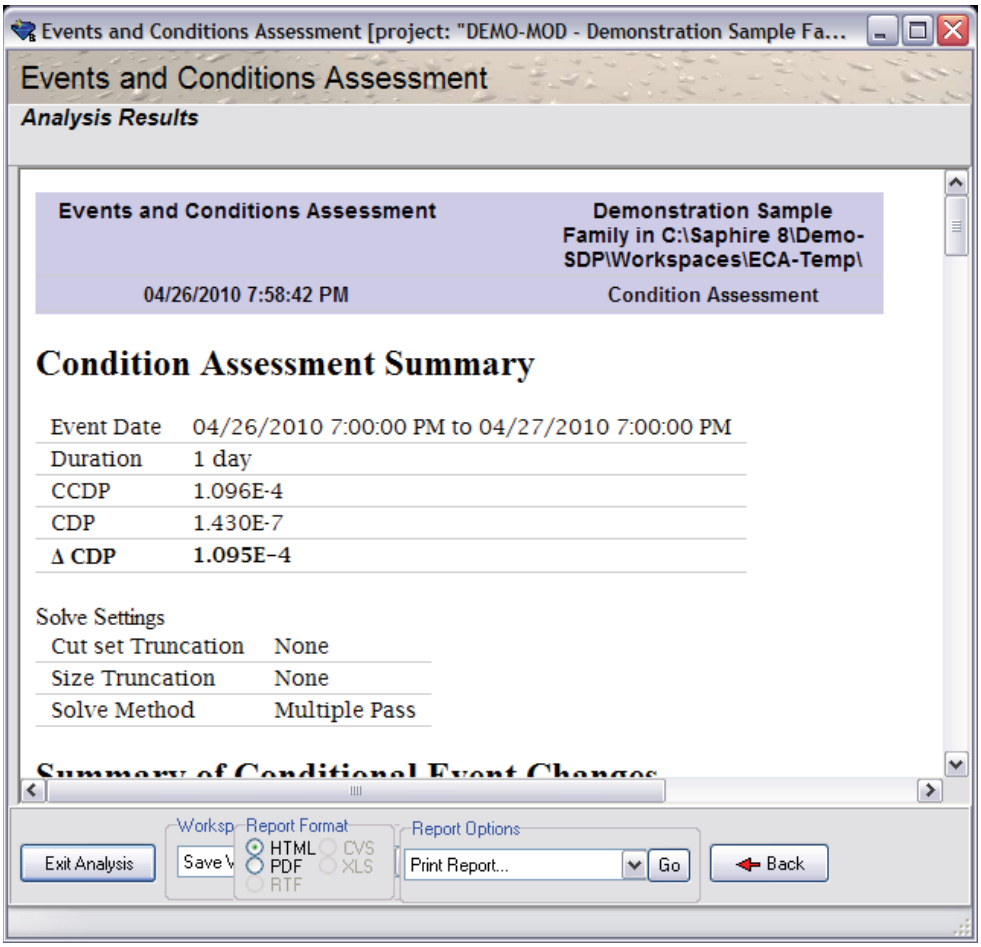
1. Start SAPHIRE and rerun Test 77 (using the DEMO-SDP project).
2. Verify the results (below) from Test 77.


Significance Determination Process [project: "DEMO-MOD - Demonstration Sample Family" folder: "C:\Saphire 8\Demo-SDP\W
Significance Determination Process
Step 4. Analysis Results
Increase in Yearly Core Damage Frequency
10-8 10-7 10-6 10-5 10-4 10-3 10-2
Increase in Screening LERF Value :5.5E-05/yr
I. Summary
Condition: Red: 1.1E-04/yr
The given condition duration is 1 day.
Safety Injection System (SIS) RWST (SIS-TNK) had adjustments made to the following failure modes:
Loss of function (FC) was changed from 1.000E-7 to True (Component Is Failed). This implies that the component was failed for the entire duration.
Exit Analysis
Workspace Options
Save Workspace As...
Go
Report Options
Print Report...
Go
Back


Significance Determination Process [project: "DEMO-MOD - Demonstration Sample Family" folder: "C:\Saphire 8\Demo-SDP\Workspac
Significance Determination Process
Step 4. Analysis Results
Significance Determination Process
Apr 26, 2010 7:54 PM
Demonstration Sample Family
Increase in Yearly Core Damage Frequency
10-8 10-7 10-6 10-5 10-4 10-3 10-2
Increase in Screening LERF Value :5.5E-05/yr
I. Summary
Condition: Red: 1.1E-04/yr
The given condition duration is 1 day.
Safety Injection System (SIS) RWST (SIS-TNK) had adjustments made to the following failure modes:
Loss of function (FC) was changed from 1.000E-7 to True (Component Is Failed). This implies that the component was failed for the entire duration.
Multi-pass option with cut set update calculation used.
Used truncation value of 1E-12
Model Version: 0.0
Exit Analysis
Workspace Options
Save Workspace As...
Go
Report Options
Print Report...
Go
Back

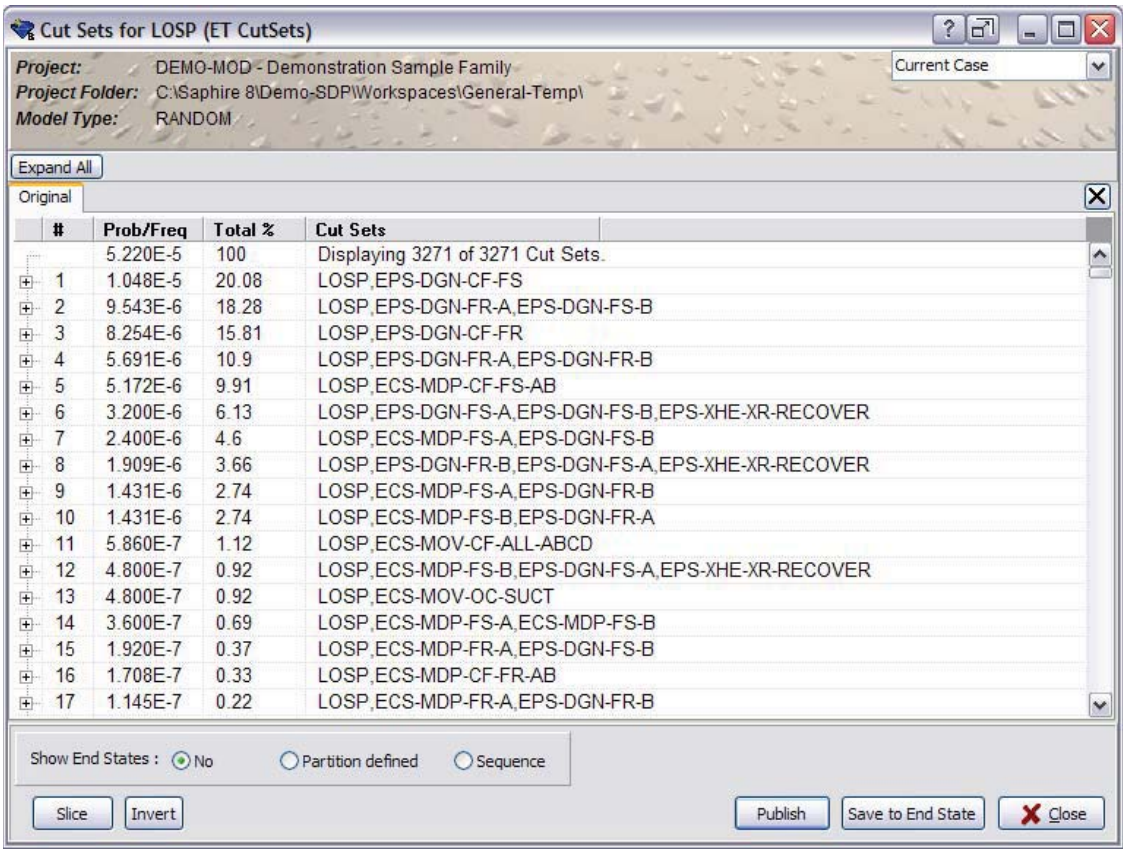
Verified (to this point)? Yes.

3. Save the Workspace (call it Test-93-SDP. Exit the workspace.
4. Without closing SAPHIRE, double click "New ECA…"
5. Select condition assessment, duration of 1 day. Click Next.
6. Select SIS-TNK-FC-RWST basic event. Click Next.
7. Change the SIS-TNK-FC-RWST to TRUE. Click Next.
8. Click Finish. Click Ok.
9. Verify to see that the Delta CDP is 1.1E-4.



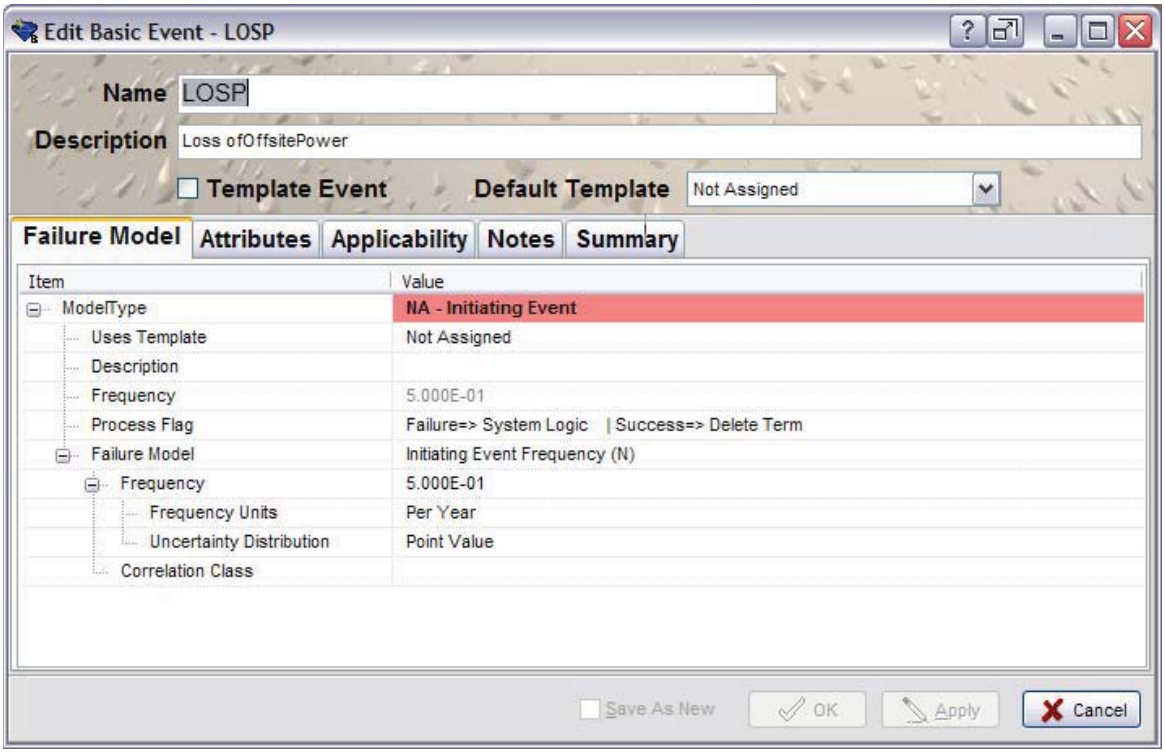
Verified (to this point)? Yes.

10. Save the Workspace (call it Test-93-ECA). Exit the workspace.
11. Without closing SAPHIRE, double click "New Analysis..." (under General Analysis).
12. Select CC-CKV-CC-1A. Click Next.
13. Change CCS-CKV-CC-1A to 1E-3. Click Next.
14. Check Event Trees (All Event Trees). Click Finish. Click Ok.
15. Highlight the LOSP event tree, right click and select View Cut Sets.
16. Verify to see that the cut sets give a value of 5.22E-2.

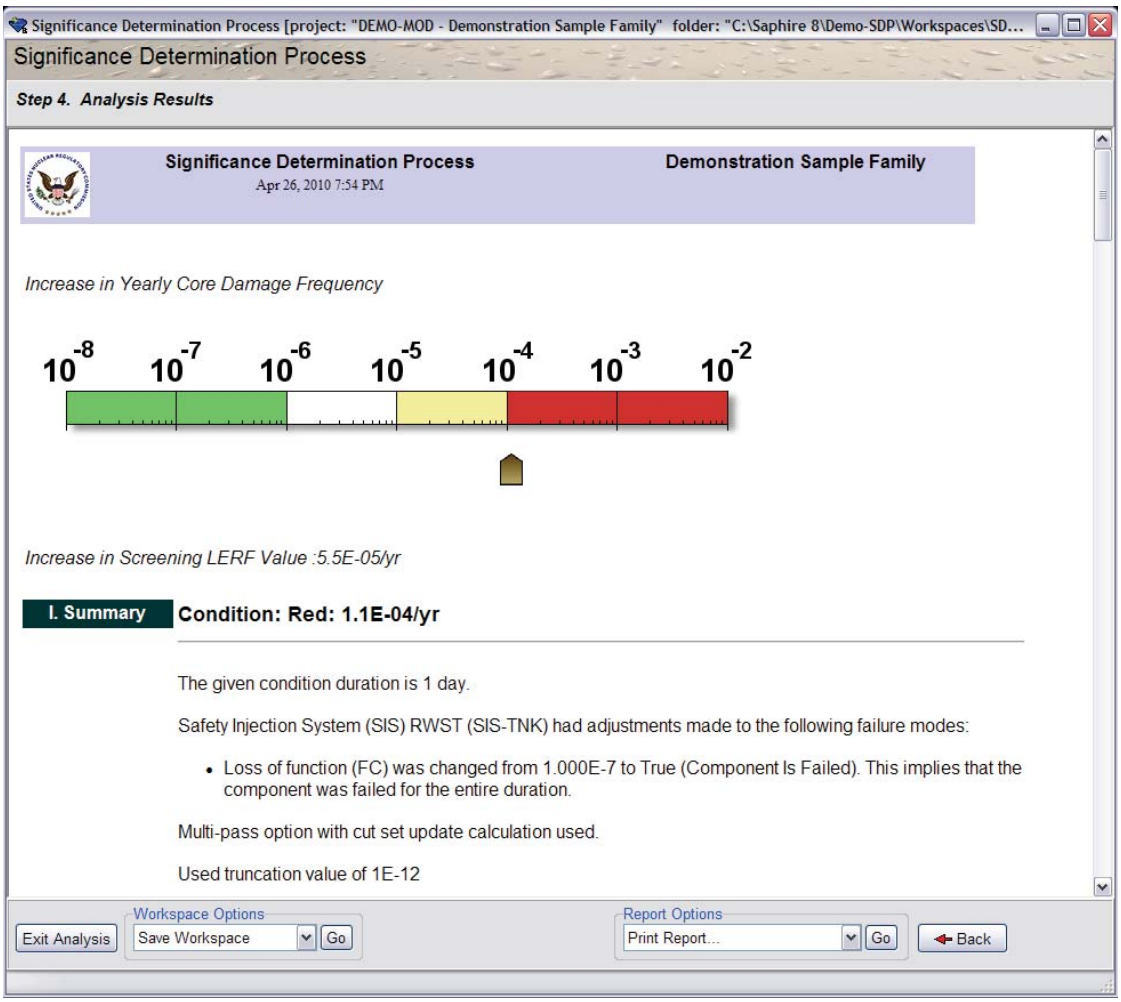


Verified (to this point)? Yes.

17. Save the Workspace (call it Test-93-GA). Exit the workspace.
18. Now, double click on the LOSP basic event. Change the frequency to 0.5 per year. Click Ok.

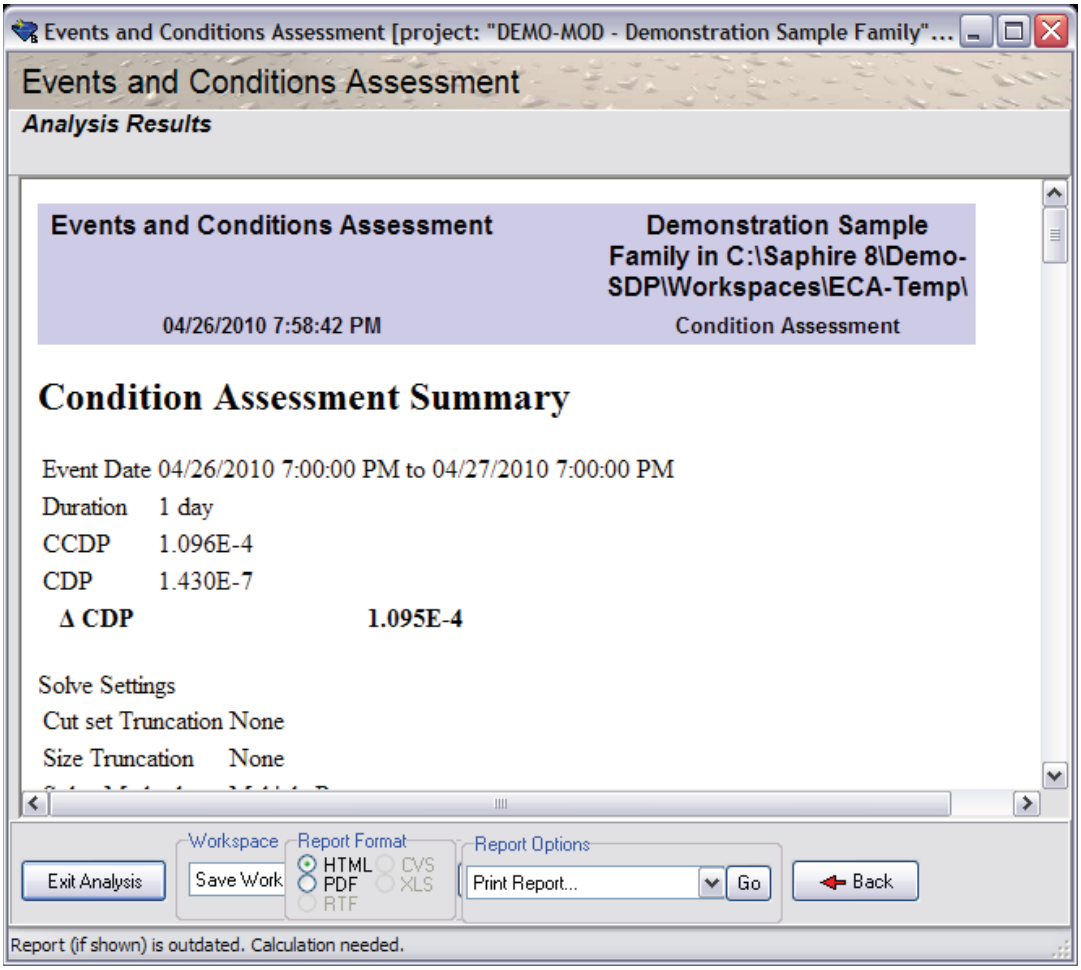


19. Double click on the SIS-TNK-FC-RWST basic event. Change its probability for RANDOM to 0.2 (from 1E-7). Click Ok.
20. Now, double click on the saved SDP workspace (Test-93-SDP). Verify that the results have not changed.



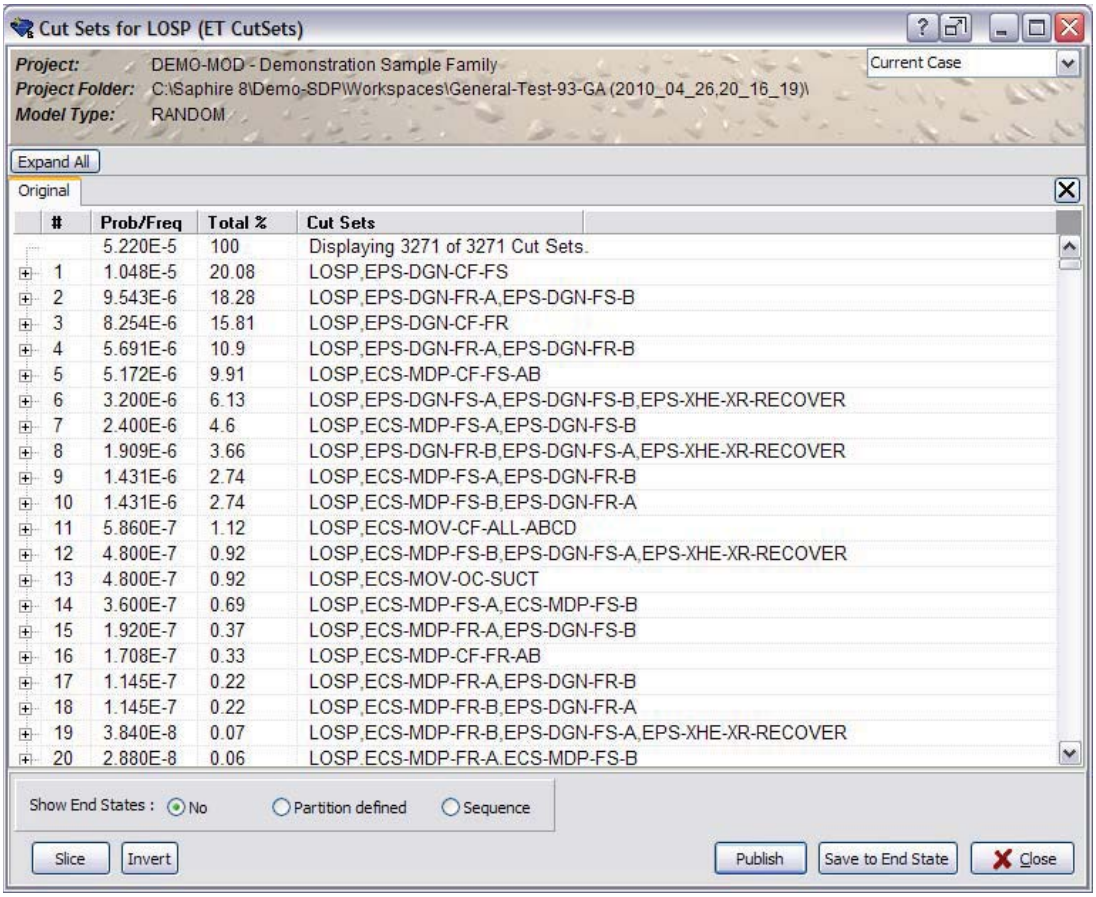
Verified (to this point)? Yes.

21. Exit the Workspace. Now, double click on the saved ECA workspace (Test-93-ECA). Verify that the results have not changed.



Verified (to this point)? Yes.

22. Exit the Workspace. Now, double click on the saved GA workspace (Test-93-ECA). Verify that the results have not changed.



Verified (overall)? Yes.

8.0 Test-94

SAPHIRE 8 Testing

Manual Testing to Augment the Automated Test Suite

April 26, 2010
Tester: Curtis Smith
Version: 8.06.06

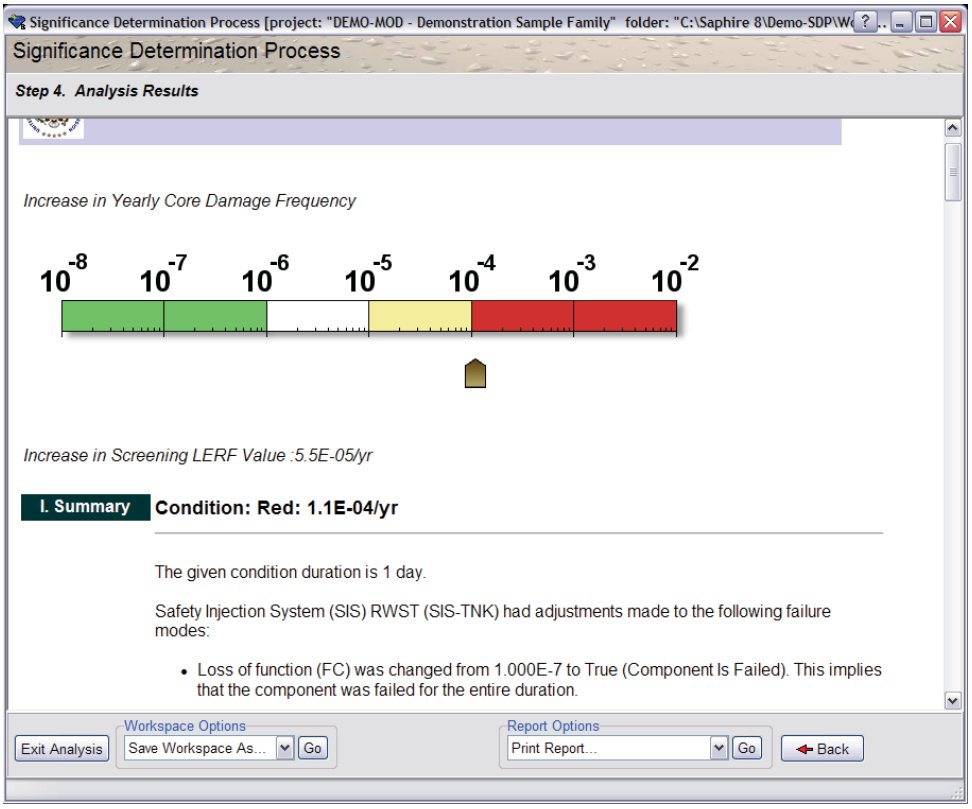
Test 94	**Project to Project Independence**	**This test verifies that opening up a project does not include anything from a previously opened project database. Examine database to ensure previous database (different from the one just opened) information is not present. Reports should be initially reviewed by a software developer and then compared with future test runs.**

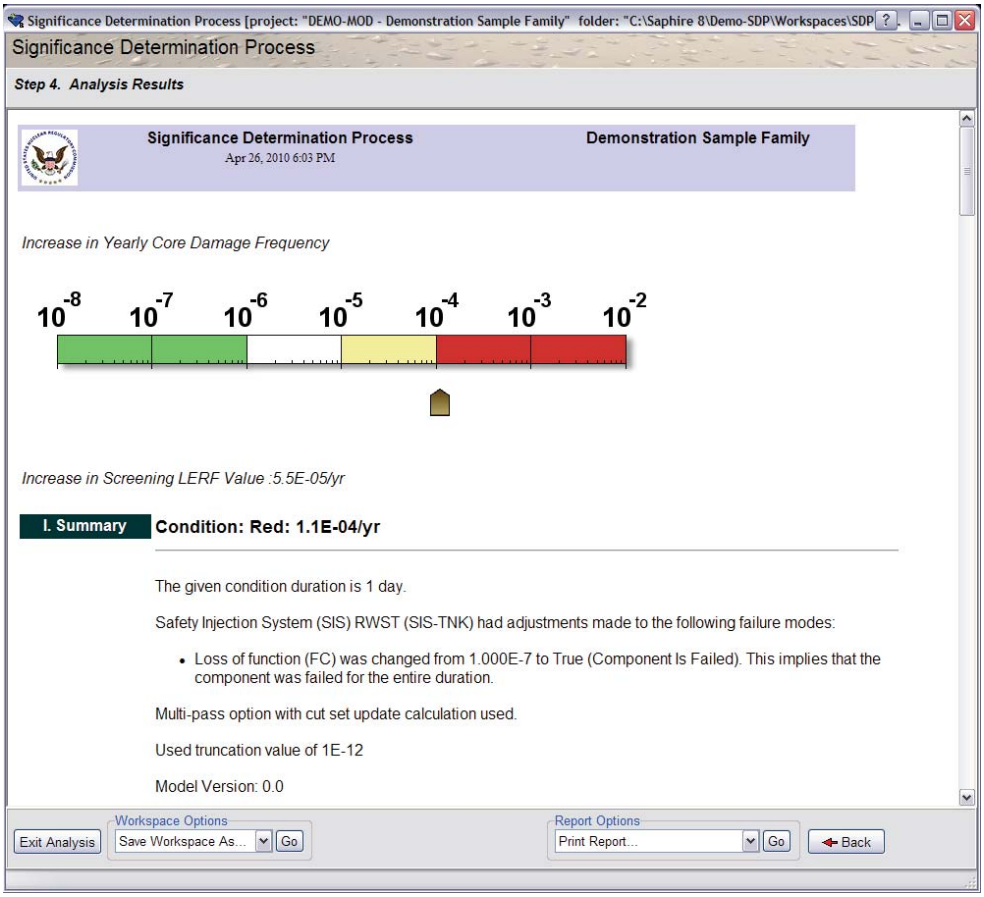
This project will be conducted by sequentially rerunning the following manual tests (and verifying the results do not change as sequential projects are opened, note that SAPHIRE will not be closed from test-to-test) in order:
Test 77
Test 102

Test 98
Test 104

Steps:

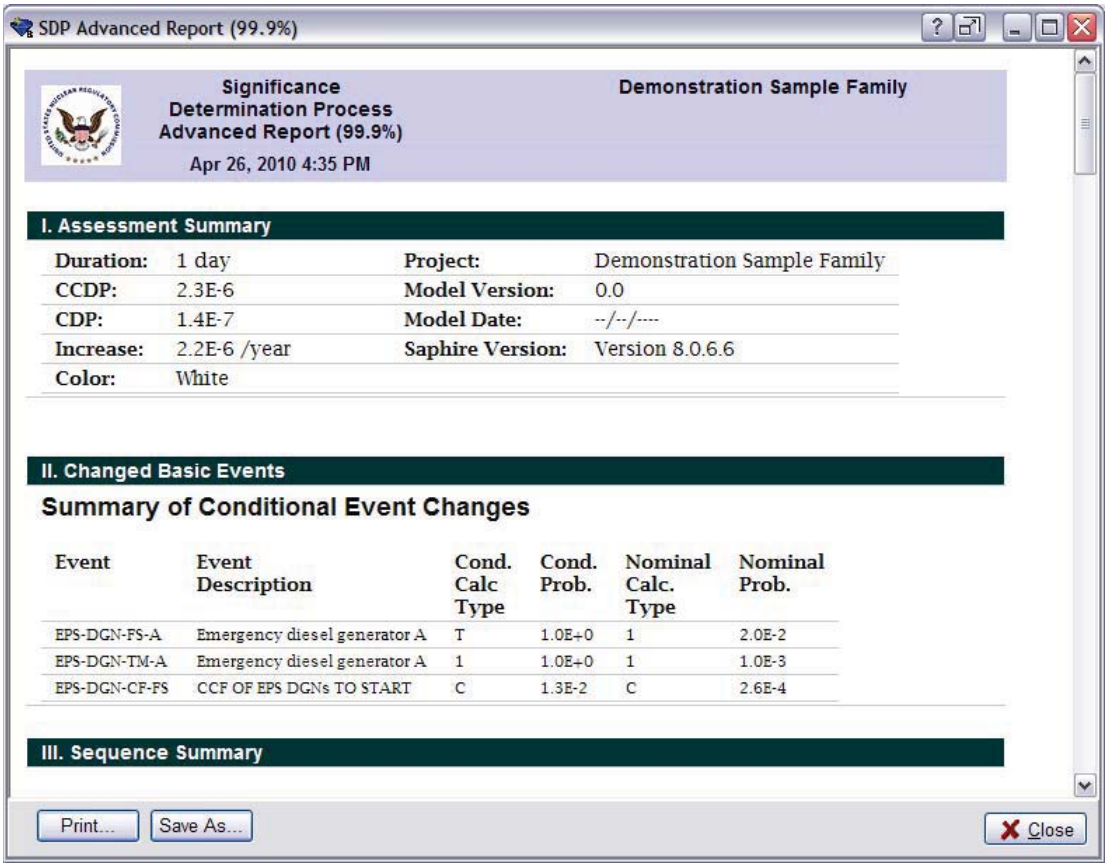
1. Start SAPHIRE and rerun Test 77 (using the DEMO-SDP project).
2. Verify the results (below) from Test 77.

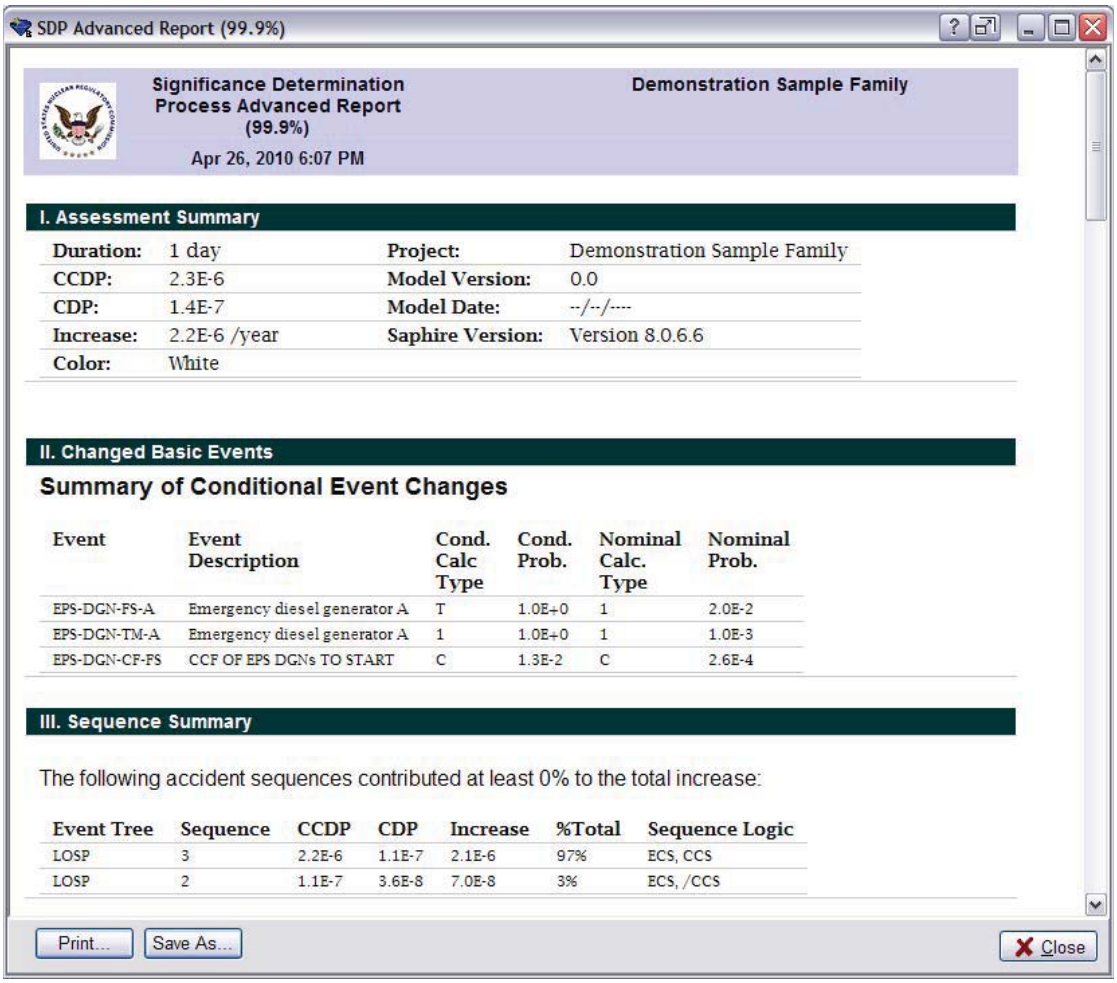




Verified (to this point)? Yes.

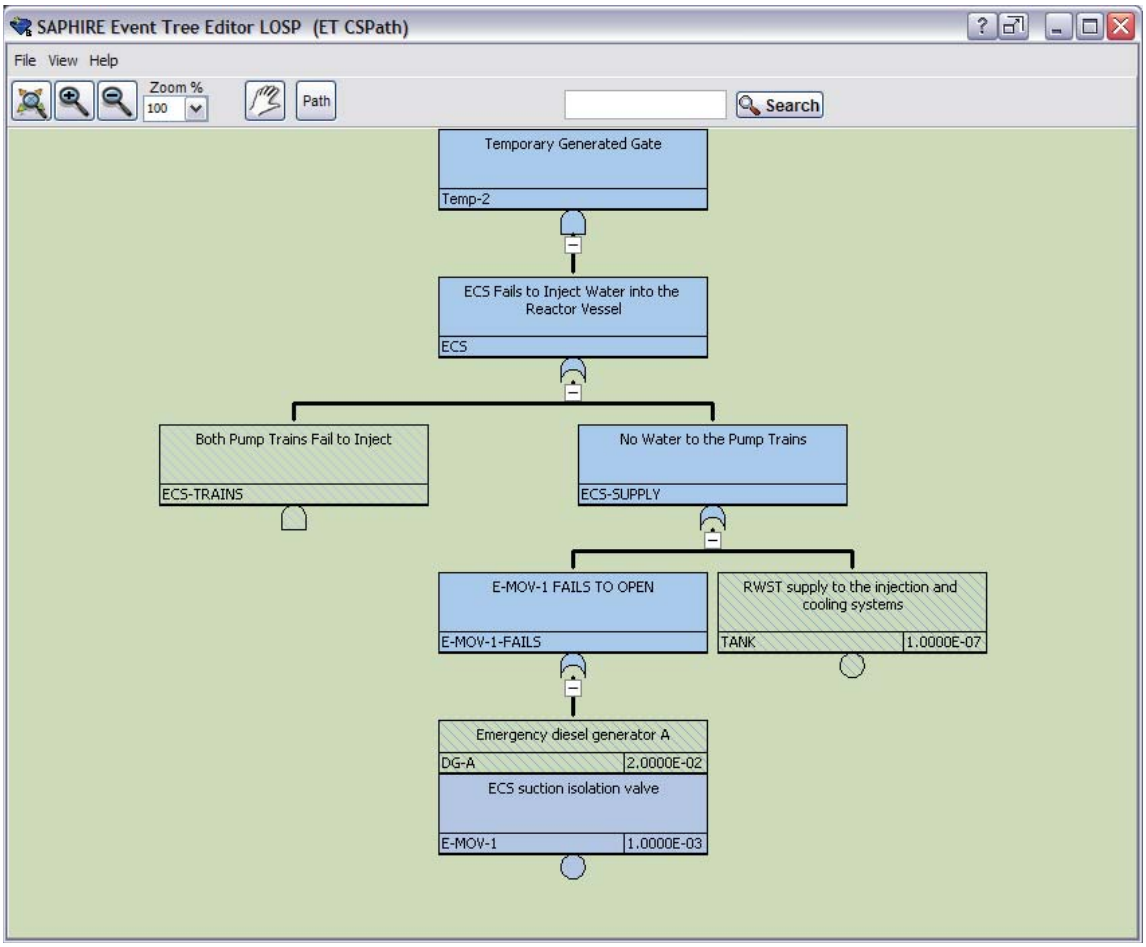
3. Without closing SAPHIRE, run Test 102 (using the DEMO-SDP project.
4. Verify the results (below) from Test 102.

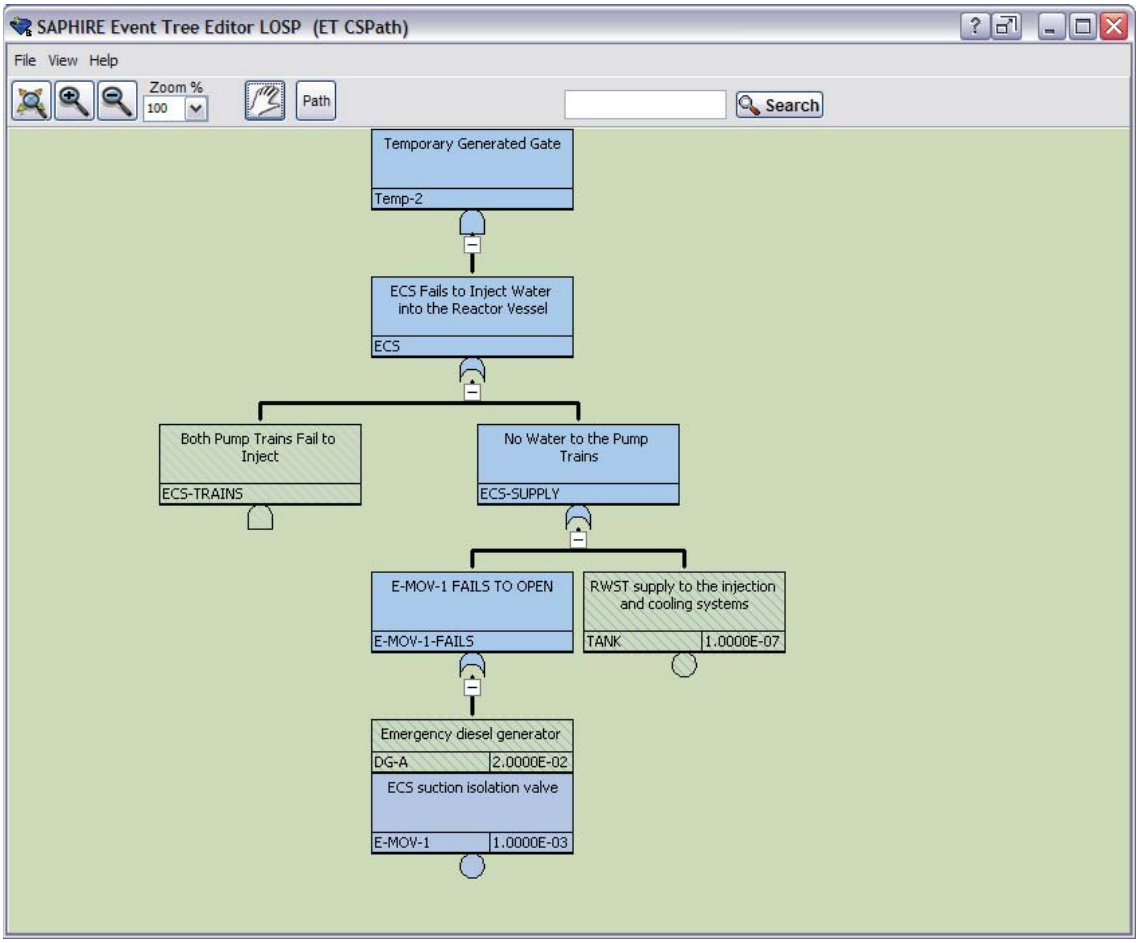

SDP Advanced Report (99.9%)
Significance Determination Process Advanced Report (99.9%)
Apr 26, 2010 4:35 PM
Demonstration Sample Family
I. Assessment Summary
Duration: 1 day
CCDP: 2.3E-6
CDP: 1.4E-7
Increase: 2.2E-6 /year
Color: White
Project: Demonstration Sample Family
Model Version: 0.0
Model Date: --/--/----
Saphire Version: Version 8.0.6.6
II. Changed Basic Events
Summary of Conditional Event Changes
Event | Event Description | Cond. Calc Type | Cond. Prob. | Nominal Calc. Type | Nominal Prob.
EPS-DGN-FS-A | Emergency diesel generator A | T | 1.0E+0 | 1 | 2.0E-2
EPS-DGN-TM-A | Emergency diesel generator A | 1 | 1.0E+0 | 1 | 1.0E-3
EPS-DGN-CF-FS | CCF OF EPS DGNs TO START | C | 1.3E-2 | C | 2.6E-4
III. Sequence Summary
Print...
Save As...
Close


SDP Advanced Report (99.9%)
Significance Determination Process Advanced Report (99.9%)
Apr 26, 2010 6:07 PM
Demonstration Sample Family
I. Assessment Summary
Duration: 1 day
CCDP: 2.3E-6
CDP: 1.4E-7
Increase: 2.2E-6 /year
Color: White
Project: Demonstration Sample Family
Model Version: 0.0
Model Date: --/--/----
Saphire Version: Version 8.0.6.6
II. Changed Basic Events
Summary of Conditional Event Changes
Event | Event Description | Cond. Calc Type | Cond. Prob. | Nominal Calc. Type | Nominal Prob.
EPS-DGN-FS-A | Emergency diesel generator A | T | 1.0E+0 | 1 | 2.0E-2
EPS-DGN-TM-A | Emergency diesel generator A | 1 | 1.0E+0 | 1 | 1.0E-3
EPS-DGN-CF-FS | CCF OF EPS DGNs TO START | C | 1.3E-2 | C | 2.6E-4
III. Sequence Summary
The following accident sequences contributed at least 0% to the total increase:
Event Tree | Sequence | CCDP | CDP | Increase | %Total | Sequence Logic
LOSP | 3 | 2.2E-6 | 1.1E-7 | 2.1E-6 | 97% | ECS, CCS
LOSP | 2 | 1.1E-7 | 3.6E-8 | 7.0E-8 | 3% | ECS, /CCS
Print...
Save As...
Close

Verified (to this point)? Yes.

5. Without closing SAPHIRE, run Test 98 (using the DEMO project).
6. Verify the LOSP results (below) from Test 102.





Verified (to this point)? Yes.

7. Without closing SAPHIRE, run Test 104 (using the DEMO project).
8. Verify the Uncertainty (below) from Test 104.

CCDP

5%	Median	Point Estimate	Mean	95%	Seed	Sample Size	Method
4.935E-8	9.257E-7	5.726E-6	5.770E-6	2.109E-5	4321	5000	Monte Carlo

CDP

5%	Median	Point Estimate	Mean	95%	Seed	Sample Size	Method
4.935E-8	9.256E-7	5.726E-6	5.769E-6	2.109E-5	4321	5000	Monte Carlo

Importance

5%	Median	Point Estimate	Mean	95%	Seed	Sample Size	Method

3.922E-12	6.730E-11	2.360E-10	2.322E-10	8.804E-10	4321	5000	Monte Carlo

(from new Test 94)

CCDP

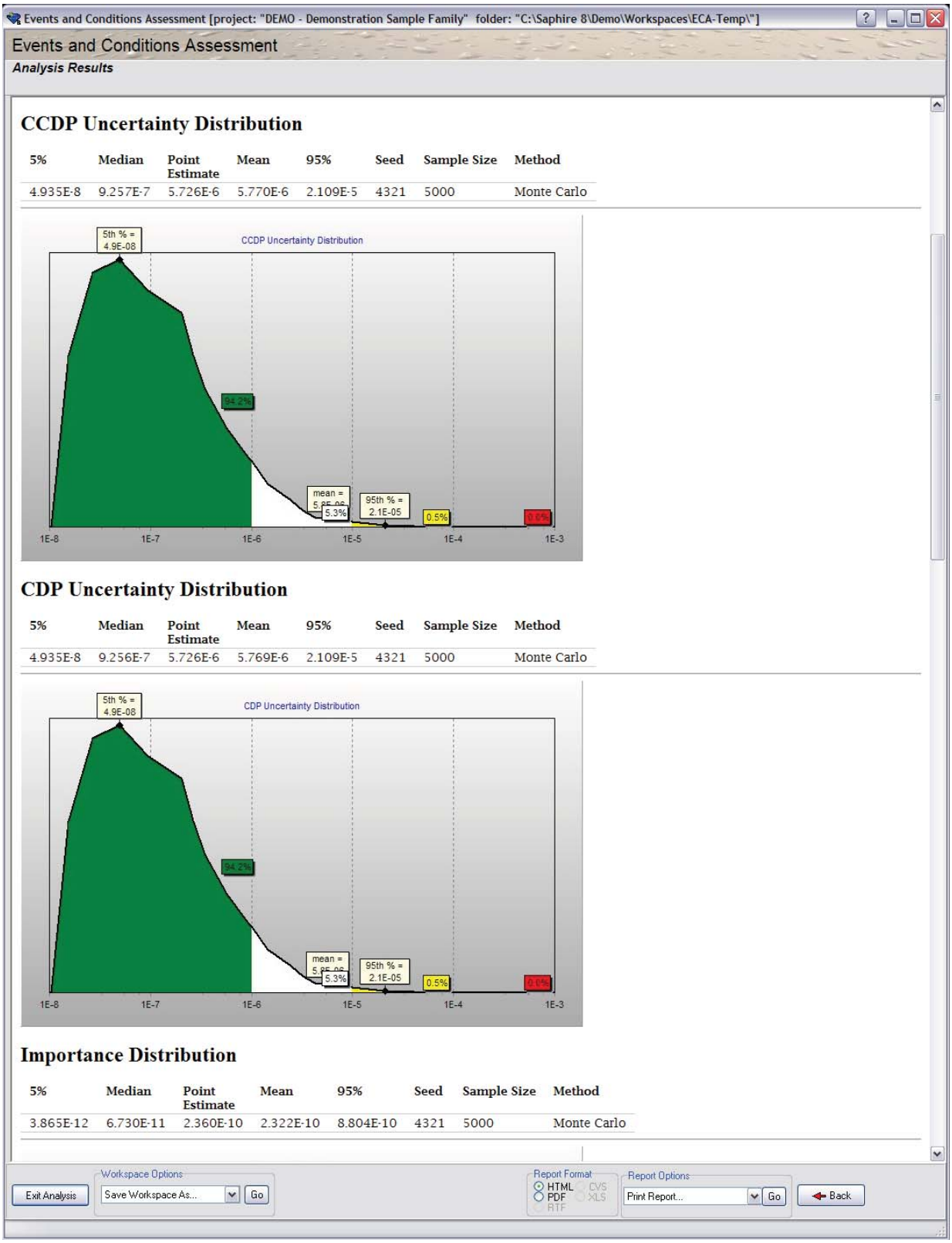
5%	Median	Point Estimate	Mean	95%	Seed	Sample Size	Method
4.935E-8	9.257E-7	5.726E-6	5.770E-6	2.109E-5	4321	5000	Monte Carlo

CDP

5%	Median	Point Estimate	Mean	95%	Seed	Sample Size	Method
4.935E-8	9.256E-7	5.726E-6	5.769E-6	2.109E-5	4321	5000	Monte Carlo

Importance

5%	Median	Point Estimate	Mean	95%	Seed	Sample Size	Method
3.865E-12	6.730E-11	2.360E-10	2.322E-10	8.804E-10	4321	5000	Monte Carlo



Verified (overall)? Yes.

9.0 Test-97

NAME OF APPLICATION UNDER TEST: SAPHIRE 8.0

TEST CASE PURPOSE: Test 97 - Event Tree Linking and Unlink in integrated models (External Events and Shutdown)

REQUIREMENT(S) VERIFIED:

TEST 01 Link 5 different event trees and verify cut sets exist.

TEST 02 Un-Link the 5 trees and verify no cut sets exist.

TEST CASE ABSTRACT OF TECHNIQUES USED TO TEST THE FEATURE:

None

OTHER FILES REQUIRED TO RUN TEST CASE:

TEST PERFORMED BY : Steve Prescott
TEST DATE : 3/31/10

10.0 Test-98

SAPHIRE 8 Testing

Manual Testing to Augment the Automated Test Suite

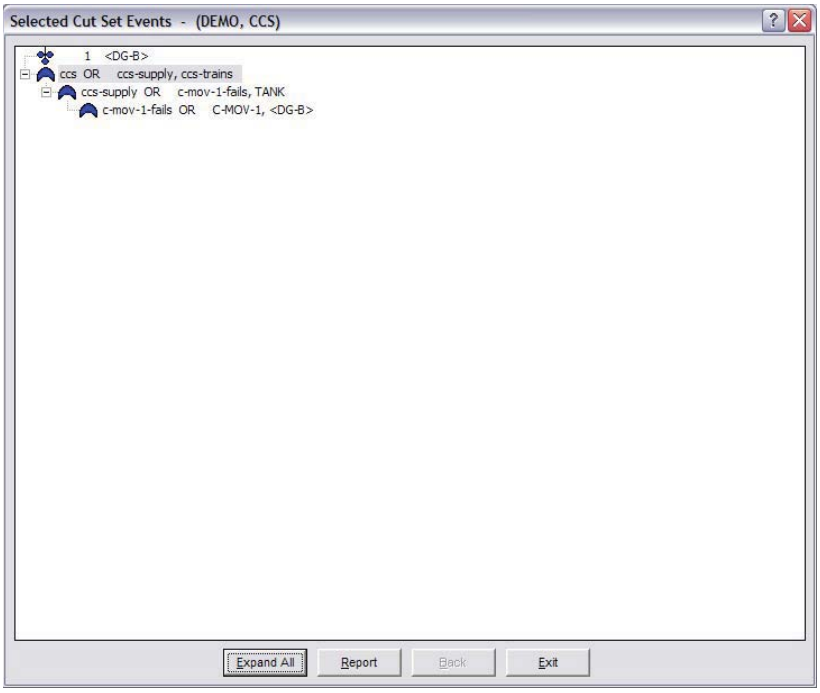
April 26, 2010
Tester: Curtis Smith
Version: 8.06.06

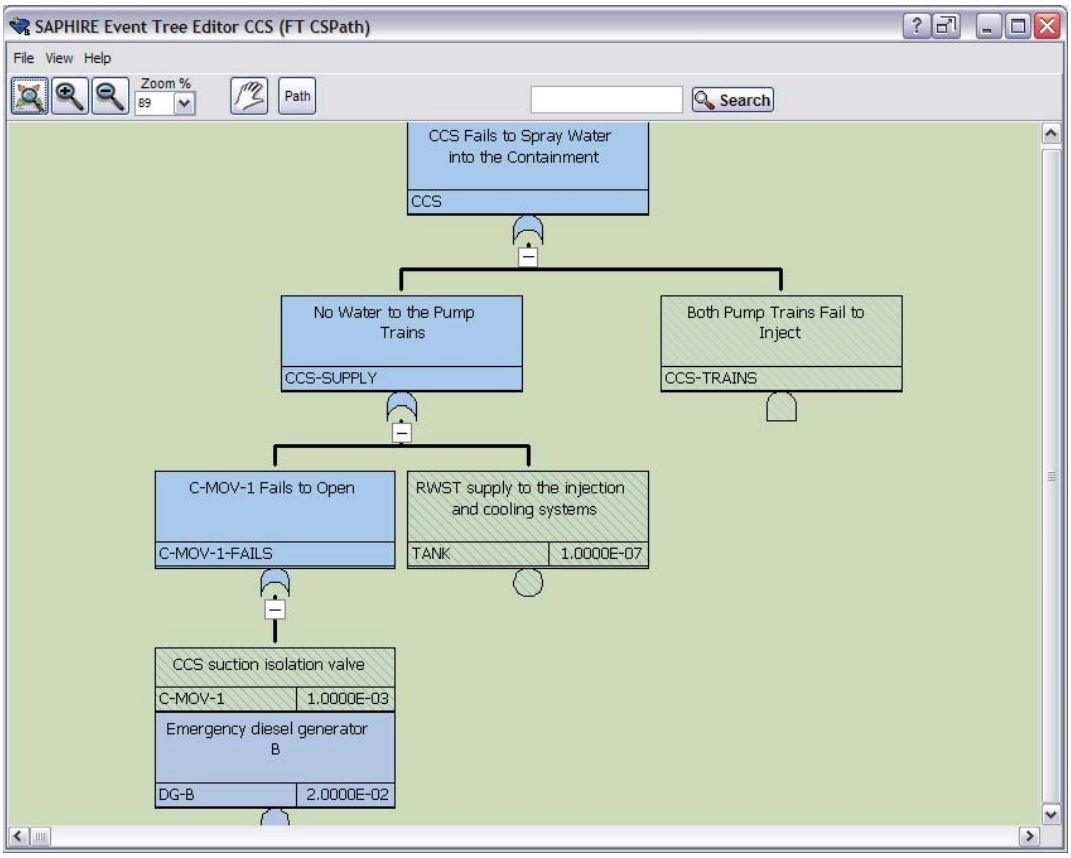
Test 98	**Verification of cut set view path**	**This test verifies all cut set path features work. The initial test will be visually verified with reports produced. Subsequent tests will compare reports to verified reports. Especially test this capability in the advanced Significance Determination Process report per cut set. Results will be reviewed by a SPAR model developer at the INL.**

Steps:

1. Start SAPHIRE and open the DEMO project.
2. Highlight the CCS fault tree.
3. Right click and select “View Cut Sets.

4. Select the dominant cut set (DG-B), right click and select “View Path.
5. Verify against the SAPHIRE 7 view path option.

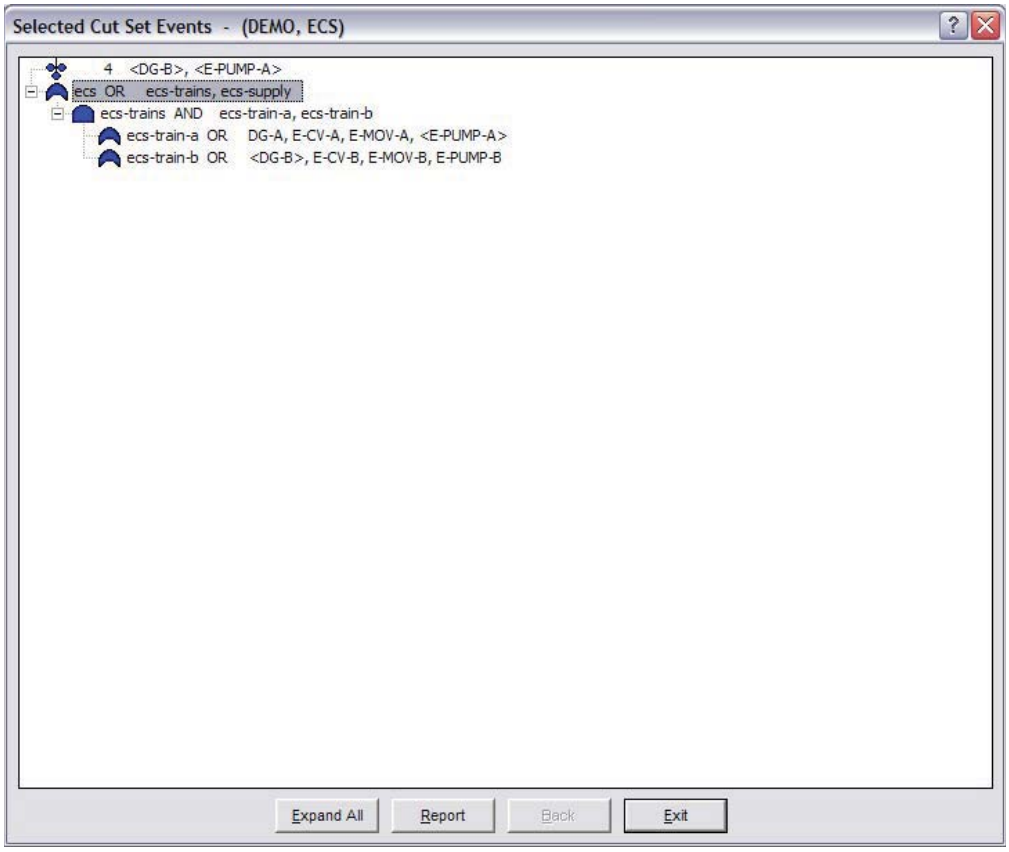


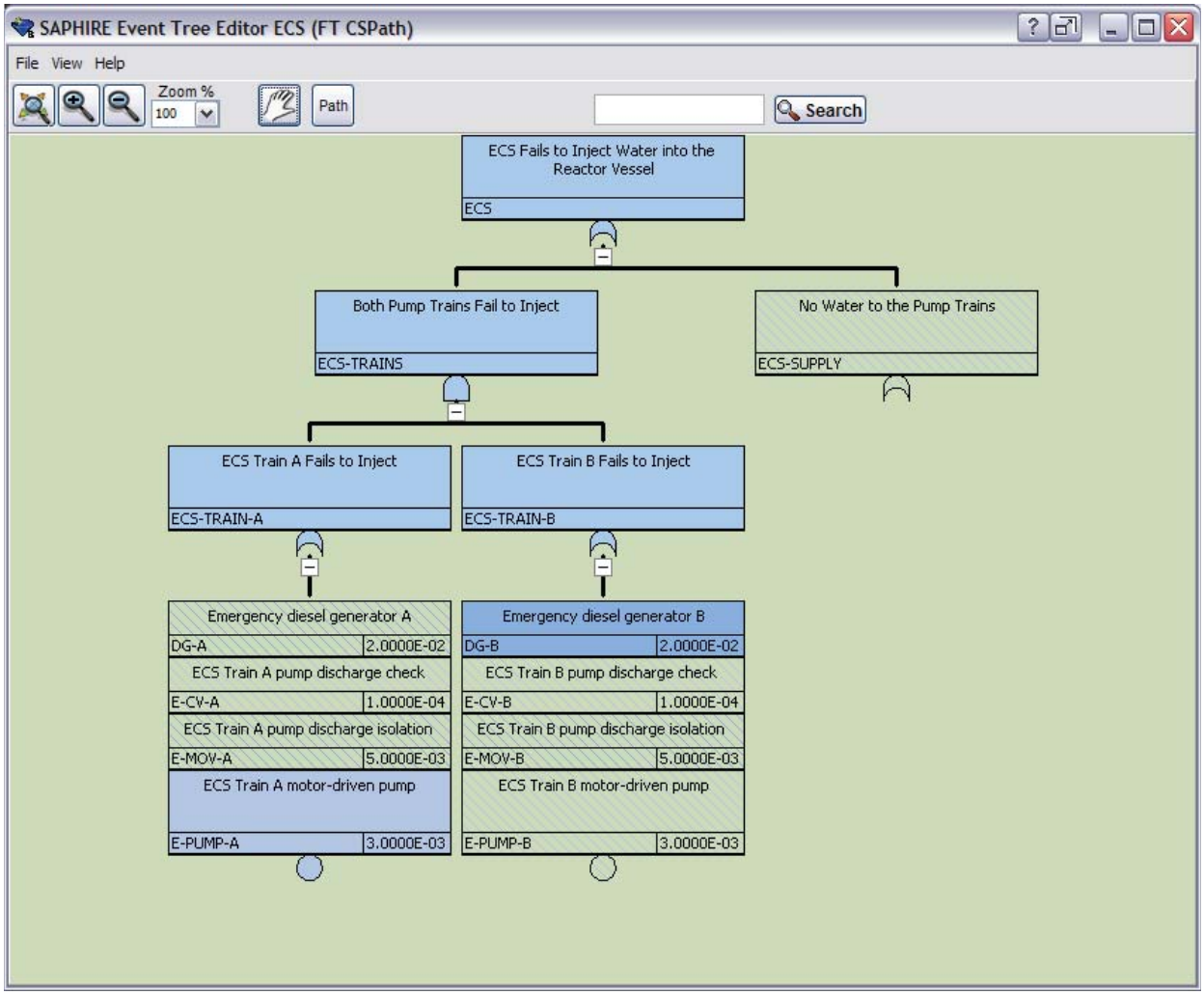


Verified? Yes.

6. Close the path viewer and select the ECS fault tree.
7. Right click and select “View Cut Sets.

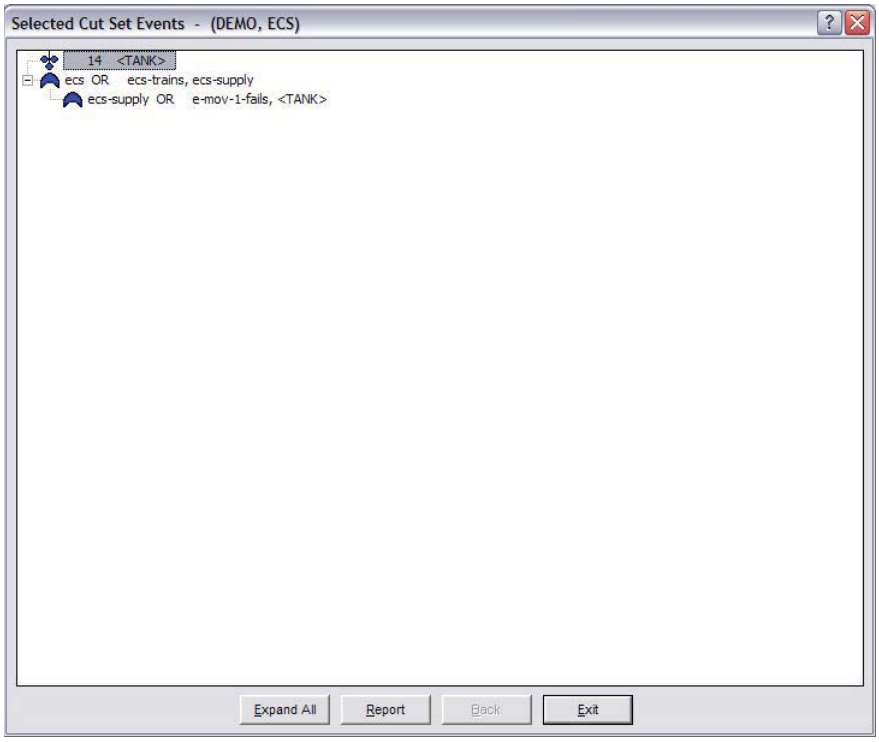
8. Select the #4 cut set (DG-B * E-PUMP-A), right click and select “View Path.
9. Verify against the SAPHIRE 7 view path option.

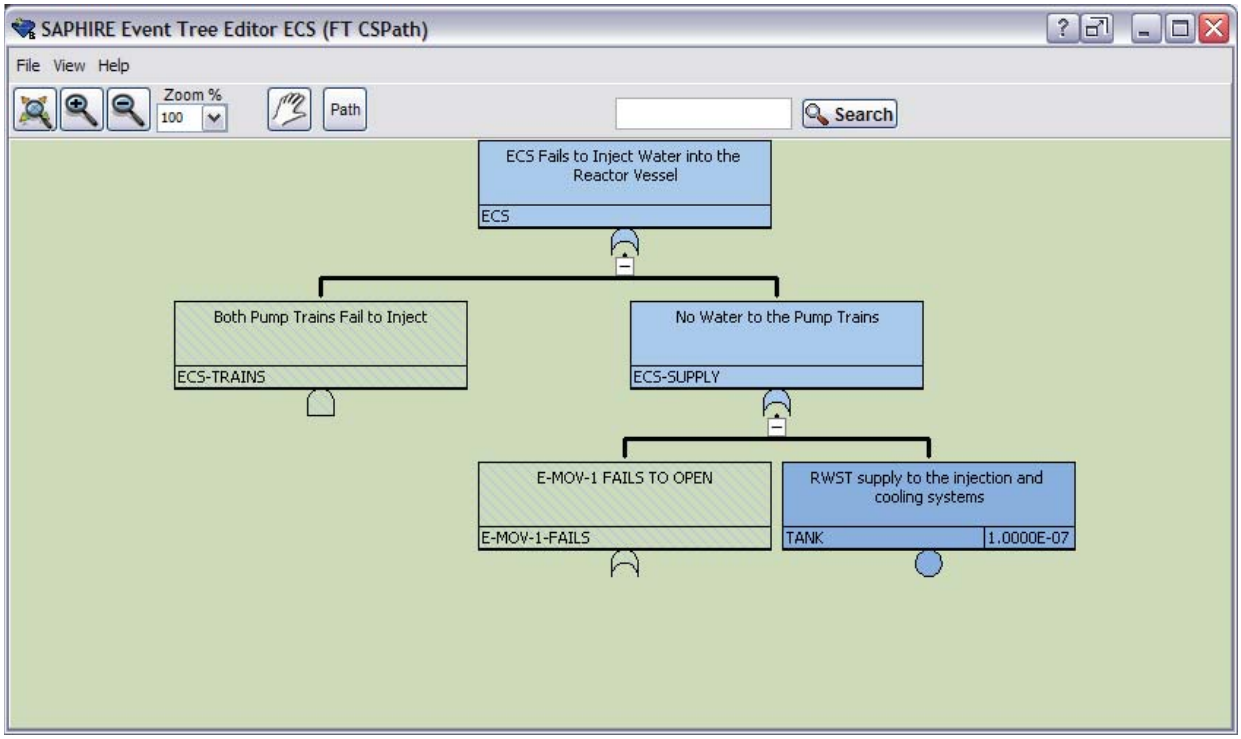




Verified? Yes.

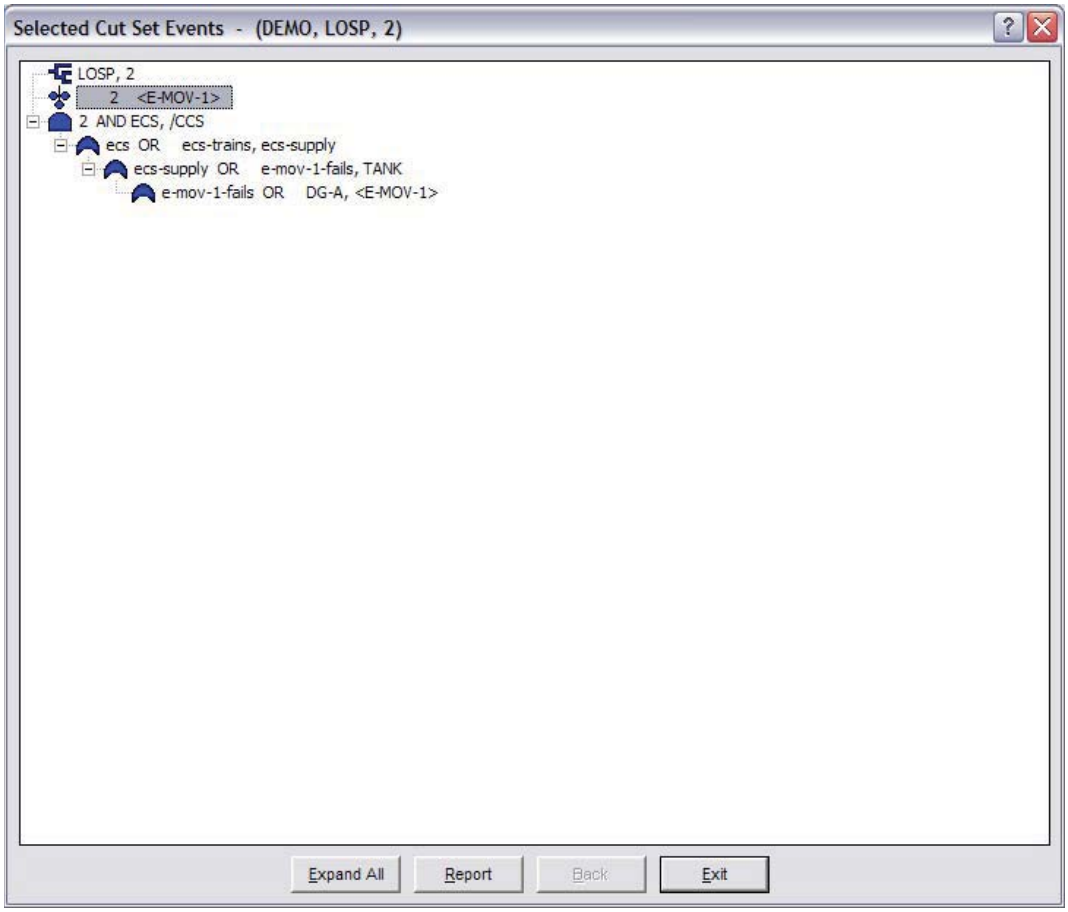
10. Close the path viewer and select the TANK cut set (cut set #14 from ECS).
11. Right click and select the “View Path” option.
12. Verify against the SAPHIRE 7 view path option.

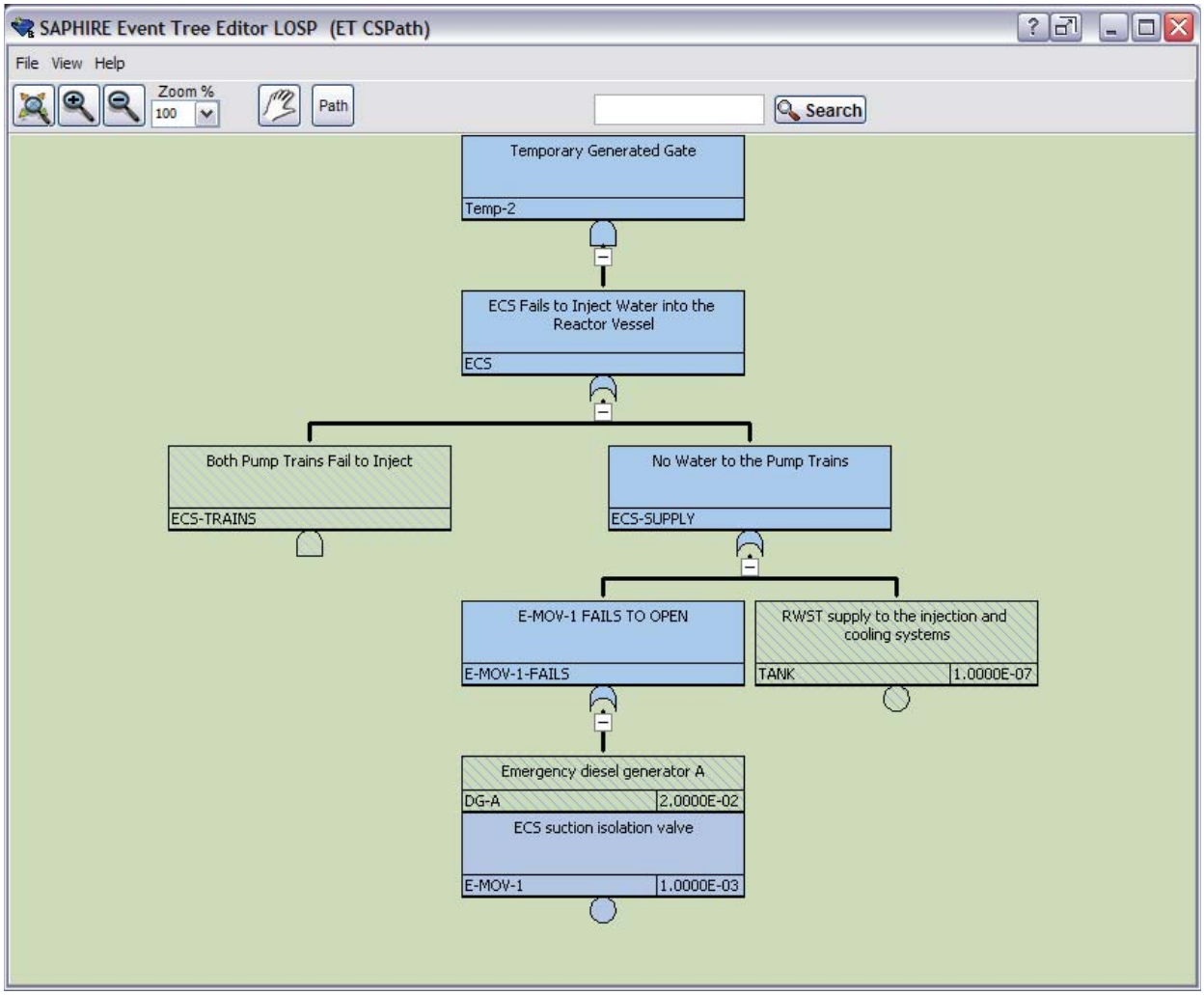




Verified? Yes.

13. Close the path viewer and select the LOSP event tree.
14. Right click and select “View Cut Sets.
15. Select the #2 cut set (LOSP and E-MOV-1), right click and select “View Path.
16. Verify against the SAPHIRE 7 view path option.


Selected Cut Set Events - (DEMO, LOSP, 2)
LOSP, 2
2 <E-MOV-1>
2 AND ECS, /CCS
ecs OR ecs-trains, ecs-supply
ecs-supply OR e-mov-1-fails, TANK
e-mov-1-fails OR DG-A, <E-MOV-1>
Expand All
Report
Back
Exit



Verified? Yes.

11.0 Test-102

SAPHIRE 8 Testing

Manual Testing to Augment the Automated Test Suite

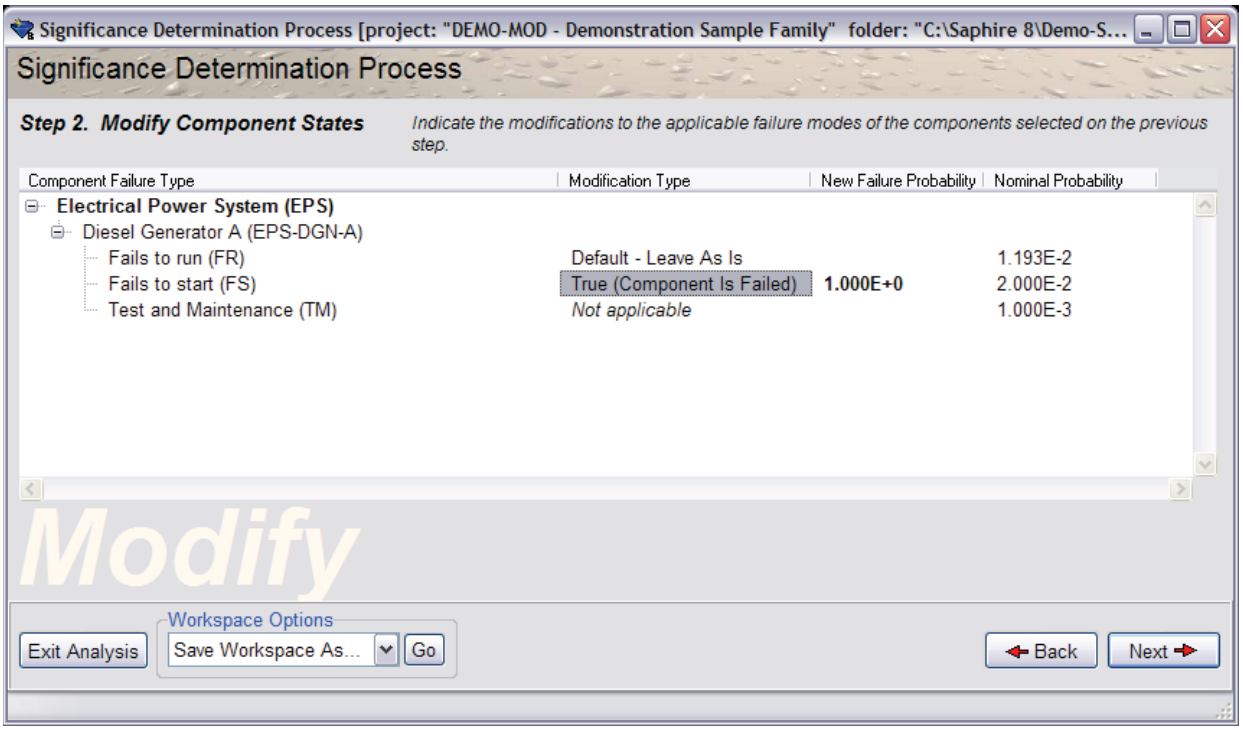
April 26, 2010
Tester: Curtis Smith
Version: 8.06.06

Test 102	**Significance Determination Process Interface testing of basic event changes**	**This test exercises Significance Determination Process basic event testing. Ensure that choosing True" performs a CCF probability calculation correctly and choosing "True" automatically handles T&M basic events correctly. Results will be reviewed by a SPAR model developer at the INL."**

Steps:

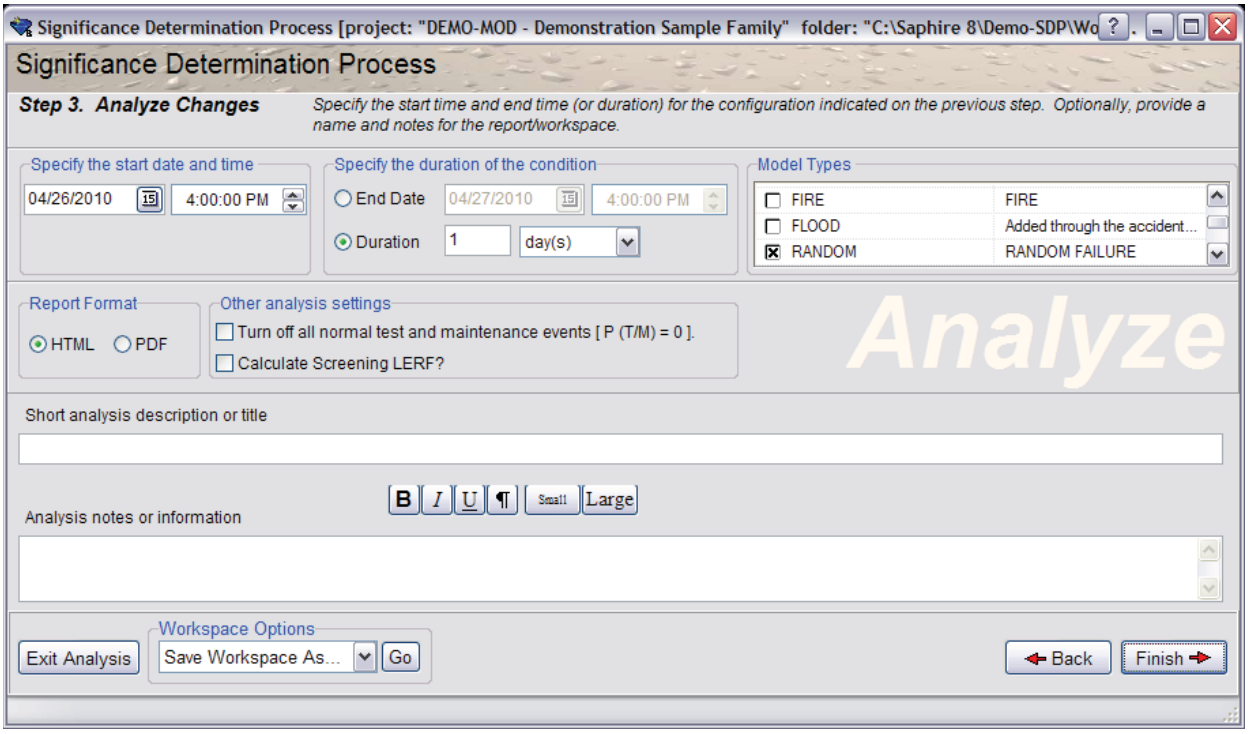
1. Start SAPHIRE and open the DEMO-SDP project.

2. Add a EPS-DGN-TM-A basic event with probability of 0.001. Modify EPS-DGN-TM-A categories to System=EPS, Component Type=DGN, Failure Mode = TM, Component ID = EPS-DGN-A
3. Double click on “New SDP…” option.
4. Click the EPS systems button. Check the Diesel Generator A component.
5. Click Next.
6. Change the Fails to Start failure mode to TRUE.
7. Verify that the TM failure mode changes to “not applicable.”

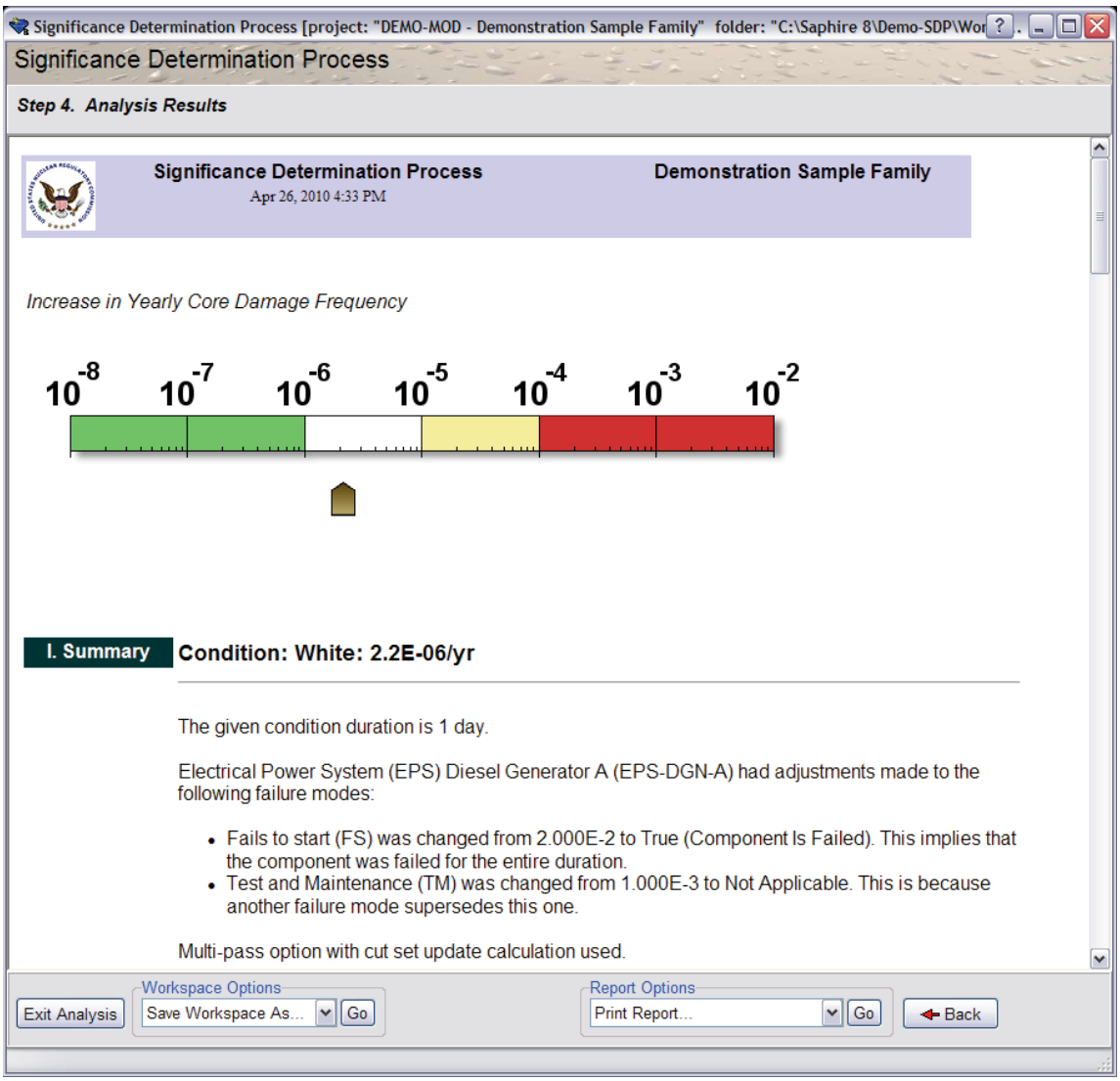


Verified? Yes.

8. Click Next.
9. Select a 1 day duration, leave the other options at their default values.

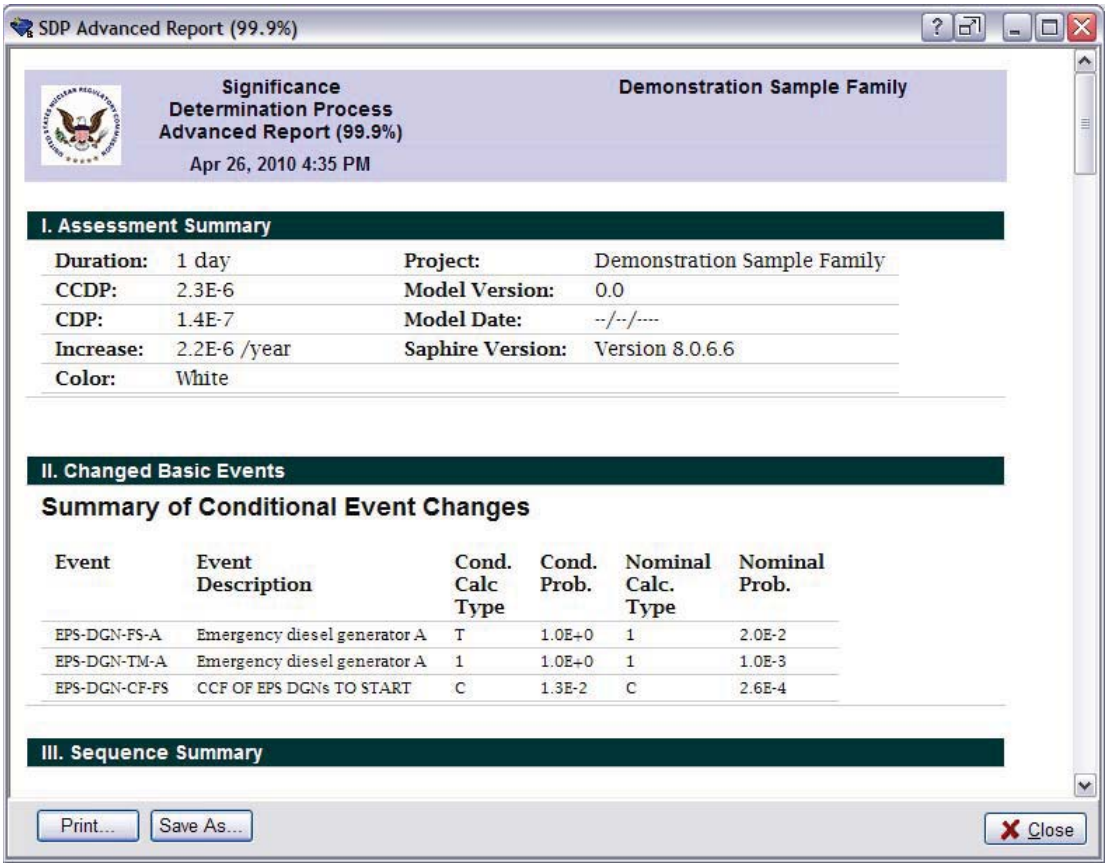


10. Click Finish. Click Ok.
11. Verify that the report indicates the Fails to Start (FS) failure mode set to TRUE and the Test and Maintenance (TM) set to not applicable.



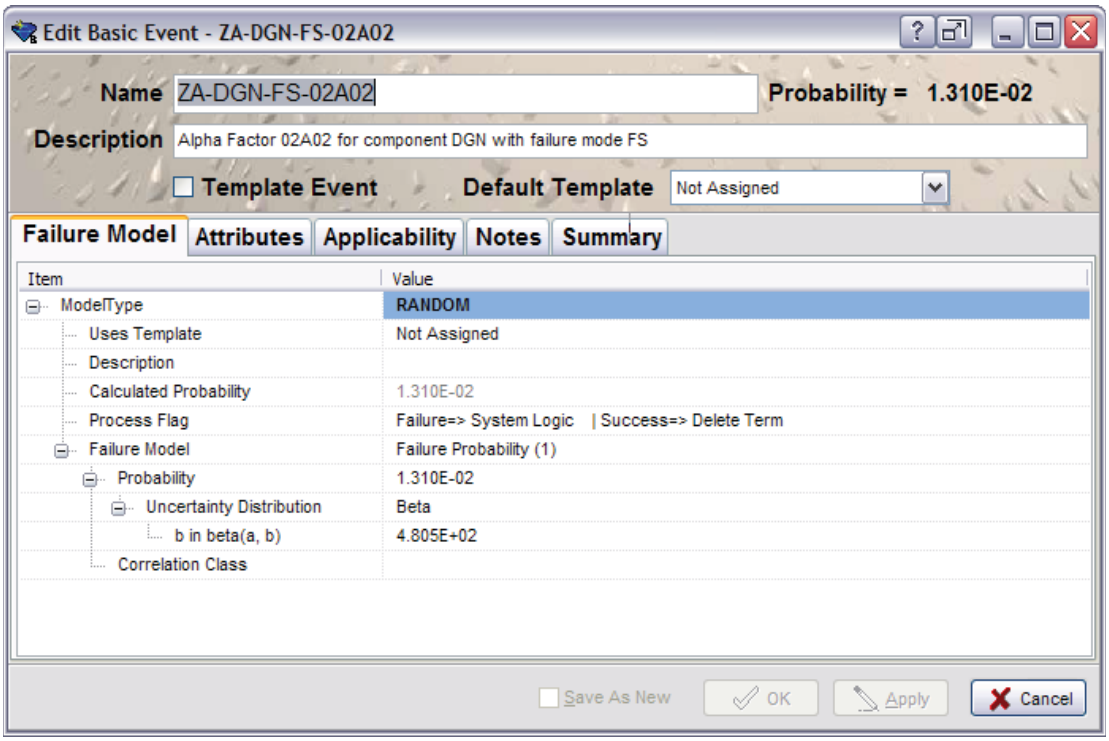
Verified? Yes.

12. Under "Report Options" select "Advanced Report (99.9% of total). Click Go.
13. Verify that both the EPS-DGN-TM-A and EPS-DGN-CF-FS basic events are modified to reflect the fails to start that was seen for EPS DGN train A.



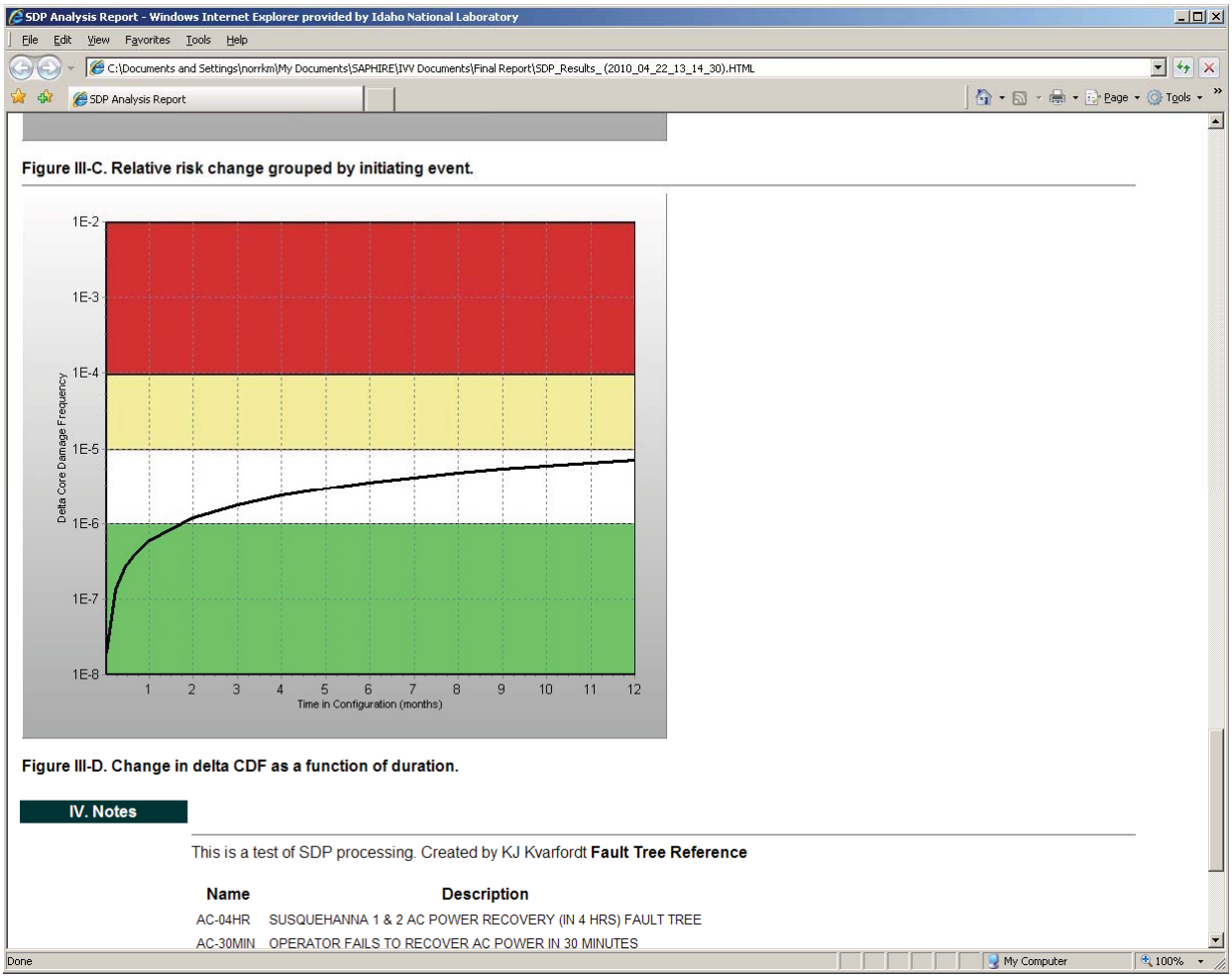
The EPS-DGN-TM-A basic event should be set to a probability of 1.0.

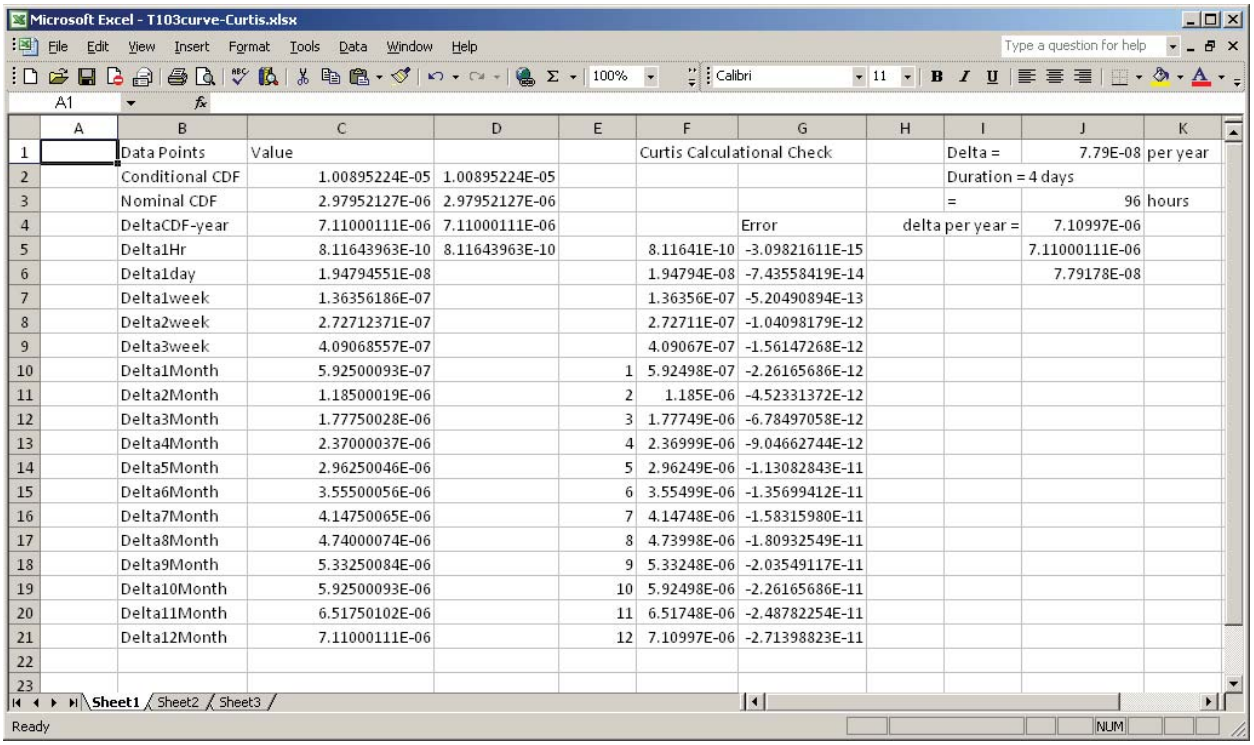
The EPS-DGN-CF-FS basic event should be set to 1.31E-2 (from a nominal of 2.62E-4) which is effectively α_2. See the screen below for the α_2 basic event.



Verified? Yes.

12.0 Test-103





Microsoft Excel - T103curve-Curtis.xlsx

File Edit View Insert Format Tools Data Window Help

	A	B	C	D	E	F	G	H	I	J	K
1		Data Points	Value			Curtis Calculational Check			Delta =	7.79E-08	per year
2		Conditional CDF	1.00895224E-05	1.00895224E-05					Duration = 4 days		
3		Nominal CDF	2.97952127E-06	2.97952127E-06					=	96	hours
4		DeltaCDF-year	7.11000111E-06	7.11000111E-06			Error		delta per year =	7.10997E-06	
5		Delta1Hr	8.11643963E-10	8.11643963E-10		8.11641E-10	-3.09821611E-15			7.11000111E-06	
6		Delta1day	1.94794551E-08			1.94794E-08	-7.43558419E-14			7.79178E-08	
7		Delta1week	1.36356186E-07			1.36356E-07	-5.20490894E-13				
8		Delta2week	2.72712371E-07			2.72711E-07	-1.04098179E-12				
9		Delta3week	4.09068557E-07			4.09067E-07	-1.56147268E-12				
10		Delta1Month	5.92500093E-07		1	5.92498E-07	-2.26165686E-12				
11		Delta2Month	1.18500019E-06		2	1.185E-06	-4.52331372E-12				
12		Delta3Month	1.77750028E-06		3	1.77749E-06	-6.78497058E-12				
13		Delta4Month	2.37000037E-06		4	2.36999E-06	-9.04662744E-12				
14		Delta5Month	2.96250046E-06		5	2.96249E-06	-1.13082843E-11				
15		Delta6Month	3.55500056E-06		6	3.55499E-06	-1.35699412E-11				
16		Delta7Month	4.14750065E-06		7	4.14748E-06	-1.58315980E-11				
17		Delta8Month	4.74000074E-06		8	4.73998E-06	-1.80932549E-11				
18		Delta9Month	5.33250084E-06		9	5.33248E-06	-2.03549117E-11				
19		Delta10Month	5.92500093E-06		10	5.92498E-06	-2.26165686E-11				
20		Delta11Month	6.51750102E-06		11	6.51748E-06	-2.48782254E-11				
21		Delta12Month	7.11000111E-06		12	7.10997E-06	-2.71398823E-11				
22											
23											

Sheet1 Sheet2 Sheet3

Ready

13.0 Test-104

SAPHIRE 8 Testing

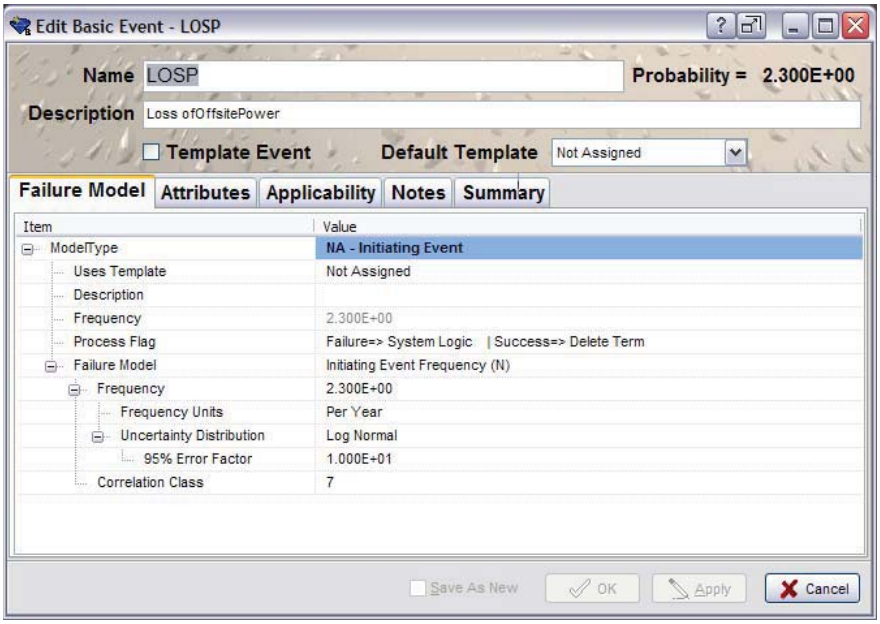
Manual Testing to Augment the Automated Test Suite

April 26, 2010
Tester: Curtis Smith
Version: 8.06.06

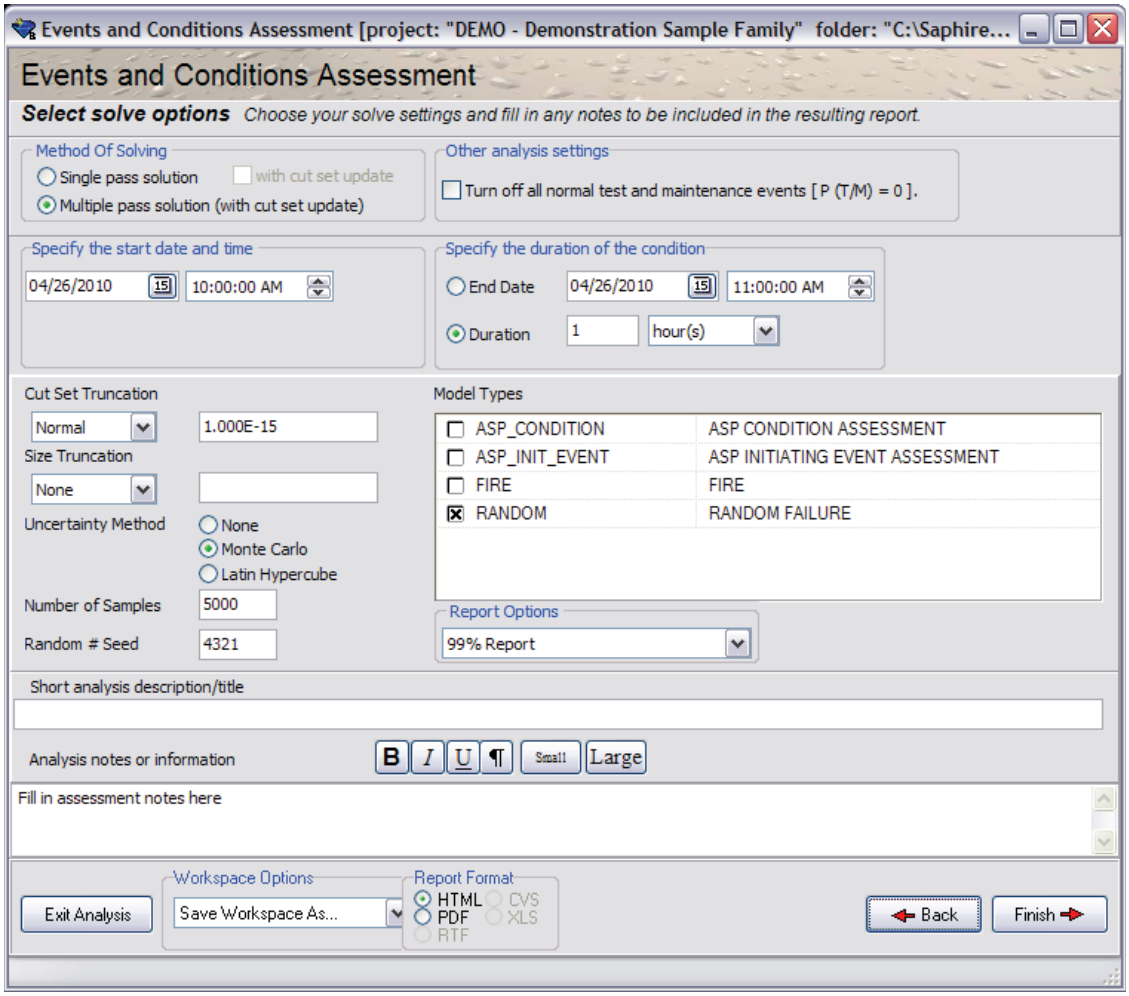
Test 104	**Event and Condition Analysis uncertainty calculations**	**This test exercises Event and Condition Analysis workspace uncertainty calculations and corresponding graph of the Importance = CCDP - CDP. Results will be compared with results reviewed from a version 7 analysis done by a SPAR model developer at the INL.**

Steps:

1. Start SAPHIRE and open the DEMO project.
2. Select the Project → Modify option.
3. Select the SPAR tab, then click the "SPAR Model? check box. Click Ok.
4. Verify that the LOSP frequency is 2.3 per year (and default project units are per year).

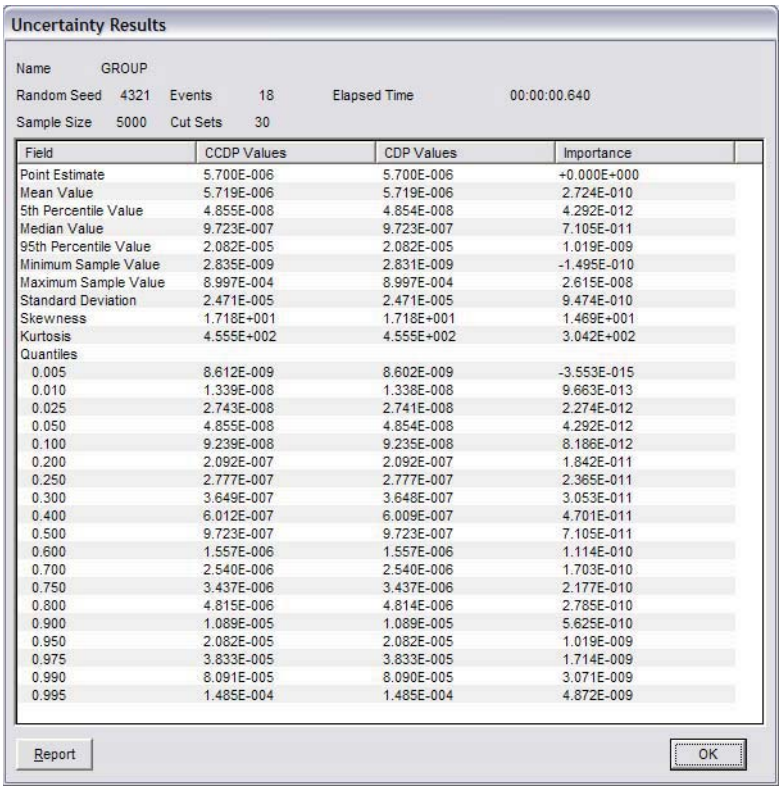


5. Double click the “New ECA…” option.
6. Select the Condition Option, Duration of 1 hour.
7. Check the TANK basic event. Click Next.
8. Click the Edit button. Modify to the probability to 1.000E-6. Click Ok.
9. Click the Next button. Change the “Random # Seed” to 4321. Leave the other options at their default values.



10. Click Finish. Click Ok.
11. Verify the results against the equivalent SAPHIRE 7 results

SAPHIRE 7



Field	CCDP Values	CDP Values	Importance
Point Estimate	5.700E-006	5.700E-006	+0.000E+000
Mean Value	5.719E-006	5.719E-006	2.724E-010
5th Percentile Value	4.855E-008	4.854E-008	4.292E-012
Median Value	9.723E-007	9.723E-007	7.105E-011
95th Percentile Value	2.082E-005	2.082E-005	1.019E-009
Minimum Sample Value	2.835E-009	2.831E-009	-1.495E-010
Maximum Sample Value	8.997E-004	8.997E-004	2.615E-008
Standard Deviation	2.471E-005	2.471E-005	9.474E-010
Skewness	1.718E+001	1.718E+001	1.469E+001
Kurtosis	4.555E+002	4.555E+002	3.042E+002
Quantiles			
0.005	8.612E-009	8.602E-009	-3.553E-015
0.010	1.339E-008	1.338E-008	9.663E-013
0.025	2.743E-008	2.741E-008	2.274E-012
0.050	4.855E-008	4.854E-008	4.292E-012
0.100	9.239E-008	9.235E-008	8.186E-012
0.200	2.092E-007	2.092E-007	1.842E-011
0.250	2.777E-007	2.777E-007	2.365E-011
0.300	3.649E-007	3.648E-007	3.053E-011
0.400	6.012E-007	6.009E-007	4.701E-011
0.500	9.723E-007	9.723E-007	7.105E-011
0.600	1.557E-006	1.557E-006	1.114E-010
0.700	2.540E-006	2.540E-006	1.703E-010
0.750	3.437E-006	3.437E-006	2.177E-010
0.800	4.815E-006	4.814E-006	2.785E-010
0.900	1.089E-005	1.089E-005	5.625E-010
0.950	2.082E-005	2.082E-005	1.019E-009
0.975	3.833E-005	3.833E-005	1.714E-009
0.990	8.091E-005	8.090E-005	3.071E-009
0.995	1.485E-004	1.485E-004	4.872E-009

SAPHIRE 8

CCDP

5%	Median	Point Estimate	Mean	95%	Seed	Sample Size	Method
4.935E-8	9.257E-7	5.726E-6	5.770E-6	2.109E-5	4321	5000	Monte Carlo

CDP

5%	Median	Point Estimate	Mean	95%	Seed	Sample Size	Method
4.935E-8	9.256E-7	5.726E-6	5.769E-6	2.109E-5	4321	5000	Monte Carlo

Importance

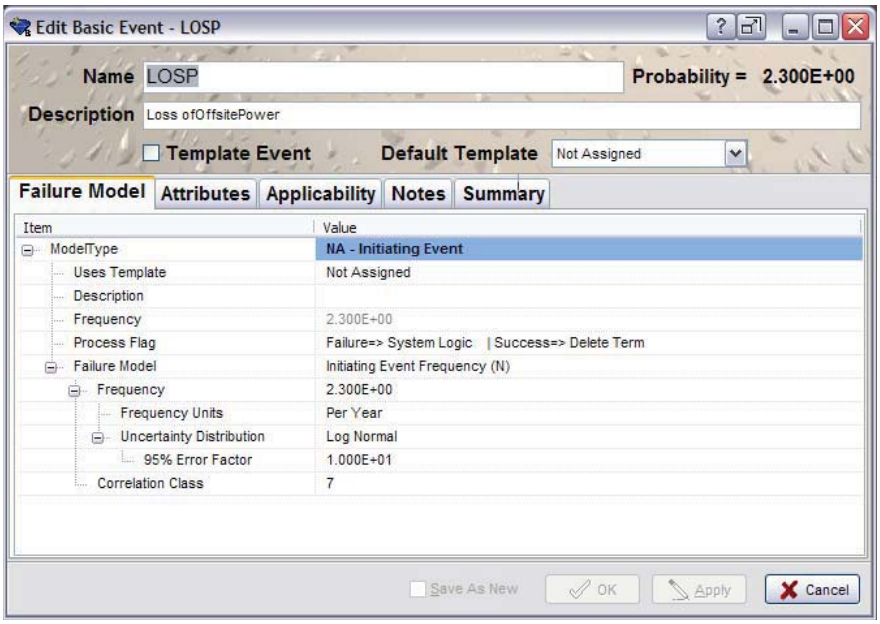
5%	Median	Point Estimate	Mean	95%	Seed	Sample Size	Method
3.922E-12	6.730E-11	2.360E-10	2.322E-10	8.804E-10	4321	5000	Monte Carlo

Verified? Yes.

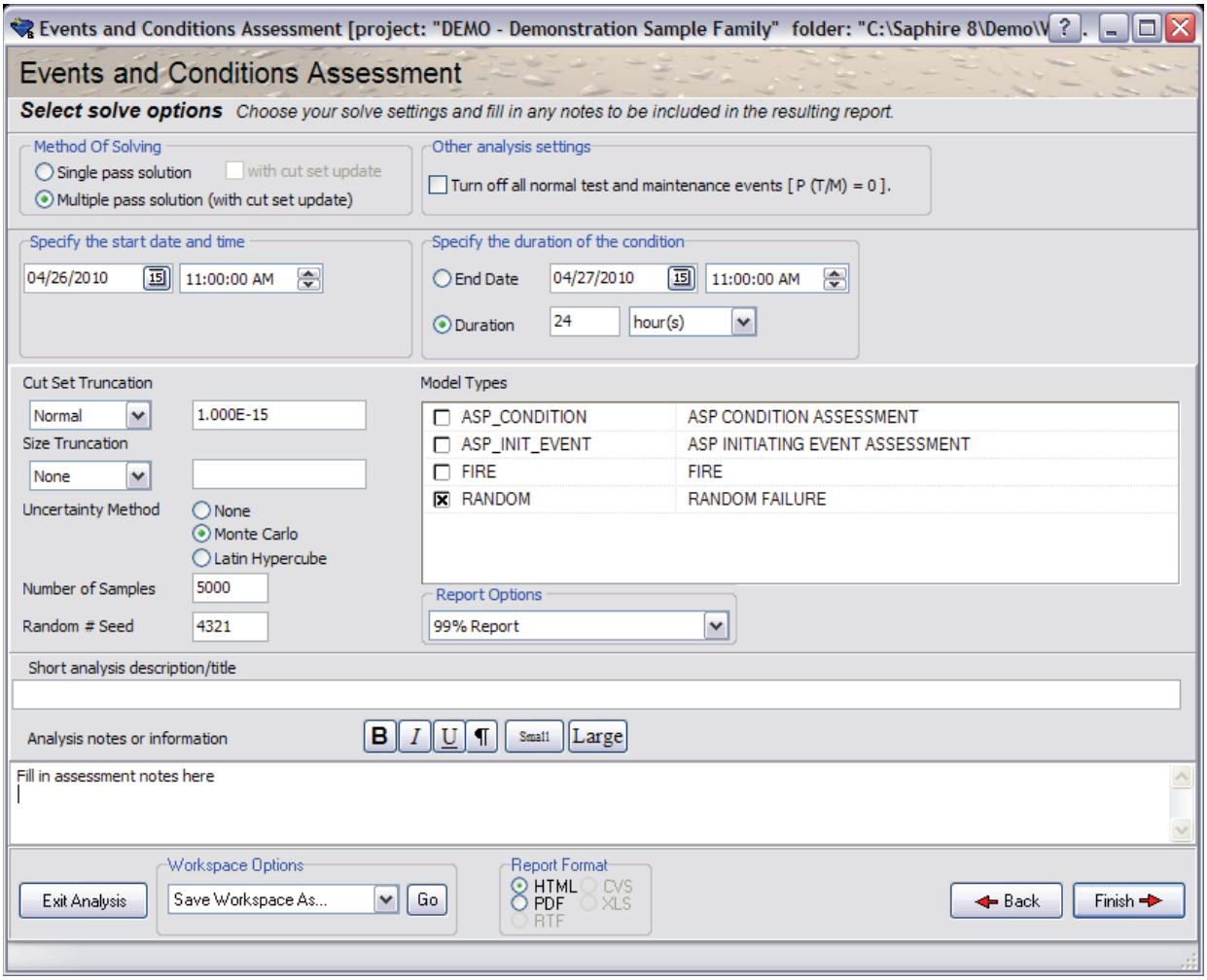
Start a new test

Steps:

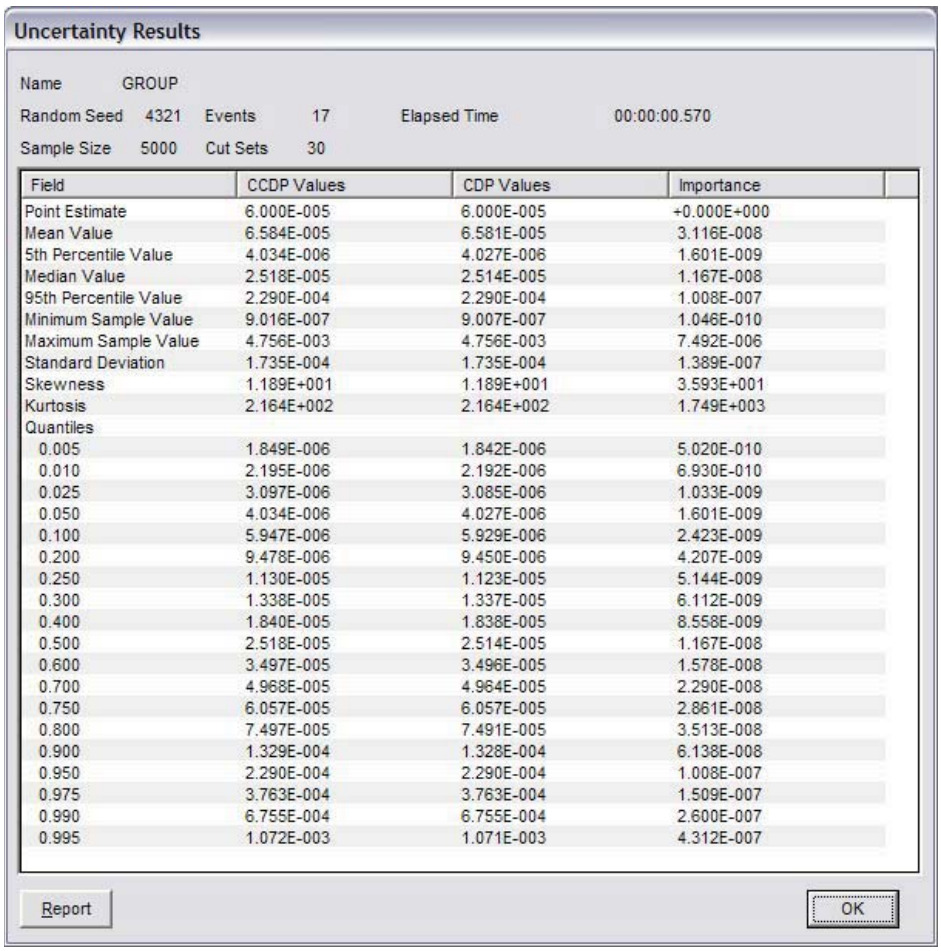
1. Start SAPHIRE and open the DEMO project.
2. Select the Project → Modify option.
3. Select the SPAR tab, then click the "SPAR Model? check box. Click Ok.
4. Verify that the LOSP frequency is 2.3 per year (and default project units are per year)..



5. Double click the "New ECA…" option.
6. Select the Condition Option, Duration of 24 hours.
7. Check the C-CV-A basic event. Click Next.
8. Click the Edit button. Modify to the TRUE. Click Ok.
9. Click the Next button. Change the "Random # Seed" to 4321. Leave the other options at their default values.



10. Click Finish. Click Ok.
11. Verify the results against the equivalent SAPHIRE 7 results



Uncertainty Results

Name GROUP

Random Seed 4321 Events 17 Elapsed Time 00:00:00.570

Sample Size 5000 Cut Sets 30

Field	CCDP Values	CDP Values	Importance
Point Estimate	6.000E-005	6.000E-005	+0.000E+000
Mean Value	6.584E-005	6.581E-005	3.116E-008
5th Percentile Value	4.034E-006	4.027E-006	1.601E-009
Median Value	2.518E-005	2.514E-005	1.167E-008
95th Percentile Value	2.290E-004	2.290E-004	1.008E-007
Minimum Sample Value	9.016E-007	9.007E-007	1.046E-010
Maximum Sample Value	4.756E-003	4.756E-003	7.492E-006
Standard Deviation	1.735E-004	1.735E-004	1.389E-007
Skewness	1.189E+001	1.189E+001	3.593E+001
Kurtosis	2.164E+002	2.164E+002	1.749E+003
Quantiles			
0.005	1.849E-006	1.842E-006	5.020E-010
0.010	2.195E-006	2.192E-006	6.930E-010
0.025	3.097E-006	3.085E-006	1.033E-009
0.050	4.034E-006	4.027E-006	1.601E-009
0.100	5.947E-006	5.929E-006	2.423E-009
0.200	9.478E-006	9.450E-006	4.207E-009
0.250	1.130E-005	1.123E-005	5.144E-009
0.300	1.338E-005	1.337E-005	6.112E-009
0.400	1.840E-005	1.838E-005	8.558E-009
0.500	2.518E-005	2.514E-005	1.167E-008
0.600	3.497E-005	3.496E-005	1.578E-008
0.700	4.968E-005	4.964E-005	2.290E-008
0.750	6.057E-005	6.057E-005	2.861E-008
0.800	7.497E-005	7.491E-005	3.513E-008
0.900	1.329E-004	1.328E-004	6.138E-008
0.950	2.290E-004	2.290E-004	1.008E-007
0.975	3.763E-004	3.763E-004	1.509E-007
0.990	6.755E-004	6.755E-004	2.600E-007
0.995	1.072E-003	1.071E-003	4.312E-007

Report OK

SAPHIRE 8

CCDP

5%	Median	Point Estimate	Mean	95%	Seed	Sample Size	Method
1.188E-6	2.299E-5	1.375E-4	1.371E-4	5.036E-4	4321	5000	Monte Carlo

CDP

5%	Median	Point Estimate	Mean	95%	Seed	Sample Size	Method
1.188E-6	2.295E-5	1.374E-4	1.371E-4	5.036E-4	4321	5000	Monte Carlo

Importance

5%	Median	Point Estimate	Mean	95%	Seed	Sample Size	Method
4.625E-10	1.049E-8	5.400E-8	6.262E-8	2.566E-7	4321	5000	Monte Carlo

Verified? Yes (by hand). Note that the SAPHIRE 7 results do not appear to be correct.

Generating cut sets with C-CV-A set to TRUE gives a CDF (per year) of 5.01E-2 (both in SAPHIRE 7 and 8). We can use this to calculate the CCDP.

CCDP = 1 – exp(-CDF * (24 hours/8760 hours per year))
= 1 – exp (- 5.01E-2 * 24/8760)
= 1.37E-4

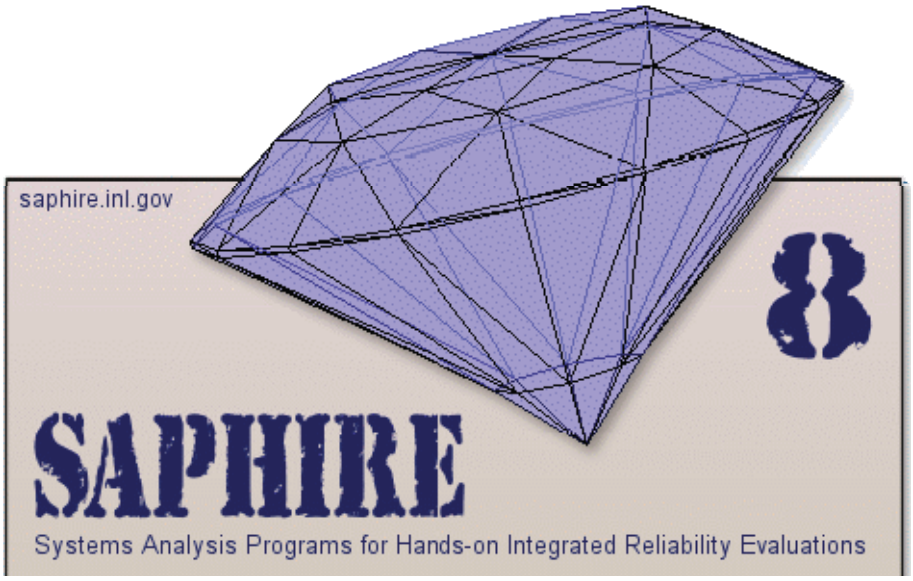
This is the point estimate, which matches that given by SAPHIRE 8. SAPHIRE 7 is showing 6E-5 (for CCDP) which is too low by 24.

APPENDIX B – IV&V Plan (INL/EXT-09-15649)

Document ID:INL/EXT-09-15649
Revision ID: 1
Effective Date: 02/08/2010

Software Independent Verification and Validation Plan

SAPHIRE 8 Software Independent Verification and Validation Plan



Revision Log

Revision Number	Effective Date	Description of Change
0	04/01/2009	Initial issue
1	08/25/2009	Removed Change Control Board and Inserted Peer Reviews

Acronyms

Acronym	Definition
ASP	Accident Sequence Precursor
CCDP	Conditional Core Damage Probability
CDF	Core Damage Frequency
CDP	Core Damage Probability
CMP	Configuration Management Plan
CDR	Critical Design Review
ECA	Events and Condition Assessment
GEM	Graphical Evaluation Module
HTML	Hyper Text Markup Language
IDD	Interface Design Document
IDS	Interface Design Specification
IE	Initiating Event
INL	Idaho National Laboratory
IRD	Interface Requirements Document
IRS	Interface Requirements Specification
IRRAS	Integrated Risk and Reliability Analysis System
IV&V	Independent Verification and Validation
GUI	Graphical User Interface
LERF	Large Early Release Frequency
NUREG	US Nuclear Regulatory Commission Regulation
NRC	Nuclear Regulatory Commission
PDR	Preliminary Design Review
PRA	Probability Risk Assessment
QA	Quality Assurance
RTM	Requirements Traceability Matrix
SAPHIRE	Systems Analysis Programs for Hands on Integrated Reliability Evaluation
SCM	Software Configuration Management
SDD	Software Design Document
SDP	Significance Determination Process
SDP	Software Development Plan
SDS	Software Design Specification
SME	Subject Matter Expert
SQA	Software Quality Assurance
SPAR	Standardized Plant Analysis Risk
SRS	Software requirements Specification
SVVP	SAPHIRE Verification and Validation Plan
STP	Software Test Plan
STR	Software Test Results
V&V	Verification and Validation

1. Introduction

The overall goal of conducting a SAPHIRE version 8 "Independent Verification and Validation" (IV&V) activity is to provide a process to support the Nuclear Regulatory Commission (NRC) in ensuring a high-quality software development process and product through a formal process.

Use of the NRC's Standardized Plant Analysis Risk (SPAR) models may be required in some of the tests. *SPAR models are designated Official Use Only and are to be treated as not publically available.*

1.1. Purpose

The SAPHIRE team is improving the software development process by conducting IV&V activities. The SAPHIRE IV&V process echo's the development process. IV&V is beneficial to the overall development process if it is conducted once the software code base is mature such that the verification takes place shortly prior to what the end users will see in a production version.

What is the definition of IV&V and why is it performed?

Normally, IV&V is the verification and validation of a software product by an organization that is both technically and managerially separate from the organization responsible for developing the product.

- Verification is the process that determines if a product meets its requirements (Are we building the right SAPHIRE product?).

- Validation is the process that determines if a product performs its intended activities (Are we building the SAPHIRE product right?).

In general, IV&V is part of the testing process. It should echo or adapt to the characteristics of the software development methodology being followed. Since SAPHIRE 8 is an 'Object Oriented" approach, each object needs to be examined as it moves through the phases of the development cycle.

Some of the high level benefits of performing IV&V include but are not limited to:

- Visibility into development
- Improved decision criteria
- Alternate technical source
- Reduced maintenance cost
- Reduced frequency of change
- Improved software performance
- Improved confidence in the reliability of the software
- Documents the compliance between the requirements specification and the code

Past SAPHIRE IV&V processes were conducted on IRRAS versions 4 and 5. SAPHIRE version 7 was not formally tested through an IV&V process due to the use of automated tests

(some of which replicate older IV&V tests) as part of the development process. These older IV&V processes and documents will be reviewed for applicability and insights as part of the initial phase of the SAPHIRE 8 IV&V team.

1.2. Objectives and Goals

SAPHIRE 8 is being developed with a phased or cyclic iterative rapid application development methodology. Due to this approach, a similar approach should be taken for the IV&V activities on each vital software object. IV&V and SQA activities occur throughout the entire development life cycle and therefore, will be required through the full development of SAPHIRE 8. Later phases of the software life cycle, the operation and maintenance phases, are not applicable in this effort since the IV&V is being done prior to releasing Version 8.

The IV&V plan is structured around NUREG/BR-0167, "Software Quality Assurance Program and Guidelines," February 1993. The Nuclear Regulatory Research Office Instruction No.: PRM-12, "Software Quality Assurance for RES Sponsored Codes," March 26, 2007 specifies that RES-sponsored software is to be evaluated against NUREG/BR-0167. Per the guidance in NUREG/BR-0167, SAPHIRE is classified as "Level 1." Level 1 software corresponds to technical application software used in a safety decision.

Previous verification and validation of SAPHIRE have also utilized the IEEE Standard for Software Verification and Validation. The SAPHIRE testing, verification and validation (TV&V) process currently in place had also been compared to the IEEE standard. From this comparison, four key recommendations were developed:

1. Reach a consensus on the target software integrity level [1, 2, 3, or 4].

2. Create a formal Software Validation and Verification Plan document that describes which V&V activities will be performed, and which will not.

3. Utilize a functionally independent (from the developmental organization) V&V person(s) for at least some V&V functions.

4. Perform a V&V audit by a non-INL entity. This audit could be conducted once a year and could be performed by a NRC employee not directly associated with the SAPHIRE development project.

This plan is designed to satisfy recommendation 3. The SAPHIRE 8 IV&V team will be following this IV&V plan.

The IV&V plan follows the Table 1, "IV&V Tasks Based on NUREG/BR-0167" given at the end of this document. A checklist has been developed to implement the Table 1 tasks and products, and is attached. The checklist provides comprehensive coverage of NUREG/BR-0167 V&V activities. A comparison of the checklist to the NUREG/BR-0167 Table 3-1, "Verification and Validation Activities by Major Life Cycle Activity," shows that V&V activities associated with Requirements Definition, Design, Implementation, Qualification Testing, and Installation and Acceptance Testing are planned to be checked. Since SAPHIRE 8 is not yet in maintenance or operations, the V&V activities are not yet applicable. However, if schedule and budget permit, the IV&V will also check on plans to maintain the software. In addition to the life cycle

phases given in NUREG/BR-0167 Table 3-1, the checklist covers the software project plan, project tracking and oversight, configuration management, and risk management which are included elsewhere in the NUREG. Furthermore, tasks and products associated with both NUREG/BR-0167 and IEEE STD 1012-2004 are included in this IV&V effort as shown in Table 1 of this plan. Therefore, this IV&V plan comprehensively covers NUREG/BR-0167 and includes some tasks and products associated with the IEEE STD 1012-2004.

Since the testing phase comes after the other phases, it is important that the IV&V remain within schedule and budget to ensure the testing activities specified in the plan will be completed. Potential deviations from the plan will be brought to the NRC's attention. Additional activities may be pursued if schedule and budget permits.

The IV&V is complemented by other V&V activities. The NRC's internal peer review will review requirements and design documents, and will test a beta version of the software. In addition, beta testers are testing the software and NRC audits are performed against NUREG/BR-0167.

The comparison report found that SAPHIRE TV&V practices most closely satisfied the IEEE standard's Level 1 tier, and in some cases the practices were felt to match higher level tiers.

The actual integrity level of a software project should be decided upon via mutual agreement between the customer and the code developers The IEEE V&V describes a set of life cycle processes (e.g., management, development, maintenance) to which the standard applies. It notes that only those life cycle processes used by a software project need comply with the standard. Table 1 below briefly describes the life cycle processes defined in the IEEE standard, and their applicability to SAPHIRE project.

The IEEE development portion of the IEEE life cycle process closely corresponds to the NUREG/BR-0167 software life cycle description. This NUREG recognizes that each software project must tailor the life cycle processes to fit the scope of effort, using cost-effective management and judgment.

Appendix B - Table of IEEE standard life cycle and applicability to the SAPHIRE development process

Life cycle process	Description	Used by SAPHIRE?
Management	Overall handling of the software project	Yes
Acquisition	Request for proposal; selection of a supplier; acceptance of software product	Limited applicability
Supply	Proposal preparation; development of project plans; delivery of product	Limited applicability
Development	Requirements analysis; design; coding; integration; testing; installation and acceptance	Yes
Operation	Operation of the product and support to users	Yes
Maintenance	Modifications due to problems or need for improvement	Yes

Appendix B - Table of IEEE software integrity levels

Error Consequence	Likelihood of occurrence of an operating state that contributes to the error			
	Reasonable	**Probable**	**Occasional**	**Infrequent**
Catastrophic	4	4	4 or 3	3
Critical	4	4 or 3	3	2 or 1
Marginal	3	3 or 2	2 or 1	1
Negligible	2	2 or 1	1	1

Appendix B - Table of IEEE definitions of consequence

Consequence	Definitions
Catastrophic	Loss of human life, complete mission failure, loss of system security and safety, or extensive financial or social loss.
Critical	Major and permanent injury, partial loss of mission, major system damage, or major financial or social loss.
Marginal	Severe injury or illness, degradation or secondary mission, or some financial or social loss.
Negligible	Minor injury or illness, minor impact on system performance, or operator inconvenience.

SAPHIRE is at IEEE integrity level "1", the lowest. If one examines the IEEE software integrity level table, SAPHIRE can be assigned an IEEE-1012 level of 1 and still be critical to supporting the decision-making process. Because SAPHIRE is not the only tool used to support the decision-making process it should not be classified as "Catastrophic." Furthermore, no metrics to support an IEEE-1012 classification higher than a "1" currently exist. The results of any calculation information from SAPHIRE depend largely on how a model has been implemented by a user. A process exists to analyze all errors reported by the user community.

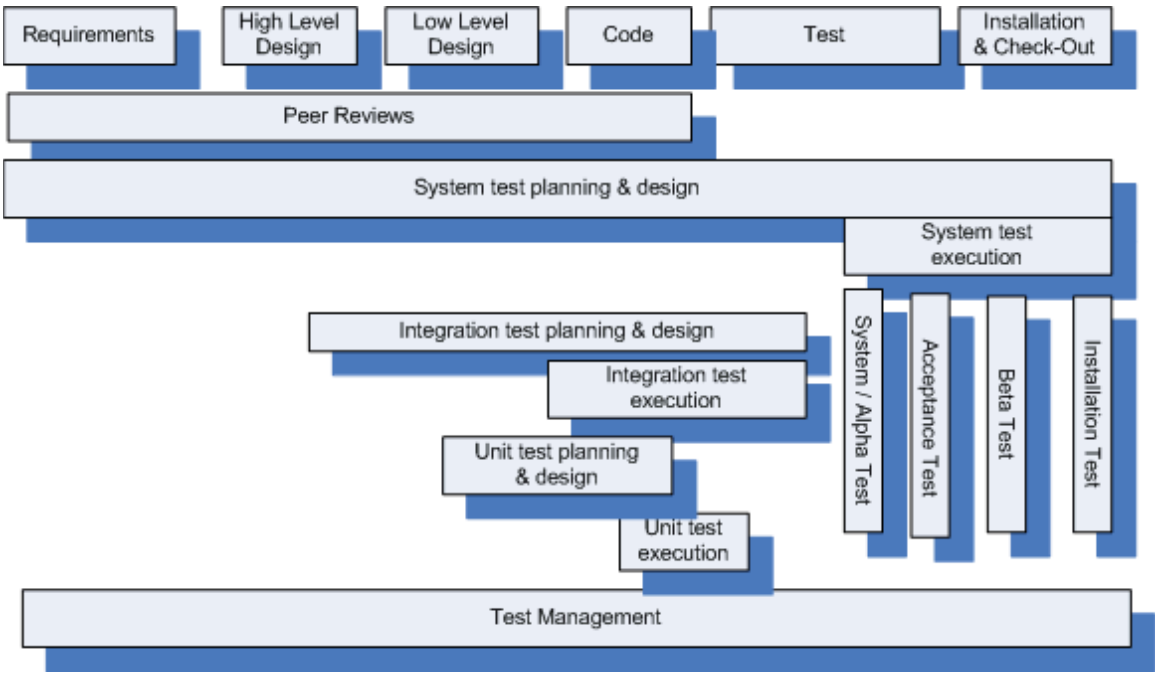
The IEEE standard levels are based on considerations of 1) the likelihood of occurrence of an operating state that contributes to the error, and 2) error consequence. IV&V activities in this plan which correspond to the IEEE software standard should be done at the level 1 tier. More rigorous reviews may be considered at higher levels for life cycle activities such as "Implementation" and/or "Test" if the schedule and budget permit. Therefore, the IV&V plan, while based on the governing document, NUREG/BR-0167, also considers how the review activities and products correspond to the current IEEE software standard.
The NUREG/BR-0167 also requires an IV&V test report upon completion of the development efforts. For meeting NUREG/BR-0167 requirements, there also needs to be an SQA interface with the development team. This individual will also interface with the IV&V representative.

Each developer is responsible for ensuring that the code they create has met the criteria discussed in the NUREG/BR-0167. According to the contract that the INL holds with the NRC, SAPHIRE 8 is supposed to be brought up to "state of the art" software. This means that activities that are called out in the NUREG/BR-0167 not currently being performed by the developers should be modified so that they are brought in compliance. If required, additional support tasks may need to be incorporated into the development process. Some tasks are the responsibility of the developers to incorporate into their code. Other tasks could be done by support personnel such as a software technician. A subject matter expert familiar with PRA modeling techniques needs to be available for consultation. Due to finite programmer resources supporting the SAPHIRE

effort, automated analysis tools may be purchased to support QA and IV&V activities and improve the analysis process.

A distinction needs to be made for clarification of IV&V activities. Verification and validation activities encompass all activities that the developers and testers, software quality assurance representatives and independent auditors perform to ensure a quality software application (see Appendix B - Figure 1 for an overview of typical testing activities). Each participant has specific roles and responsibilities based on the function being performed by the individuals. In this plan, it was attempted to delineate the expected inputs and outputs between the developers and SAPHIRE 8 team members as compared to the IV&V team members.

For each functional area, the tasks outlined in the NUREG/BR-0167 Software Quality Assurance Program and Guidelines will be noted. If, upon review, an item is found to be lacking, an action plan will be implemented to take corrective action and monitored until corrected or explained. Not every item listed will be applicable to each major functional area. Further, not all comments will need to be resolved prior to a general release of SAPHIRE 8 – minor issues and recommendations may be addressed during a later release of the software. The NRC will make these determinations.



Appendix B - Figure 1. General Testing Activities and the Software Life Cycle.

Figure 1 maps the basic phases of software development and the types of testing possible during the life cycle of a software application development effort. The SAPHIRE 8 development team is not performing every type of test that is indicated in the figure. The SAPHIRE team has selected certain test phases as the most effective approached to the testing effort. See Table 1 IV&V Tasks Based on NUREG/BR-0167 for the specific test phases to be performed. The IV&V Team will witness all or a portion of the tests and inspect the results of the tests performed by the development team. Additional analysis and indication of needed test effort may be required by the IV&V Team as part of the overall verification and validation effort and to provide customer confidence in the new software release. See Table 1 IV&V Tasks Based on

NUREG/BR-0167 for a break out of specific products required for by the development team and the IV&V team to support the SAPHIRE 8 V&V effort .

2. Referenced Documents and Sources

Applicable sources of information that will be available to the IV&V team include:

- Access to personnel staffing the development team
- Source code stored in the revision control system
- Beta test feedback stored in the change log system
- NRC Form 173s
- NRC Form 189s
- General INL project information (e.g., monthly reports)
- Automated tests and QA results
- SAPHIRE Verification and Validation Plan, Volumes 1 and 2
- Module design documentation
- SAPHIRE 8 New Features and Capabilities document
- User feedback checklists
- Design review documentation
- Past IV&V reports, including prioritization of key features
- SAPHIRE 8 Source code.
- SAPHIRE 8 Software Requirements, Design and Test documentation
- NUREG/BR-0167 Software Quality Assurance Program and Guidelines
- NUREG/BR-0167 SQA Audit Check Sheet
- IEEE-1012 2004 Standard
- SAPHIRE Modeling & Analysis Software Compliance to Requirements - Assessment Checklist

3. IV&V Overview

This section discusses the project organization, schedules, resource allocation and tools, techniques, and methodologies.

3.1. Organization of IV&V Activities

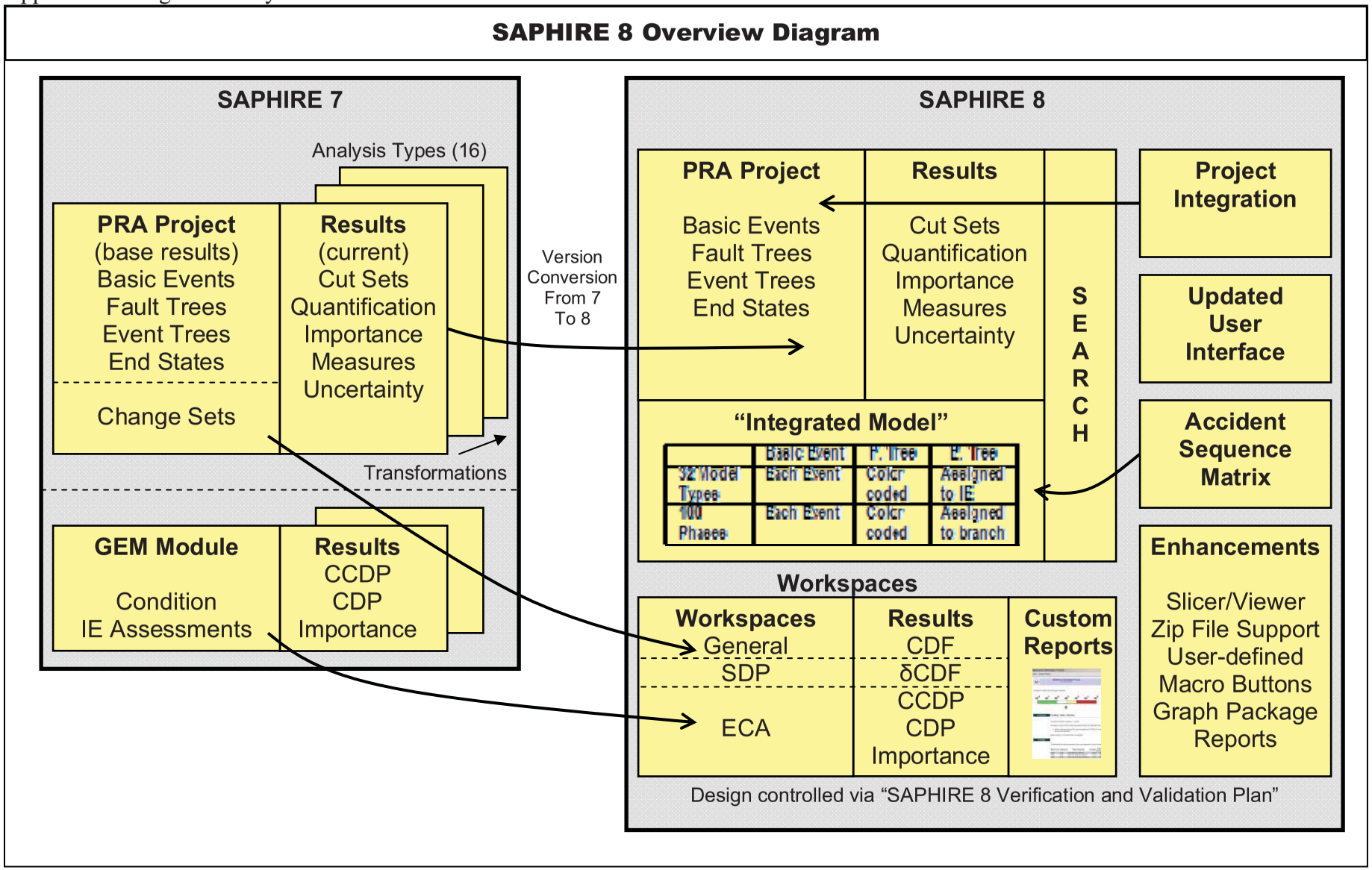
The Table 1, "IV&V Tasks Based on NUREG/BR-0167," provides the list of activities to be performed by life cycle phase. As can be seen in this table, certain activities also correspond to activities in the IEEE software standard. The checklist developed for the NRC audits of SAPHIRE can be found in the Revision Control System (RCS). This checklist may be useful for the IV&V team to consult, but does not replace the activities and products given in the table which are to be completed.

The key functional areas of focus for the IV&V team are shown in Appendix B - Figure 2. The team, which will be selected during the initial phase of the IV&V, will focus on vital aspects of these key areas. Vital aspects, new or carried over from the previous SAPHIRE version 7, will be included in the IV&V. Non-vital aspects should also be included in the scope of the IV&V; however, the focus should be on the vital aspects.[1]

Note that the team members will have a variety of backgrounds (e.g., QA, PRA). The SAPHIRE 8 IV&V team is looking for "functional" independence (from the SAPHIRE development project) for team members. Consequently, INL staff that work on other NRC projects or that have used SAPHIRE in the past can be considered for the IV&V team.

[1] For the V&V of SAPHIRE Version 5 (as described in NUREG/CR-6116 Volume 9), a "vital feature" was defined as those that (a) affected the results of a PRA and (b) are essential for completing a PRA analysis.

Appendix B - Figure 2. Key Elements of SAPHIRE Version 8 Software and Contrast with Version 7.



The SAPHIRE 8 graphical user interface (GUI) is implemented using a modern Windows-design environment which allows for multiple, resizable forms. Functionality for the previous GEM and SAPHIRE interfaces will be accessed from within SAPHIRE 8. The GUI is coded in Delphi and object Pascal.

The GUI has a top-level main form that allows the user to choose between model development or to perform an analysis. Under the model development option, the user will be able to select a fault tree logic diagram, an event tree logic diagram, basic events, end states, or a project workspace.

When a user performs an analysis, a copy of the relational database files are created and stored in a unique workspace folder in the workspaces directory. Once the analysis is complete (i.e., saved) the relational database files will be compressed into a single .zip file. The compressed file may be shared with another user if desired. The uncompressed file may be opened at a later time and the database reviewed to inspect the analysis. Currently, three types of workspaces are available: General, SDP, and Events and Condition Assessment (ECA). The analysis process, reports, and results are customized specific to each type of workspace.

A variety of enhancements have been implemented in SAPHIRE 8. For example, SAPHIRE has a more powerful cut set slicer, supports compressed files, allows users to assign macros to on-screen buttons, contains a better graphing package, and uses HTML-based report templates.

Analysis improvements have been implemented. In SAPHIRE 7, different "types" of models were stored in select analysis type parts of the database such that aggregate results were not available. In SAPHIRE 8, the user may define up to 32 "model types" (e.g., full power internal events, low power internal events, seismic events, and flooding events) such that this information is shareable within a single project enabling aggregate (or single if needed) risk assessment.

To support the development of "integrated models" (models with multiple model types), features such as an "accident sequence matrix" are used to enable the development of external events models via a semi-automated process. The fault tree model editor has been designed to be aware of the different model types and will show the user which events (and their respective probabilities) apply to the individual model types.

In SAPHIRE 8, the user now has the ability to search (in text fields such as names and descriptions) on objects in the project database, thereby facilitating a way to quickly find information in large project.

3.2. Schedule of Activities

The IV&V functions can commence upon receipt of funding and will last approximately eight months. An approximate schedule is presented below in Schedule and Products, assuming a March start (a later start will push the timetable back by the delay time). For example, the first area targeted will be the core functionality of model construction and examination of the updated and existing SAPHIRE 8 capabilities. This includes construction of Basic Events, Fault Trees, Event Trees, and End States. Since this is the core of the SAPHIRE application and will support

any additional functionality, performance of SQA and IV&V as early as possible will insure a solid review for future use of the software.

Key Areas

1. Model Construction
2. Standard Analysis Interface
3. Workspace Analysis Interfaces
4. PRA Quantification
5. General Support Features and Capabilities

Schedule and Products

T0 – IV&V team selection and finalize IV&V plan, including prioritization of activities. Final test plan must be approved by the NRC Project Manager.

Period: March, 2009
Product: IV&V plan including comments from IV&V team

T1 – Requirements, Design, Implementation Review, IV&V assessment

Period: April – July, 2009
Products: Monthly progress reports; IV&V products in the table; draft report sections for final report. Checklist review (e.g., requirements, design, implementation, etc.), IV&V assessment.
Note: Some IV&V observation/evaluation/testing can begin.

- Checkpoint: NRC assesses progress and determines if additional IV&V time is needed

Milestone: Version 8 beta 4 ready for IV&V testing completed by end of June, 2009. NRC will review this version to ensure it is ready for IV&V testing prior to it being provided to the IV&V team in July. This version will not include algorithmic improvements for SAPHIRE calculation speed.

T2 – Test, Installation and Checkout

Period: August 2009 – January 2010
Products: Monthly progress reports; IV&V products in the table; draft report sections for final report.

- Checkpoint: NRC assesses progress and determines if additional IV&V time is needed

Product: Final Report – January 2010 or later as specified by NRC Project Manager based on NRC assessments. Checklist review (e.g., testing, installation and checkout, etc.)
Note: IV&V observation/evaluation/testing to be completed. In addition, the development team is utilizing a rapid application, spiral methodology approach for software development. Therefore some criteria in the checklist may need to be reassessed and reviewed to complete any remaining life cycle phases.

Milestone; Version 8 beta 5 ready for NRC review by end of January 1010

T3 – SAPHIRE Development Team Finalizes Version 8 for release

Period: February, 2010 – March, 2010

Management

NRC approval is necessary for

- the final IV&V plan
- changes in scope, level of effort, or schedule
- acceptance test plan developed by the development team for the vital and non-vital aspects prior to beginning the test phase (T2)
- determining which major IV&V team recommendations to resolve before releasing Version 8 (it is recognized that not all recommendations will need NRC approval for resolution)

Detailed monthly progress reports will be provided to the NRC Project Manager and Technical Monitor.

The INL SAPHIRE development team will respond to IV&V findings, as appropriate, as the IV&V review is being done. Additional time (T3) will be available to the SAPHIRE development team after completion of the Final Report to allow the team to finalize Version 8 for release.

3.3. Resource Summary

The IV&V personnel will consist of one "Full Time Employee" assigned to act as the IV&V Lead. This person is an experienced developer or QA engineer that has not developed code specifically for SAPHIRE 8.

Two additional ½ time support persons on an as needed basis for performing some the IV&V activities. This may include but is not limited to subject matter experts, software technicians or student interns. All personnel will be required to read this document and be familiar with the software development methodology. These roles may last for a few days or a few weeks depending on the need. A resume of all personnel utilized in this effort will be on file.

All test equipment needed currently resides at the INL.

3.4. Tools, Techniques and Methodologies

The tools to be utilized in the SAPHIRE 8 IV&V process are:

Windows XP Professional Desktop computer with all current security patches
SAPHIRE 8 executable installed on the Windows computer

Component Software Revision Control Software tool (CS-RCS)
SAPHIRE automated test suite
Code Healer Software Analysis Tool Version 2.5 SOCK software
Delphi 2007 Software Development Environment
MS Word Processor
SPAR models
Delphi and Modula-2 Coding Standards

Techniques and methodologies will include code review of randomly chosen source code files against the NUREG/BR-0167 standard, Code Healer analysis of randomly chosen sections of the software, tracing of randomly chosen functional areas from requirements to final test results. Possible auditing of any and all documentation pertaining to design reviews, software change processes or other pertinent SAPHIRE 8 processes and products.

4. Completion and Deliverables for the IV&V Activities

The basic high level functional areas will be examined in the order listed. This will echo the application development and provide immediate feedback while the code is still being developed and tested; and provide a solid basis for further interface and development for the next iterative cycle. See Table 1 for the high level focus areas. For the high level areas, the IV&V team will be reviewing and testing as described in the NUREG/BR-0167 and IEEE STD 1012-2004 (IEEE STD 1024-1998 has been superseded) as a secondary reference where applicable. See Section 3.2 for the high level breakdown of the SAPHIRE 8 IV&V focus.

For each functional area, the tasks outlined in the NUREG/BR-0167 Software Quality Assurance Program and Guidelines will be accounted for. If upon review an item is found to be lacking, an action plan will be implemented to take corrective action and monitored until corrected or explained. Not every item listed will be applicable to each major functional area.

Table 1 lists all the expected tasks and deliverables to support this activity. Since the IV&V echoes the development process, as each vital feature for key areas are complete, the corresponding IV&V activities should commence. If the development is delayed, the IV&V activities must be delayed as well.

The key deliverable will be the final IV&V report listing the results of the IV&V process. This report will provide input to the SAPHIRE developers in order to focus future software development. This report will focus on what modifications should be considered in order to ensure SAPHIRE Version 8 is a quality product. The NRC will review these suggestions and, in conjunction with INL feedback, prioritize the suggestions for resolution. An overview of the IV&V process and results will also be summarized as a chapter in the SAPHIRE SVVP document.

4.1 Final Report Format

For each IV&V Review Area evaluated, the IV&V Review Report should contain the status of the SAPHIRE 8 Project, including any pertinent historical background information. The report should also contain a detailed analysis of each applicable IV&V Review Area, which answers at least the following questions:

- What are the current processes, procedures, practices and technology?
- What is good about the current processes, procedures, practices and technology?
- What about the current processes, procedures, practices, and technology needs improvement?
- What are the test results and insights?
- Is the project documentation accurate and up-to-date?
- What deviations from the IV&V plan exist and are they reported?

Here are the sections that will be presented in the SAPHIRE 8 Software Independent Verification and Validation Review Report

- Section 1 Executive Summary
- Section 2 Background Information
- Section 3 Project Summary
- Section 4 Summary of Findings
- Section 5 Summary of Analysis
- Section 6 Summary of Recommendations
- Section 7 Summary of Best Practices
- Section 8 Summary of Lessons Learned
- Attachment 1: List of Personnel Contacted
- Attachment 2: List of Documents Reviewed
- Attachment 3: List of Software Test Tools and Tool Descriptions
- Attachment 4: Detailed Findings and Recommendations Table
- Attachment 5: Project Best Practices
- Attachment 6: Project Lessons Learned

Note – IV&V will generate independent tests and review developer test processes, test suite , and test results as specified in this plan.

Appendix B - Table 1 IV&V Tasks Based on NUREG/BR-0167

Life cycle Phase	Tasks performed by IV&V based on Developer Tasks/Requirements	Inputs to IV&V from Development Team	IV&V Products
Project Plan	Project Plan - Compliance to NUREG/BR-0167$_1$	• SAPHIRE 8 Project Plan$_1$	Results of document review$_1$
Requirements	Requirements Traceability Analysis: • Analysis of Software Requirements Specification (SRS)$_3$ • Analysis of Interface Requirements$_3$ • IV&V Development of Initial SVVP in parallel with Developer Tasks$_3$ • Peer Review Monitoring	• SRS$_3$ • Interface Requirements Specification(IRS)$_3$ • Requirements Traceability Matrix(RTM)$_3$ • Acceptance Test Plan$_3$ • Peer Review Data	Report Results of Traceability Analysis$_3$ Report Results of Requirements and Interface Document reviews$_3$ Status Report$_1$ High Level System Test Plan$_3$ Software Validation and Verification Plan(SVVP)$_3$ Monthly Report of Peer Reviews and Status Review RCS for Peer Reviews
Design	• Participation in Preliminary Design Review (PDR)$_3$ • Assess traceability of design to requirements$_3$ • Assess interfaces$_3$ • Assess Documents to appropriate Standards$_3$ • Peer Review Monitoring • Participate in Critical Design Review (CDR)$_3$	• SRS$_3$ • Software Design Specification (SDS)$_3$ • Iinterface Design Specification(IDS)$_3$ • RTM$_3$ • Results of PDR$_3$ • Results of CDR$_3$ • Configuration Management Plan$_3$ • Peer Review Data • Change Control process & reporting convention is finalized$_3$	Anomaly Reports of Traceability & interfaces$_3$ Anomaly reports of documentation to Standards$_3$ Update SVVP$_3$ Monthly Report of Peer Reviews and Status Review RCS for Peer Reviews Results of Configuration Management Plan review$_1$
Configuration Management	• Configuration Management Methodology$_1$ • Baselines established and under Change Control$_3$ • Review of Anomaly Reports	• Updated Configuration Management Plan$_3$ • Peer Reviews & Code Walkthrough	Results of Configuration Management Plan review$_1$ Results of Peer Reviews and Code Walkthroughs Review RCS for Anomaly Reports & Peer Reviews Monthly Report of Peer Reviews and Status

Life cycle Phase	Tasks performed by IV&V based on Developer Tasks/Requirements	Inputs to IV&V from Development Team	IV&V Products
Implementation	If changes made to SRS, SDS, and/or IRS, re-validate through requirements, design, and interface prerequisites: • Evaluate RTM to ensure traceability of requirements from source to design to software requirements spec$_3$ • Evaluate regression test results$_3$ • Review CMP requirements against information in Status Accounting (Access Database or other mechanism for tracking - configuration and change control)$_3$ • Review Anomaly reports • Peer Review Monitoring	Updated SDS, SRS, IRD as needed (if changes were made) • RTM$_3$ • Source code of new modules/units$_3$ • Results from regression testing of modules that may be affected by new code$_3$ • User Documentation$_3$ • Status Accounting$_3$ • Anomaly Reports • Peer Review Data	Reports of updated documentation, results of traceability assessments, regression tests$_3$ Evaluate coding standards and that there are complete and correct **comments in all affected modules of the source code**$_1$ Monthly Report on Anomalies and Peer Reviews and Status Review RCS for Anomaly Reports & Peer Reviews Update SVVP (as needed)$_3$
Test **Static Analysis Tests**	• Evaluate Test Plans prior to test$_3$. • Ensure Test case identifiers map to design components to software requirements (RTM)$_3$ • User Documentation is accurate (user's functionality maps to testing, etc.)$_3$ • Review CMP requirements against information in Status Accounting$_3$ • Review automated test suite$_3$ • Some or all: Performance, Path, Static Analysis, Memory Link, Coverage, Trending, Complexity, Functional • CM of Anomaly Reports • Review of Anomaly Reports • Peer Review Monitoring •Others determined by IV&V team	RTM STP User Docs (if updated) Access to Configuration Management "Library" and Change Control Reviews, etc. Baseline source code$_3$ Software executable compiled in debug mode. A copy of the *.map file created during build process Anomaly Reports Peer Review Data	Reports of status of RTM, test cases, test scenarios, and test procedures, results of testing, and user manuals/documentation Reports on metrics produced from static analysis and techniques and tools Monthly Report on Anomalies and Peer Reviews and Status Updated SVVP issued Reports on metrics produced from static analysis and techniques and tools Monthly Report on Anomalies and Peer Reviews and Status Review RCS for Anomaly Reports & Peer Reviews

Life cycle Phase	Tasks performed by IV&V based on Developer Tasks/Requirements	Inputs to IV&V from Development Team	IV&V Products
Functional Tests	• Review developer's automated test suite$_3$ • Observe and evaluate developer's tests and test results$_3$ • Cutset level reviews • Review Anomaly reports • Peer Review Monitoring	Executable Code or SAPHIRE-formatted Macros for automated test suite$_3$. Acceptance Test Plan. Tests to be included in (but not limited to) the developer's Acceptance Test Plan: • Cutset level reviews for analysis using new features, capabilities, algorithms, and methods. • Verify the Multi-pass algorithm, the min-max algorithm, and the Figure III-D on the Significance Determination Process Step 4 "Analysis Results." • Tests specific to the application of cut set "recovery rules." • Verify algorithm modifications that could affect numerical results. • Comparison of results generated by different user interfaces$_3$ Anomaly Reports Peer Review Data	Reports of status of automatic test cases, automated test scenarios, and automated test procedures, results of automated testing$_3$, Update SVVP$_3$ Monthly Report on Anomalies and Peer Reviews and Status Review RCS for Anomaly Reports & Peer Reviews
Qualification / Acceptance Test	• Monitor Acceptance Test execution$_3$ • Review Anomaly reports • Peer Review Monitoring	Qualification/ Acceptance Test procedures$_3$ Anomaly Reports Peer Review Data	Reports of status of RTM, test cases, test scenarios, and test procedures, results of qualification/ acceptance testing$_3$ Update SVVP$_3$ Monthly Report on Anomalies and Peer Reviews and Status Review RCS for Anomaly Reports & Peer Reviews
Installation and Checkout	• Review Installation instructions$_3$ • Execute Installation Instructions$_3$	Installation Instructions$_3$	Final Report generation – V&V summary report, Anomaly Report, etc.$_3$

Footnote Legend:
1: Located in NUREG/BR-0167
2: Located in IEEE-1012
3: Located in NUREG/BR-0167 and IEEE-1012

SAPHIRE Modeling & Analysis Software
Compliance to Requirements - Assessment Checklist

The following checklist items are provided at a level of rigor that is intended to:

1) Provide sufficient information to NRC for audit purposes.

2) Update artifacts to begin a path forward for further improvements to meet good software engineering practices commensurate with NRC and industry standards.

3) Conduct IV&V in a cooperative environment with developers. It is not the intent that IV&V be conducted in an "adversarial" environment. IV&V and the developers must work as a team to be successful. Should issues arise that cannot be resolved between IV&V and the developer, the issue(s) can either be resolved by the NRC sponsor or identified in the checklist with developer and IV&V differences addressed in the comments section of the checklist.

4) Identify the IV&V test effort. IV&V will ~~not~~ conduct independent testing and also will evaluate and observe the developer's tests to ensure they are complete and accurate and that the test processes are met according to the approved documentation. The applicable IEEE integrity level is level 1; however, the IV&V may consider IEEE testing activities (or other activities) at a greater level given the schedule and budget constraints.

5) The checklist comprehensively covers NUREG/BR-0167. Some tasks performed in a "full-up" IV&V effort as identified in industry standards, such as IEEE, will not be performed. IV&V tasks will be identified in the IV&V Plan and developed in a coordinated effort with the developer and the sponsor

6) Only those checklist items that are applicable (as agreed between the developer, sponsor, and IV&V) will be evaluated. This checklist is only a guide and some of the checklist items may be N/A. However, during the assessment process, checklist items may precipitate additional items that will be incorporated into this checklist. Checklist items are also prioritized to help meet schedule and budget constraints.

7) Provide information in the comments for EVERY checklist item. Comments must identify the location (e.g., RCS) for criteria that "Pass" for use as objective evidence of the review. The intent for using the checklist is not only to identify issues (i.e., "Fail") but also any "exceptional" practices. Explanations for N/A criteria must also be identified.

8) Each of the criteria in the checklist is prioritized. High priority is "1", medium priority is "2", and low priority is "3"

This checklist does not require that the assessment items be conducted as provided in the order below.

SOFTWARE PROJECT PLAN		
Criteria Priority: 1	**Has the developer created a Software Project Plan? NUREG/BR-0167 Section 4.2 and 5.2.4**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Does the Project Plan provide project background and objectives? NUREG/BR-0167 Section 5.2.4**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Has the Project Plan address plan scope and organization? NUREG/BR-0167 Section 5.2.4**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 2	**Does the Project Plan address plan maintenance (i.e., Project Plan updates)? NUREG/BR-0167 Section 5.2.4**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Has the Project Plan been approved by the NRC sponsor? NUREG/BR-0167 Section 5.2.4**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 3	**Does the Project Plan describe the approach used to plan the project? NUREG/BR-0167 Section 5.2.4.1**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Does the Project Plan describe the approach used to track technical progress? NUREG/BR-0167 Section 5.2.4.2**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 2	**Does the Project Plan describe the approach used to track conformance to the planned schedule? NUREG/BR-0167 Section 5.2.4.2**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 2	**Does the Project Plan describe the approach used to track costs as related to actual work performed? NUREG/BR-0167 Section 5.2.4.2**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 3	**Does the Project Plan describe the approach used to track metrics? NUREG/BR-0167 Section 5.2.4.2**	
Pass		Comments

Fail		
N/A		
Criteria Priority: 3	**Does the Project Plan describe the approach used to track security? NUREG/BR-0167 Section 5.2.4.2**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 3	**Does the Project Plan describe the approach to track risk? NUREG/BR-0167 Section 5.2.4.2**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 2	**Does the Project Plan address the organization, tasks, and responsibilities (i.e., Show how the tasks in the SOW are assigned to responsible elements of the project organization? NUREG/BR-0167 Section 5.2.4.3**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 2	**Does the Project Plan provide the initial, top-level project schedule and the rationale for arriving at this schedule? NUREG/BR-0167 Section 5.2.4.4**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 2	**Does the Project Plan identify project resources including staffing, software engineering environment, and support tools? NUREG/BR-0167 Section 5.2.4.5**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Does the Project Plan address Configuration Management, specifically, project baselines, change control, baseline status, proposed changes, implemented changes, software development library, and documentation and code? Has the Change Control Process/Procedure been identified? NUREG/BR-0167 Section 5.2.4.6 – Software Best Practices**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 2	**Does the Project Plan describe how each major life-cycle task of the SOW work will be implemented? NUREG/BR-0167 Section 5.2.4**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Does the Project Plan describe the nonconformance reporting and corrective action process, including nonconformance detection and reporting, impact assessment and corrective action and tracking, and tracking and management reports? NUREG/BR-0167 Section 5.2.4**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 2	**Does the Project Plan identify all deliverables and the dates they are due? NUREG/BR-0167 Section 5.2.4**	

Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Does the Project Plan address standards, procedures, conventions and metrics to be used? This includes product standards, such as documentation standards and coding standards and process standards, including inspection and review procedures. NUREG/BR-0167 Section 5.2.4 – Software Best Practices**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Does the Software Project Plan provide information on tracking and oversight? NUREG/BR-0167 Figure 5-1**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Does the schedule include milestones for life-cycle reviews, such as requirements reviews, preliminary design reviews, and critical design reviews for IV&V review? NUREG/BR-0167 Section 3.**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Does the Software Project Plan map the tasks in the SOW to elements in the WBS? Has the WBS been developed and under CM control? NUREG/BR-0167 Section 1.4, Section 5.2, Software Best Practices**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 2	**Does the Software Project Plan provide a project schedule, such as a GANTT chart, and rationale for tasks identified in the project schedule? NUREG/BR-0167 Figure 5-1**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 3	**Does the Software Project Plan identify resources needed (equipment, personnel, tools)? NUREG/BR-0167 Section 2.5**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Does the Software Project Plan describe nonconformance reporting and corrective action processes (nonconformance detection and reporting)? NUREG/BR-0167 Figure 5-1 and Section 3 of the PMP**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Is an impact assessment performed on nonconformance items and corrective actions identified? NUREG/BR-0167 Section 7**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**How are nonconformance items, their related reports, and corrective actions tracked (e.g., DBMS, Excel Spreadsheet, Configuration Management, etc.)? NUREG/BR-0167 Section 7**	

Pass		Comments
Fail		
N/A		
Criteria Priority: 2	**Is the quality assessment approach and improvement approach been described? NUREG/BR-0167 Section 5.2, Section 8**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 2	**Are deliverables and dates due identified? (Also in the project schedule)? NUREG/BR-0167 Section 1.2 and Table 8.1**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Are standards used for documentation identified and adhered to? NUREG/BR-0167 Section 5.2.1**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Are coding convention standards identified and adhered to? NUREG/BR-0167 Section 5.2.1**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Are code and documentation inspections and reviews identified, recorded, and under CM Control? NUREG/BR-0167 Section 3.2.3**	
Pass		Comments
Fail		
N/A		

PROJECT TRACKING AND OVERSIGHT		
Criteria Priority: 2	**Is monitoring, assessing, and reporting technical progress performed and actual results and performance tracked against the Software Project Plan? NUREG/BR-0167 Section 5.3**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Is monitoring progress performed on an ongoing basis to maintain communications at all levels of the developer and sponsor organizations? Is there a record of this activity (reviews, reports, meetings, brainstorming sessions) and the information placed under configuration control? NUREG/BR-0167 Section 5.3**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 2	**Are technical progress, costs, critical target computing resources, schedule, and risks tracked quantitatively? NUREG/BR-0167 Section 5.3**	
Pass		Comments
Fail		
N/A		
Criteria Priority:	**Does the PM determine and report schedule, cost status of variances from the baseline plan? (Is there a baseline Plan and is it under CM Control?) NUREG/BR-0167 Section 5.3**	
Pass		Comments
Fail		
N/A		
Criteria 2 Priority:	**Are corrective actions implemented when actual results and performance issues indicate significant deviations between the Software Project Plan and current schedule, including but not limited to adding staff, extending work week, and or changing the skill mix? NUREG/BR-0167 Section 5.3**	
Pass		Comments
Fail		
N/A		

SOFTWARE CONFIGURATION MANAGEMENT		
Criteria Priority: 1	**Does the Configuration Management approach/methodology identify, define and reference procedures used for establishing and maintaining project baselines? NUREG/BR-0167 Sections 2.5, 6.2, 6.4**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Does the Configuration Management approach/methodology identify, define and reference procedures used for establishing and performing change control? NUREG/BR-0167 Section 6**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Does the Configuration Management approach/methodology identify, define and reference procedures used for implementation and release of changes? NUREG/BR-0167 Section 6**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Does the Configuration Management approach/methodology identify, define and reference procedures used for code, access, and media controls? NUREG/BR-0167 Section 6**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Does the Configuration Management approach/methodology identify, define and reference procedures for the use, access, and maintenance of the software development library? NUREG/BR-0167 Section 6**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Are all nonconformance items under CM Control? NUREG/BR-0167 Section 6 and 7**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Are the monthly progress reports under configuration management control? NUREG/BR-0167 Section 6**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Are peer reviews and structured walkthrough documents/completed forms under configuration control? NUREG/BR-0167 Section 3.2.3**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Does the developer follow a written configuration management policy/methodology? NUREG/BR-0167 Section 6.1**	
Pass		Comments

Fail		
N/A		
Criteria Priority: 1	**Are baseline documents for planning, managing and building the system (software) established and controlled (Explicitly identify project baselines for software products (source code, test cases, software specifications (standards & procedures) needed to establish & maintain stability of software activities? NUREG/BR-0167 Section 6.2**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Have a naming / labeling system that: uniquely identifies all project entities (documents, software elements, and test cases), changes by revision or version (and under CM Control), unique identification of configuration/version of revised software for use? NUREG/BR-0167 Section 6.2**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Are baseline documents for planning, managing and building the system (software) established and controlled? NUREG/BR-0167 Section 6.2**	
Pass		Comments
Fail		
N/A		

SOFTWARE REQUIREMENTS **It is assumed that shall and will are requirement identifications whereas should and would are "statements of fact" and not considered "testable" requirements.**		
Criteria Priority: 1	**Does the Requirements Document identify requirements that are uniquely identified, testable, and traceable through the software life cycle?** **NUREG/BR-0167 Section 4.3**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Does the Requirements Document address the functions that the software is to perform and only what is to be performed?** **NUREG/BR-0167 Section 4.3.1, Software Engineering Practices**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Does the Requirements Document address time-related requirements of software operation such as speed, response time, and/or other performance requirements?** **NUREG/BR-0167 Section 4.3.2**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 3	**Does the Requirements Document address constraints imposed on implementation activities, including but not limited to hardware platform and programming language?** **NUREG/BR-0167 Section 4.3.3**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 2	**Does the Requirements Document address attributes of the software, such as portability, access controls, property of an object, element, or file?** **NUREG/BR-0167 Section 4.3.3 – Best Practices**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 2	**Does the Requirements Document identify external interfaces – interactions/communications with people, hardware, and other software? NOTE: Interfaces may be identified in a separate document, e.g., an Interface Requirements Specification.** **NUREG/BR-0167 Section 4.3.3**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Does the Requirements Document identify internal interfaces – interactions/communications which exist between separate software components and provide a programmatic mechanism by which these components can communicate? NOTE: Interfaces may be identified in a separate document, e.g., an Interface Requirements Specification.** **NUREG/BR-0167 Section 2.2, Section 3.2.2.2 – Section 3.2.4.1 -Software Best Practices**	
Pass		Comments
Fail		
N/A		
Criteria	**Does the Requirements Document identify assumptions, constraints, or dependencies**	

Priority: 1	**that the requirements are based upon? NUREG/BR-0167 Section 4.3, Software Best Practices**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Is each requirement uniquely identified and requirements baseline under CM control? NUREG/BR-0167 Section 6.2**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Are the requirements verifiable (clarity increases verifiability)? NOTE: A requirement is verifiable if some method can be devised for objectively demonstrating that the software implements it. NUREG/BR-0167 Section 3.2.1.5**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 2	**Does each statement of a requirement contain one and only one requirement? Are all requirements identified uniquely and unambiguous? (Functional, Performance, Design Constraints, Attribute, Interfaces). Do requirements state WHAT and not HOW they are implemented? Note: Interface requirements may be included in the SRS if not in a separate document. NUREG/BR-0167 Section 3.2.1.5**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Is there a Requirements Traceability Matrix? NUREG/BR-0167 Section 3.2.1.5**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Does the Requirements Traceability Matrix (RTM) provide the preliminary trace of Functional Requirements (e.g., FR-01), Performance Requirements (e.g., PR-01), Design Constraint Requirements (e.g., DCR-01), Attribute Requirements (e.g., AR-01), and Interface Requirements (e.g., IR-01) down to the unit level and do test cases map to requirements? NUREG/BR-0167 Section 3.2.1.5**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Are all requirements testable? (If it is not testable, then it is not a requirement) NUREG/BR-0167 Section 1.7, Table 1-1, Section 2.1, Section 2.5.2, Table 3-1, Section 3.2.2.3**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Is the RTM under Configuration Management and Change Control? NOTE: The RTM is a living document and should be <u>baselined</u> at the end of each life-cycle phase or when changes to requirements occur within a life-cycle phase after it has been baselined. NUREG/BR-0167 Table 1-1, Section 6, Section 6.2**	
Pass		Comments
Fail		
N/A		

Criteria Priority: 2	**Does the SRS identify the purpose and scope? NUREG/BR-0167 Section 2.2, 4.3**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 2	**Does the SRS identify what the products will and will not do? Software Engineering Practices**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 2	**Does the SRS describe the objectives and goals? NUREG/BR-0167 Section 5.2.1**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 2	**Does the SRS describe ant constraints on memory or other system constraints? Software Engineering Practices**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 3	**Does the SRS describe backup and recovery operations, if applicable? Software Engineering Practices**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 2	**Does the SRS describe assumptions? (Assumptions can lead into Risks) Software Engineering Practices**	
Pass		Comments
Fail		
N/A		

SOFTWARE DESIGN and INTERFACE DESIGN		
Criteria Priority: 1	**Does the Software Design Specification (SDS) present the structure of the software such that it can be translated into code? NUREG/BR-0167 Section 4.4**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Does the SDS provide a description of the major elements/components of the software as related to the requirements in the SRS? NUREG/BR-0167 Section 4.4**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Does the SDS provide a technical description in terms of the theoretical basis? NUREG/BR-0167 Section 4.4**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Does the SDS provide a technical description in terms of the mathematical model? NUREG/BR-0167 Section 4.4**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Does the SDS provide a technical description of the data flow(s) and data structure(s)? NUREG/BR-0167 Section 4.4**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Does the SDS provide the defined range of input values? NUREG/BR-0167 Section 3.2.4.1 (boundary conditions)**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Does the SDS provide the defined range of output values? NUREG/BR-0167 Section 3.2.4.1 (boundary conditions)**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Has the "Test Plan" and "Test Suite" for validating the software (by the development team) been addressed? NUREG/BR-0167 Appendix B**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Has the RTM been updated to map the design components back to the defined requirements and are the design components/requirements mapped to test cases? NUREG/BR-0167 Section 4.3**	
Pass		Comments
Fail		
N/A		
Criteria	**Has the acceptance criteria for specifying how to determine the validity of the software**	

Priority: 1	**provided, given the results of the test cases? NUREG/BR-0167 Section 2.6**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Are the test case identifiers unique/unambiguous? NUREG/BR-0167 Section 6.2, 2.6.2**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 3	**Has a data dictionary been developed? Software Engineering Practices**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 2	**If the SRS is found to require an update, has the SRS been updated, information represented correctly, completely, and accurately in the SRS? NUREG/BR-0167 Section 4.3, Section 6**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Have all documents, including revised documents from the Requirements phase, been placed under Configuration Control and were Configuration Control procedures been performed completely and accurately? NUREG/BR-0167 Section 6**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Have Peer Reviews, Software Requirements Reviews, Preliminary Design Reviews, Critical Design Reviews and Qualification Readiness Reviews been performed, with recorded results (usually via checklist or pre-approved form), and placed under configuration control? NOTE: IV&V activities require attendance at all major life-cycle reviews and audits. NUREG/BR-0167 Section 3.1 and 3.2.2, 3.2.3**	
Pass		Comments
Fail		
N/A		

RISK MANAGEMENT		
Criteria Priority: 3	**Is a Risk Management Plan established? NUREG/BR-167, Section 5.8**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 3	**Does the Risk Management Plan identify, assess, document, and rank resources and schedule risks? NUREG/BR-167, Section 5.8.1**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 3	**Has a Risk Mitigation Plan been developed (or incorporated into a Risk management Plan) and is it under CM Control? NUREG/BR-167, Section 5.8.2**	
Pass		Comments
Fail		
N/A		

PROJECT TEST PLAN		
Criteria Priority: 1	**Has a Project Test Plan been initiated? NUREG/BR-0167 Section 4.9.1**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Does the Project Test Plan identify WHAT test activities will be performed? Appendix B, Glossary (Test Plan)**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 3	**Does the Project Test Plan identify the resources, team responsibilities, and techniques to plan, develop, and implement test activities through the life-cycle, and identify testing techniques and test phases? NUREG/BR-0167 Section 5.2.4**	
Pass		Comments
Fail		
N/A		

IMPLEMENTATION / USER DOCUMENTATION		
Criteria Priority: 1	**Have any changes been made as a result of "issues or inconsistencies" discovered during the code development? NUREG/BR-0167 Section 2.4**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Do the code changes (if needed) require modifications to requirements, interfaces, and/or design? NUREG/BR-0167 Section 2.4**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**If changes in requirements, design, or interfaces are made, have the appropriate documents been updated, including the RTM? NUREG/BR-0167 Section 2.4**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**If changes were needed, were the changes identified and reviewed via peer reviews, design reviews, code walkthroughs, etc.? NUREG/BR-0167 Section 3.2**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Were the revised documents and "review notes/checklists" placed under configuration control? (Ensure that the configuration control process follows the Configuration Management Plan procedures/processes). NUREG/BR-0167 Section 6.3**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 2	**Has an installation plan been developed (or in development/DRAFT)? Note: Installation Instructions can also be identified in a User Guide Software Engineering Practices**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 2	**Has a schedule of installation activities been generated? NUREG/BR-0167 Section 5.2 (3)**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 3	**Does the Installation Plan include/address required deliverables to user/installation sites? NUREG/BR-0167 Section 4.9**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Does the Installation Plan identify the qualifications required (equipment and personnel) to perform the installation?**	

	Software Engineering Practices	
Pass		Comments
Fail		
N/A		
Criteria Priority: 2	**Does the Installation Plan provide installation tests and expected results (to ensure the installation was correct)? NUREG/BR-0167 – Throughout the document – References to Acceptance and Qualification Testing**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 3	**Has a training program /Training Plan been developed? NUREG/BR-0167 Section 4.7,**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Have unit tests been developed and performed to verify the input and output for each module? NUREG/BR-0167 Table 1-1 (Unit Testing); IEEE-1008, Software Unit Testing**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Have test cases, scenarios & procedures for new functionality/bug fixes been developed in preparation for in-house tests (including regression tests) for observation by IV&V? NUREG/BR-0167 Section 7.2.2**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Upon completion of code and documentation for this phase, have ALL artifacts (code, code walkthrough sheets, updated documentation, test cases, test results, etc.) placed into CM and ALL information BASELINED? NUREG/BR-0167 Section 6**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 2	**Is the User Manual complete, including: A description of User's interaction with the software, description of required training necessary to use the software, input and output specifications and formats with sample cases, limitations of the software, anticipated errors and user response to errors, error messages with workarounds (when applicable), information about user support? NUREG/BR-0167 Section 4.7**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 2	**Does the User Manual provide instructions on how to install, setup, and access the application? NUREG/BR-0167 Section 2.6**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 3	**Does the User Manual provide a complete, consistent, correct, and adequate coverage of software functionality and is it presented in a "logical" and hierarchical order? NUREG/BR-0167 Section 2.2, Section 4.3**	
Pass		Comments

Fail		
N/A		
Criteria Priority: 3	**Does the User Manual provide screen shots, reports, examples etc. to provide end users' with typical/example outputs (for reference, help, etc.)? NUREG/BR-0167 Section 4.7**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 3	**Does the User Manual provide instructions on accessing on-line help features (including User Support)? NUREG/BR-0167 Section 4.7**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 3	**Has a Programmer's Reference Manual been generated (or included in the User's Guide)? Software Best Practices**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 3	**If a Training Program is required (via SOW or other contractual mechanism), does the training program provide trainees with knowledge and skills to use the software? NUREG/BR-0167 Section 4.7**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Has the RTM been updated to reflect any changes identified during coding and has it been placed under CM Control? NUREG/BR-0167 Section 6**	
Pass		Comments
Fail		
N/A		

INSTALLATION and ACCEPTANCE		
Criteria Priority: 1	**Do all the interface requirements identified in the SRS and RTM have test procedures, etc.?**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Upon completion of the interface tests, has a peer review been performed and a test report created, reviewed, issued, and placed under CM control?**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Is the System Test Plan complete and under CM Control?**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Does the system testing validate ALL requirements in accordance with the System Test Plan?**	
Pass		Comments
Fail		
N/A		
Criteria Priority:	**When errors are discovered during system test, are they reviewed by the development team, SQA, and IV&V?**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 2	**Are the errors assigned a severity level and the necessary actions to mitigate/resolve the error(s) determined? (There must be an audit trail of all tests and their results)**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**If errors are discovered and repaired, are all modules that initiated the error(s) and units/modules with interfaces to the repaired modules retested and comments regarding the correction identified in the source code?**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Are all actions used to identify, record, etc. the error and final outcome of retesting been recorded and placed under CM Control?**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 2	**Did the RTM require an update and if so, did the update affect documentation developed in prior lifecycle phases?**	

Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Where revisions made to these documents, re-baselined, and placed under CM Control?**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 3	**Prior to conducting acceptance testing, has the QA & IV&V representatives been notified?**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 3	**Has QA generated a pre-acceptance checklist?**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Have structured walkthrough of checklist performed prior to acceptance testing?**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 1	**Has the sponsor agreed to the level of rigor for acceptance tests?**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 3	**Has a Maintenance Plan (if applicable) been developed, reviewed, approved, and placed under CM Control?**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 2	**Were there errors, inconsistencies, and/or misinterpretations in the installation instructions and therefore, need modification?**	
Pass		Comments
Fail		
N/A		
Criteria Priority: 2	**Were these changes performed, document(s) updated and placed under CM control?**	
Pass		Comments
Fail		
N/A		